JEPPIAAR

INSTITUTE OF TECHNOLOGY

"Self-Belief | Self Discipline | Self Respect"

QUESTION BANK

Regulation: 2017

Year: I

Semester: 02

Batch: 2019 - 2023

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Vision of the Institution

Jeppiaar Institute of Technology aspires to provide technical education in futuristic technologies with the perspective of innovative, industrial and social application for the betterment of humanity.

Mission of the Institution

• To produce competent and disciplined high-quality professionals with the practical skills necessary to excel as Innovative professionals and entrepreneurs for the benefit of the society.

• To improve the quality of education through excellence in teaching and learning, research, leadership and by Promoting the principles of scientific analysis, and creative thinking.

• To provide excellent infrastructure, serene and stimulating environment that is most conducive to learning.

• To strive for productive partnership between the Industry and the Institute for research and development in the Emerging fields and creating opportunities for employability.

To serve the global community by instilling ethics, values and life skills among the students needed to enrich their lives.

Department Vision

To foster contemporary Skills in the field of Electrical and Electronics Engineering with innovatory Skills, Global Understanding and Nation building for the progress of Humankind.

Department Mission

M1: To Encompass Quality Engineers with skills as persevere to enrich the global technically.

M2: To engage in research activities leading to innovative application of technology with Industrial approach for the benefit of mankind.

M3: To provide quality structure and beneficial learning system.

M4: To enable them as responsible human who value Ethics and environment.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1: To provide students with the fundamental Knowledge, methodologies and use of cutting-edge Technologies.

PEO2: To provide students with an awareness and skills in lifelong learning and self-education.

PEO3: To Cultivate Teamwork, Technical writing and Oral communication skills.

PEO3: To provide students with an appreciation of engineering impact on society and the Professional responsibilities of an engineers.

PROGRAM SPECIFIC OBJECTIVES (PSOs)

PSO 1: Apply the fundamentals of mathematics, Science and Engineering knowledge to identify, formulate, design and investigate complex engineering problems of electric circuits, analog and digital electronics, electrical machines and systems.

PSO 2: Apply appropriate technique and modern Engineering hardware and software tools in power systems to engage in life-long learning and to successfully adapt in multi-disciplinary environments.

PSO 3: Understand the impact of Professional Engineering solutions in societal and environment context, commit to professional ethical and communicate effectively.

BLOOM’S TAXONOMY

Definition: Bloom’s taxonomy is a classification system used to define and distinguish different levels of human cognition like thinking, learning and understanding.

Objectives:

➢ To classify educational learning objectives into levels of complexity and specification. The classification covers the learning objectives in cognitive, affective and sensory domains.

➢ To structure curriculum learning objectives, assessments and activities.

Levels in Bloom’s Taxonomy:

➢ **BTL 1 – Remember** - The learner recalls, restate and remember the learned information.

➢ **BTL 2 – Understand** - The learner embraces the meaning of the information by interpreting and translating what has been learned.

➢ **BTL 3 – Apply -** The learner makes use of the information in a context similar to the one in which it was learned.

➢ **BTL 4 – Analyze -** The learner breaks the learned information into its parts to understand the information better.

➢ **BTL 5 – Evaluate -** The learner makes decisions based on in-depth reflection, criticism and assessment.

➢ **BTL 6 – Create -** The learner creates new ideas and information using what has been previously learned

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HS8251 **L T P C**
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TECHNICAL ENGLISH

Objectives:

The Course prepares second semester engineering and Technology students to:

- Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- Foster their ability to write convincing job applications and effective reports.
- Develop their speaking skills to make technical presentations, participate in group discussions.
- Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialization.

UNIT I INTRODUCTION TECHNICAL ENGLISH 12

Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises- **Speaking** –Asking for and giving directions- **Reading** – reading short technical texts from journals- newspapers- **Writing-** purpose statements – extended definitions – issue- writing instructions – checklists-recommendations-**Vocabulary Development**- technical vocabulary **Language Development** –subject verb agreement - compound words.

UNIT II READING AND STUDY SKILLS 12

Listening- Listening to longer technical talks and completing exercises based on them-**Speaking** – describing a process-**Reading** – reading longer technical texts- identifying the various transitions in a text- paragraphing- **Writing-** interpreting charts, graphs- **Vocabulary Development-**vocabulary used in formal letters/emails and reports**Language Development-** impersonal passive voice, numerical adjectives.

UNIT III TECHNICAL WRITING AND GRAMMAR 12

Listening- Listening to classroom lectures/ talks on engineering/technology -**Speaking** – introduction to technical presentations- **Reading** – longer texts both general and technical, practice in speed reading; **Writing**-Describing a process, use of sequence words- **Vocabulary Development-** sequence words-Misspelled words. **Language Development-** embedded sentences

UNIT IV REPORT WRITING 12

Listening- Listening to documentaries and making notes. **Speaking** – mechanics of presentations-**Reading** – reading for detailed comprehension- **Writing-** email etiquette- job application – cover letter –Résumé preparation(via email and hard copy)- analytical essays and issu based essays-**Vocabulary Development**- finding suitable synonyms-paraphrasing-. **Language Development-** clauses- if conditionals.

UNIT V GROUP DISCUSSION AND JOB APPLICATIONS 12

Listening- TED/Ink talks; **Speaking** –participating in a group discussion -**Reading**– reading and understanding technical articles **Writing**– Writing reports- minutes of a meeting- accident and survey **Vocabulary Development- verbal analogies** Language **Development-** reported speech

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course learners will be able to:

- Read technical texts and write area- specific texts effortlessly.
- Listen and comprehend lectures and talks in their area of specialisation successfully.
- Speak appropriately and effectively in varied formal and informal contexts.
- Write reports and winning job applications.

TEXT BOOKS:

1. Board of editors. **Fluency in English A Course book for Engineering and Technology.** Orient Black swan, Hyderabad: 2016
2. Sudharshana.N.P and Saveetha. C. **English for Technical Communication**. Cambridge University Press: New Delhi, 2016.

REFERENCES

1. Raman, Meenakshi and Sharma, Sangeetha- **Technical Communication Principles and Practice.**Oxford University Press: New Delhi,2014.
2. Kumar, Suresh. E. **Engineering English**. Orient Blackswan: Hyderabad,2015
3. Booth-L. Diana**, Project Work,** Oxford University Press**,** Oxford: 2014.
4. Grussendorf, Marion, **English for Presentations,** Oxford University Press, Oxford: 2007
5. Means, L. Thomas and Elaine Langlois, **English & Communication For Colleges.** Cengage Learning, USA: 2007

Students can be asked to read Tagore, ChetanBhagat and for supplementary reading.

	UNIT 1: Sharing Information Related To Oneself/Family& Friends
	Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises- **Speaking** –Asking for and giving directions- **Reading** – reading short technical texts from journals- newspapers- **Writing-** purpose statements – extended definitions – issue- writing instructions – checklists-recommendations-**Vocabulary Development-** technical vocabulary **Language Development** –subject verb agreement - compound words.
	PART*A
1.	**Technical Vocabulary 2M BTL1** a.contaminated i.makeeasy b. facilitate ii. unclean c.renowned iii.Calculate d.estimate iv.Famous (a.- ii, b- i, c- iv, d- iii) a.narrate i.requirement b.necessity ii.cover c.muffle iii.envious d.jealous iv.Tell (a-iv ,b- i, c- ii, d- iii.) a.identical i.joyous b.illegible ii.complex c.intricate iii.unreadable d.jubilant iv.Alike (a-iv ,b- iii, c- ii, d- i) a.gather i.swoon b.guilty ii.Accumulate c. faint iii.flaw d.defect iv.Ashamed (a-ii ,b- iv, c- i, d- iii.) a.wage i.definitely b.undoubtedly ii.pay c.tolerate iii.Amusement d.recreation iv.Endure(a-ii ,b- i, c- iv, d- iii.) **Match the words inColumnA with theirantonyms inColumnB** A B a. whole i. common b. various ii.harmful c. useful iii. part d. rare iv. Identical(a-iii,b- i, c- ii, d- iv.) a. assist i. detest b. assent ii. Proud c. ashamed iii. hinder d. admire iv. Dissent(a-iii ,b- iv, c- ii, d- i.)

	a. cautious i. welcome b. banish ii. Forgetful c. barren iii. polite d. impudent iv. Fertile(a-iv ,b- i, c- ii, d- iii.) a. moderation i. conceal b. rapid ii. Disapprove c. reveal iii. slow d. recommend iv. Greed(a-iv ,b- iii, c- i, d- ii.)
3.	**Subject-Verb Agreement2M BTL1** **Fill in the blanks with the correct verb that agrees with the subject. [BTL3]** 1. Some of the amazing pictures taken by the contestants ____________ (is/**are)** displayed in the hall. 2. He is one of the successful business men who ______________ (**is**/are) sincere and hard working. 3. The committee ____________ (**have**/has) carefully studied the proposal for providing loan for the needy. 4. The official United Nations website for Peacekeeping_____________ a. (Contain/**contains)** information on operations around the world. 5. Twenty five kilometers ____________ (**is**/are) a long distance to run every day. 6. The number of unemployed citizens _______________ (**are**/is) more in developing counties. 7. There ____________ (are/**is**) several reasons for implementing the new policy 8. The boy who won the two medals___________________ (are/**is**) a friend of mine 9. The person who is responsible for planning and implementing aims and objectives of the company __________________ (**is**/are) the manager. 10. According to a recent survey, the number of people who opt for purchasing Online. II. **Choose the correct form of the verb that agrees with the subject.** (is, are, am, was, were, has, have) 1. The price of the jeans **is** reasonable. 2. The books borrowed from the library **are** on my desk.

	3. Bread and butter **is** our daily food. 4. The quality of the candies **was/is** poor. 5. There **were** ten books in the box. 6. Many a student **were** made the same mistakes. 7. One of the books **has** been missing. 8. Fifty miles is a long distance. 9. The poor **are** suffering. 10. One of the most intelligent students **is** John. 11. She and her friends **are** at the fair. 12. The book or the pen **is** in the drawer. 13. The boy or his friends **run** (run) everyday. 14. His friends or the boy **runs** (run) everyday. 15. The committee **decides** (decide) how to proceed.
4	**IV Compound Words 2M BTL1** **Expand the following Compound Noun** 1.Animalbehavior-Thebehavior of ananimal 2.Aluminumextraction -Theextraction of aluminum 3. Batteryvalve -Valve of abattery 4. Boathouse - Boatused as a house 5. Butterflyvalve -Valve whichis in the shapeof a butterfly 6. Calculator memory - Memoryof a calculator 7. Carbondioxide - Dioxideof carbon

8. Coalgas - Gas obtained fromcoal

9. Computer language - Language used for computer operation

10. Computer manual - Manualfor operatingthecomputer

11. Computertechnology -Technology usedin computers

12. Datainput - Inputof data

13. Disk drive - Driveof a disk

14. Flood damage - Damage caused byflood

15. Gear mechanism - Mechanismfor operating thegear

Compound Nouns:

1. Inflation rate Rate of inflation
2. Information centre Centre for giving information
3. Box top Top of the box
4. Carbon steel rod Rod made of carbon steel
5. Component location Location of the component
6. Computer fuel testing Testing the fuel using the computer
7. Cylinder walls Walls of the cylinder
8. Drinking water Water for drinking purpose
9. Engine repair Repair works related to engine
10. Engine housing Housing to protect the engine
11. Ferrous oxide Oxide of ferrous
12. Gear pump Pump operates by means of gears
13. Language code Code which specifies the language
14. Pare industry Industry manufacturing paper
15. Passenger ship Ship for the purpose of carrying passengers
16. Radar scan Scan performed by radar
17. Turret lathe Lathe having a turret
18. Toy factory Factory for making toys

5	**Purpose Statement:2M BTL2** 1. A barometer **is used to** measure atmospheric pressure. 2. Another way of expressing purpose is shown in the following sentences. 3. **The purpose of** painting iron parts **is to protect** them from rust. 4. **The purpose of** a thermostat **is to maintain** temperature at a constant level 5. **The aim of the** test **is to predict** the rise in pressure. ***Use the hint below to make sentences expressing purpose(Use any of the patterns illustrated above)*** 1. **An aerial: receives broadcast signals**. An aerial is used to receive broadcast Signals **2. A feasibility report: makes recommendations on the practicality of a project** A feasibility reports is used to make recommendation on the practicality of a project 3. **Sending telegrams: ensures that the message reaches the address quickly**. Sending telegrams are used to ensure that the messages reached the address quikly. **4. An experiment: demonstrates a principle** An experiment is used to demonstrate a principle **5. Constructing a bypass road: reduces traffic congestion in a city.** Constructing a bye-pass road is used to reduce traffic congestion in a city. **6. A sheet of carbon paper: makes copies while one types.** A sheet of carbon paper is used for making copies while one types **7. A litmus test: identifies acids an alkalies.** A litmus test is used for identifying alkalies. **8. A flow chart: represents a process as a series of steps.** A flowchart is used for representing a process as a series of step. **9. A calculator: calculates with numbers** A calculator is used for calculating numbers **10. A life Boat: rescues people who are in danger at Sea** ALife boat is used for rescuing people who are in danger at Sea **11. A Compass: Finds direction** A compass is used for finding direction 12. **Robot: do Heavy and dangerous jobs**. Robot is used for doing heavy and dangerous jobs. **13. A Satellite: Collects information for communication** A satellite is used for collecting information for communication.

	14. A glass bottle : stores acid. A Glass bottles is used for storing acids. **15. A moderator: slows down the speed of free neutrons** A moderator is used to slow down the speed of free neutron.
	Extended Definition:2M BTL2 Example : 1 ***(Sentence definition)*** We can define an **SUV** as a vehicle which is usually driven on rough terrain. ***(Illustration)***SUV is an acronym which stands for **s**ports **u**tility **v**ehicle. ***(Description)***The engines of the SUV vehicles supply power to all four wheels, so they are better for cruising sand dunes. ***(Classification)*** SUV vehicles vary in size; some of them can seat 5 passengers, while others can seat 7 passengers. ***(causal analysis)*** SUV vehicles are quite common in Saudi Arabia due to the low cost of petrol and their fantastic performance in the desert. Example : 2 ***(Sentence definition)*****The periodic table** can be defined as an organized array of all the chemical elements in order of the atomic weight. ***(Illustration)***The elements show a periodic recurrence of certain properties. ***(Chronology)***It was first discovered in 1869 by Dmitry I. Mendeleyev. ***(Description)***Those in the same column or group of the table as usually arranged have similar properties. ***(Chronology)***In the 20th century, when the structure of atoms was understood, the table was seen to precisely reflect increasing order of atomic number. ***(Description)*** Members of the same group in the table have the same number of electrons in the outermost shells of their atoms and form bonds of the same type. Example : 3 ***(Sentence definition)***Glass is a hard transparent material which is used to make windows, bottles and other objects. ***(Etymology)*** glass is an English word and was first used before the twelfth century. ***(Chronology)***Glass has been used as a decorative object indoors since ancient times. Today, glass is widely used in the construction and telecommunication sectors. ***(Description)*** It is made by cooling molten ingredients such as silica sand with sufficient rapidity to prevent the formation of visible crystals. Example :4 Appropriate technology is that technology which is affordable within the resources available, is culturally acceptable and is environmentally harmless.
	PART *B
1.	**INSTRUCTION16M BTL3** **1. To control noise pollution: (May/Jun 2011)**

1. Prohibit noise producing vehicles
2. Avoid using high sounding crackers
3. Don’t use loud speakers near schools and hospitals.
4. Use a silencer to absorb noise of the vehicle
5. Establish industrial units away from residential areas
6. Plant trees to absorb noise.
7. Live away from the airport
8. Avoid using high sounding pressure horns
9. Be aware of noise pollution

2. ***To reduce unemployment problem:***

1. Ensure employment to at least one person in a family
2. Increase the number of technical training institutes
3. Give loans to encourage self-employment
4. Give subsidies to encourage the entrepreneurs
5. Employ unemployed graduates for additional government duties like election duties
6. Encourage private sectors to generate employment.
7. Establish more industries in rural areas
8. Train the graduates to start small scale industries

3. ***To keep the college campus clean:***

1. Keep the environment always clean
2. Plant trees in the college campus
3. Conduct awareness classes to make the students to realise the importance of cleanliness.
4. Place more number of dust bins in the campus
5. Impose punishment on these who violate the rules
6. Maintain the vehicles properly
7. Avoid cutting of trees in the name of development
8. Always maintain strict discipline

4. To maintain a computer / a laptop in good working condition (Jan 2006; May/Jun 2007; Jan 2010)

1. Don’t touch the cables
2. Avoid touching the open sockets
3. Avoid touching the monitor
4. Always shut down the system when it is not in use.
5. Shut down the system properly.
6. Don’t misplace and replace the equipment.
7. Don’t handle the equipment roughly.
8. Don’t keep your legs on the UPS.

5. ***Safety instructions in a chemical engineering lab (Jan 2010)***

1. Don’t work in the laboratory barefoot.
2. Don’t handle the instruments roughly.
3. Don’t wear gold ornaments.
4. Keep all the doors and windows open.

5. Keep your working place neat and tidy.
6. Don’t wear loose clothes.
7. Wear apron and gloves while handling the chemicals.
8. Handle all glassware items carefully.
9. Don’t drink or eat in lab.
10. Don’t taste or sniff chemicals.
11. Identify the safety equipment.
12. Read the chemical safety instructions.

6. ***Instructions must be followed by all pedestrians (Road safety)***

1. Walk on the pavement always.
2. Use subways; though it is long.
3. Avoid crossing suddenly.
4. Don’t walk on road dividers.
5. Don’t ignore traffic signals.
6. Cross the road only at zebra crossing.
7. Make sure that the road is clear, before crossing the road.
8. Avoid using the cell phone while walking along the road.
9. Be familiar with the traffic rules.

7. ***Instructions to save petrol (May / Jun 2012)***

1. Keep the engine in good condition
2. Fit the vehicle with an engine that gives high mileage.
3. Don’t keep the engine running while the vehicle is not in motion.
4. Inflate the tyres at an optimum level of air pressure.
5. Use the correct engine oil for the proper functioning.
6. Service the vehicle regularly.
7. Avoid clutch driving.
8. Avoid frequent change of gear to save petrol.

8. ***Instructions to maintain two/four wheelers in good working condition (May/Jun 2005/2006)***

1. Always maintain the air pressure in the tyre to the recommended levels.
2. Drive only at optimum level of speed depending on the roads.
3. Clean the air-filter regularly since clogged air filters increase fuel consumption.
4. Do not idle the engine not more than 30 seconds to warm it up when starting.
5. Avoid sudden breaks and frequent gear changing.
6. Handle the gear, brake and clutch softly.
7. Service the vehicles regularly for better performance as well as fuel saving
8. Always maintain the lubricants at the required level to ensure running of the engine.
9. Avoid pressure horns.
10. Avoid faulty silencers.

9. ***Write eight instructions to preserve environment. (May 2004/2005)***

1. Reduce the usage of plastic
2. Use the eco-friendly papers made out of alternative sources.

	3. Use rechargeable batteries for frequent usages to reduce the number of dead batteries 4. Use natural fertilizers and pesticides for agriculture. 5. Don't cut trees. 6. Plant native and adaptive trees. 7. Turn light off at office as well as at home whenever it is not needed. 8. Treat sewage and industrial effluents before discharging into the water bodies. 9. Conduct awareness programmes for preserving the environment. 10. Encourage rain water harvesting. **10. *Instructions for giving first aid to a victim of a road accident*** 1. Check the victim thoroughly whether the victim is breathing or not 2. Take the victim to the side of the road. 3. Try to stop the bleeding by applying pressure on the bleeding side. 4. Give artificial respiration if the victim is struggling for breathe. 5. Don't crowd round the victim and prevent airflow. 6. Handle the victim carefully. 7. Examine the head, eyes, nose, ears, chest, and abdomen to detect wounds. 8. Ask the victim to move the toes, and fingers to check their movements or function. 9. Take the victim to the hospital
9	**II Checklists 16M BTL2** **1.Checklist for an Interview** **Yes No** 1. Have I taken the ticket? ☐ ☐ 2. Have I taken the certificates? ☐ ☐ 3. Have I taken the call letter? ☐ ☐ 4. Have I taken money? ☐ ☐ 5. Have I arranged the certificates properly? ☐ ☐ 6. Have I taken my project report? ☐ ☐ 7. Have I taken my friends' contact number? ☐ ☐ 8. Have I packed the formal wear? ☐ ☐ **2. Checklist for an Industrial Visit** **Yes No** 1. Have I taken the ticket? ☐ ☐ 2. Have I taken money? ☐ ☐ 3. Have I taken the conformation letter? ☐ ☐ 4. Have I taken all the documents? ☐ ☐ 5. Have I taken my Identity Card? ☐ ☐

6. Have I taken my cell phone and charger? ☐ ☐
7. Have I packed the formal wear? ☐ ☐
8. Have I taken my friends' contact number ☐ ☐

3. Checklist for conducting a two day conference Yes No

1. Have I sent the invitations? ☐ ☐
2. Have I invited the chief guest? ☐ ☐
3. Have I invited the Principal and staffs? ☐ ☐
4. Have I prepared the welcome address? ☐ ☐
5. Have I prepared the agenda? ☐ ☐
6. Have I arranged the conference hall? ☐ ☐
7. Have I arranged enough refreshments? ☐ ☐
8. Have I made the stage ready? ☐ ☐

4. Checklist for organizing a Paper Presentation session Yes No

1. Have I arranged the venue? ☐ ☐
2. Have I finalized the papers? ☐ ☐
3. Have I fixed the judges? ☐ ☐
4. Have I arranged for refreshment and lunch for delegates? ☐ ☐
5. Have I purchased the kits? ☐ ☐
6. Have I prepared the certificates? ☐ ☐
7. Have I prepared the agenda? ☐ ☐
8. Have I prepared the welcome address? ☐ ☐
9. Have I informed the participants? ☐ ☐

5. Checklist for one day Training Programme in Delhi Yes No

1. Have I reserved the tickets? ☐ ☐
2. Have I taken the money? ☐ ☐
3. Have I taken the dresses? ☐ ☐
4. Have I taken the Laptop? ☐ ☐
5. Have I taken the documents? ☐ ☐
6. Have I taken the notes for training? ☐ ☐
7. Have I taken the confirmation letter? ☐ ☐
8. Have I taken the venue address? ☐ ☐

Recommendations 16M BTL3

I. Recommendations to preserve our water resources:-

1. It is recommended to observe rain water harvesting by all.
2. It is important to control sand smuggling.
3. It is necessary to construct rain water storage tanks.
4. It is recommended to encourage the people for afforestation.
5. It is essential to conduct awareness programmes.
6. It is advised to plant native and adaptive plants.
7. It is recommended to water gardens and fields early in the morning to avoid evaporation.
8. It is highly recommended to recycle the water.

II. RECOMMENDATIONS

1. Write a set of eight recommendations to preserve our water resources.

Ans: Title : Recommendations to preserve our water resources:-

9. It is recommended to observe rain water harvesting by all.
10. It is important to control sand smuggling.
11. It is necessary to construct rain water storage tanks.
12. It is recommended to encourage the people for a forestation.
13. It is essential to conduct awareness programmes.
14. It is advised to plant native and adaptive plants.
15. It is recommended to water gardens and fields early in the morning to avoid evaporation.
16. It is highly recommended to recycle the water.

2. Power cut is a major problem in southern parts of India and it badly affects small scale industries. Write a set of eight recommendations to ensure continuous power supply to the small scale industries. **(AUC DEC-JAN 2016)**

Ans: Title : Recommendation to ensure continuous power supply to small scale industries

1. It is recommended that UPS may be installed.
2. It is recommended to create general awareness among public and educate them to save energy resources.
3. It is recommended to introduce feasible solar systems as an alternative source of energy.
4. It is recommended to take adequate measures to implement plants to generate power through pedal power.
5. It is recommended to learn to conserve electricity.
6. It is recommended to use net metering technology which is eco-friendly and economical.
7. It is recommended to tap more alternative sources.
8. It is recommended to generate bio mass power.

3.Write a set of eight recommendations to reduce unemployment problem.

Ans: Title : Eight recommendations to reduce unemployment problem.

1. It is recommended that the government can increase the number of technical training institutes.
2. It is recommended to give loans to encourage self-employment.
3. It is recommended to introduce entrepreneurship courses in the school and college curriculum.
4. It is recommended to give subsidies to encourage the entrepreneurs.
5. It is recommended to start more industries in rural and suburban areas.
6. It is recommended to encourage private sectors to generate employment.
7. It is recommended that the government can ensure employment to at least one person in a family.
8. It is recommended to employ the unemployed graduates for additional government duties like elections duties etc.

4.There are many social problems such as poverty and hunger in India, which need to be solved. Write a set of eight recommendations to solve these problems.
Ans : Title : Eight recommendations to solve social problems such as poverty and hunger in India

1. It is recommended that the government can measures to increase exports.
2. It is recommended to concentrate on the development of the small scale industries.
3. It is recommended to provide loans for small business in rural areas.
4. It is recommended to create livelihood opportunities for the poor and the needy by the state government.
5. It is recommended that the charitable institutions can support the government to eradicate hunger and poverty.
6. It is recommended that the multinational companies can be encouraged to start business for the increase of job opportunities and income.
7. It is recommended that the children suffering from malnutrition can be adopted by social organizations.
8. It is recommended to take necessary steps to monitor whether the deserving people are benefitted of the services provided for them.

5.Write a set of eight Recommendations to make environment clean and less polluted.

Ans : Title : Eight recommendations to make environment clean and less polluted.

1. It is recommended to use renewable resources which can be replenished.
2. It is recommended to start replenish forests for producing raw materials and increasing the area under forest.
3. It is recommended to ban killing or poaching of animals.

4. It is recommended to preserve natural habitat for animals.
5. It is recommended to monitor and survey the maintenance of greenery around by the concerned officials.
6. It is recommended to encourage growing of more trees.
7. It is recommended to stop using plastics and burning of it.
8. It is recommended to use eco-friendly appliances and gadgets.

6.Write a set of eight recommendations for selecting a proper fuel.

Ans : Title : Eight recommendations for selecting a proper fuel.

1. It is recommended to select such a fuel which can burn easily.
2. It is recommended to select the fuel which produces sufficient energy.
3. It is recommended to select the fuel which is available in plenty.
4. It is recommended to select the fuel for which the storage is easy and safe.
5. It is recommended to select such a fuel which does not pollute the air on burning.
6. It is recommended to select a fuel which does not leave behind much residue.
7. It is recommended to select a fuel for which the transportation is easy and safe.
8. It is recommended to select an inexpensive fuel.

UNIT II READING AND STUDY SKILLS 12

Listening- Listening to longer technical talks and completing exercises based on them-**Speaking** – describing a process-**Reading** – reading longer technical texts- identifying the various transitions in a text- paragraphing-**Writing**- interpreting charts, graphs- **Vocabulary Development-**vocabulary used in formal letters/emails and reports**Language Development-** impersonal passive voice, numerical adjectives.

PART*A

Impersonal Passive 2M BTL1

1. **The company had manufactured high powered engines.**

   High powered Engines had been manufactured

	2. One can easily solve this problem. This problem can be solved **3. Users have maintained this pump themselves.** This pump has been maintained **4. The men are laying roads in many parts of the city.** Roads have been laid in many parts of the city. **5. The Cricket Board men offer to give 1400 transmitters.** 1400 transmitters have been offered. 6. **They will start production on the new type of reactor soon**. New type of reactors production with soon be started. **7. We pass an electric current across the electrodes** An electric current will be passed across the electrode. **8. The workers are repairing the bridge.** The bridge is being repaired . 9. **We can cast this metal into very complicated shapes**. This metal can been casted into very complicated shapes
	Write the sentence into Passive form 2M BTL1 1. I can answer the question- The question can be answered by me. 2. She would carry the box. – The box would be carried by her. 3. You should open the window – The window should be opened by you. 4. We might play cards. - Cards might be played by us. 5. You ought to wash the car. – The car ought to be washed by you. 6. He must fill in the form. – The form must be filled in by him. 7. They need not buy bread. – Bread need not be bought by them. 8. He could not read the sentence. - The sentence could not be read by him.

9. Will the teacher test our English? - will our English be tested by the teacher?
10. Could jenny lock the door? – Could the door be locked by jenny?

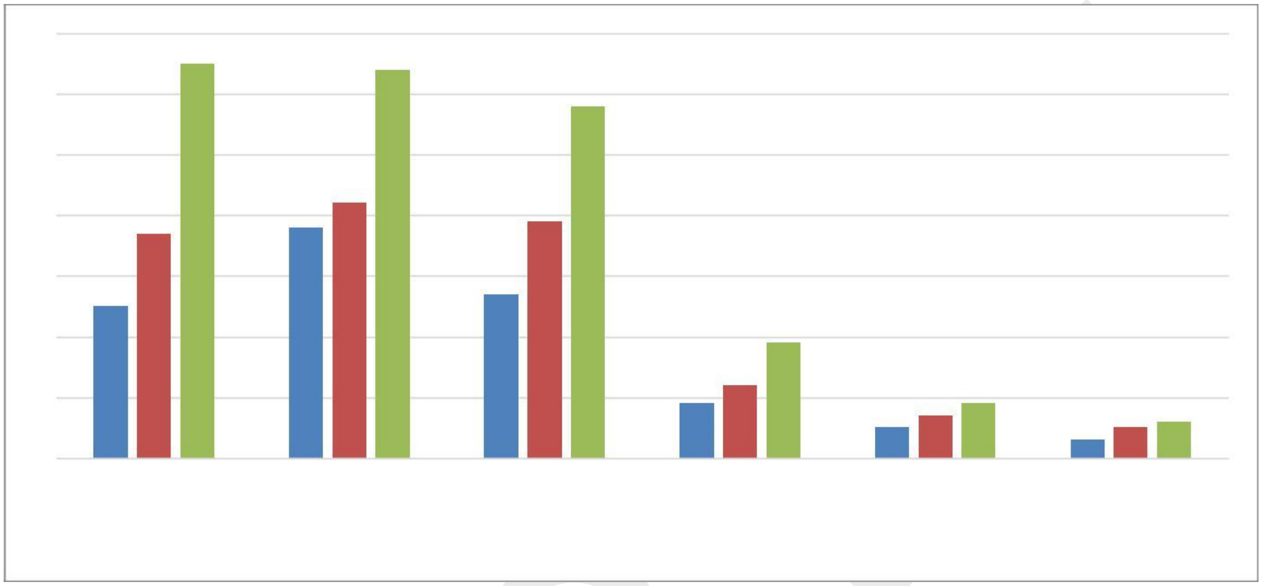
II Numerical Adjectives. 2M BTL1

Rewrite the following as numerical expressions

1. A flask with a capacity of 10 liters- A 10 liter flask
2. A journey of 20 miles- A 20 mile journey
3. A squad of 1000 men- A 1000 men squad
4. A civilization which in 2000 years old- 2000 year old civilization
5. A project of 10 years- A 10 year project.
6. A match lasting five days- A five day Lasting match.
7. At intervals of 10 minutes- A 10 minute interval
8. A DC supply of 240 volts- A 240 volt DC supply
9. A lamp of a power of 60 watts- A 60watts power Lamp.
10. An investment of Rs. 3, 50,000- A 3, 50,000 investment.
11. A book in six volume – a 6 volume book
12. An engine with 100 cc power – a 100 cc power engine
13. A walk of five kilometers – A 5 kilometer walk
14. A drive for 8 hours – A 8 hour drive
15. A committee of 6 members – A 6 member committee
16. A rope with a length of 5 meters – A 5 meter rope
17. A can with a capacity of 25 liters – A 25 liter tank
18. A training programme for 25 days - A 25 day training programme
19. An auditorium of 1000 capacity – A 1000 capacity auditorium
20. A pen drive with 16 GB storage. – A 16 GB pen drive
21. A lab with 30 computers – A 30 computer lab
22. The pipe is 3 feet long – A 3 foot pipe
23. A colony with 200 houses – A 200 house colony
24. A road measuring 100 feet – A 100 foot road
25. A video running for 40 seconds– A 40 second video.

	Interpreting charts and graphs.16M BTL-4 **Look at the following information and graph about the pass percentage of the students in the plus two examination. Analyze the given data and write a short review of the pass percentage of the student in a paragraph of not more than 120 words:** About John Higher Secondary School This school was started in a village to cater to the needs of the poor people. In 2011, many experienced teachers left the school . After reviewing the low performance of the students in the plus-two examination, the infrastructure facilities were improved and teachers were given adequate training to teach their subjects effectively Besides, the management has started giving special incentives to the teachers who give cent percent results in the examination.

II. The following chart represents the arrival of tourists from different regions. Analyze the given data and write a paragraph:

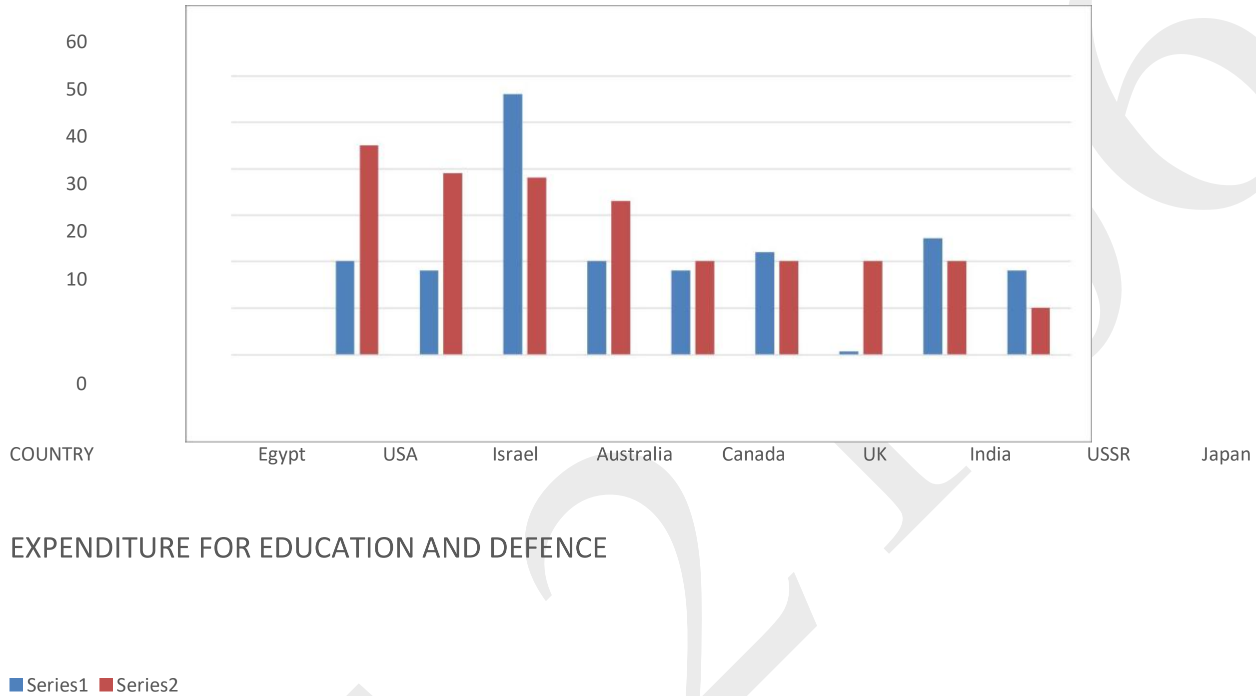


□		2012	2.5	3.8	2.7	0.9	0.5	0.3
□		2013	3.7	4.2	3.9	1.2	0.7	0.5
□		2014	6.5	6.4	5.8	1.9	0.9	0.6

X- axis – Tourists arrival from region of origin

Y-axis- Tourists who visited India in millions

Look at the following bar chart which describes the expenditure on education and defense of the total expenditure incurred by different countries. Write a paragraph presenting the information contain in it using expressions of comparison.



Unit-III

TECHNICAL WRITING AND GRAMMAR 12

Listening- Listening to classroom lectures/ talks on engineering/technology -**Speaking** – introduction to techni presentations- **Reading** – longer texts both general and technical, practice in speed reading; **Writing**-Describing process, use of sequence words- **Vocabulary Development-** sequence words- Misspelled words. **Langua Development-** embedded sentences

	PART*A
1.	I**. Sequence Words** 2M BTL1 **Fill in the blanks with appropriate sequence words**. 1. Half an hour passed, but there was no sign of bus. -------------, we decided to go home. 2. The documentswill bescrutinized by the bank officials. ------------ they will sanction the loan. 3. To reduce weight, -----------create rigorous exercise. 4. When air conditioner is used reversed. ---------reverse mechanism, hot air is propelled towar indoor and coolair towards outdoor. 5. How can you lay two audio tracks --------- in Windows Live Movie Maker? 6. ---------- you buy a new lay out you should decide on what you really need. 7. In the process of making chocolates, firstly the cocoa beans are finely ground. ----------,it is mixe with cocoa butter and sugar and then smoothened. 8. Cheese is a concentrated source of many of the nutrients in milk. -----the usual cheese making process, the amount of various nutrients retained depends on the (a)Then press the "Send" option. (b) Next type your message and add "smileys" or images, if you want. (c) To begin with, go to "messages" (d) After that "Add" the contact number of the recipient. (a) Then, the tea water is filtered and is served with sugar cubes. (b) First, water is taken in a kettle and is allowed to boil. (c) After that, the decoction is allowed to settle down. (d) Next, tea leaves are added to the boiling water. (a) First, the clothes and soap powder are put in the respective slots. (b) Water is drawn repeatedly as per requirement to wash and rinse. (c) When the start button is pressed the machine starts to draw water from the tap and the operation starts after the tank is full. (d) Finally clothes are dried.

(a) The image is charged with electricity.

(b) The document for taking photocopy is kept in the machine.

(c) Then, an ink powder called toner sticks to the charged parts of the image and is transferred on to paper.

(d) Secondly, a bright light reflects the image of the document on to a plate or drum.

(a) After you enter your information, click "Sign Up"

(b) On here you will need to enter your information.

(c) Towards the right side of the screen you will see a "sign up" screen.

(d) Go to www.facebook.com.

3. **Misspelt word 2M BTL3**

Correct the spelling of the misspelt words.

1. Occasion- occasion
2. Committee- Committee.
3. Tomorrow- tomorrow
4. Charactar- Character.
5. Greatful- Grateful
6. Neessary- Necessary
7. Sychology- Psychology
8. recieve -receive
9. leisue- Leisure.
10. Apetite- Appetite
11. Careulness-Carefulness
12. Exceled- Exceled
13. Prohiited- Prohibited
14. Groupped- grouped
15. Earnned– Earned.
16. Transmited- Transmitted.
17. Aloted– Allotted
18. Refering- Referring
19. Traping– Trapping
20. Stimuleted- Stimulated

4. **Embedded Sentences [BTL2]**

Complete the following sentences with appropriate Embedded Clauses

	1. The music, ________________________ gave me a headache. 2. The old lady, _______________________ waited for a taxi. 3. The bus, _________________________ sped down the street. 4. The loaf of bread, ___________________ was spoilt. 5. The singer, _________________________ was the chief guest on our College Day. 6. The child, ___________________________ was crying in the super market 7. The airplane,____________________ finally landed at the airport 8. The elderly man, _________struggled to cross the road 9. The astronaut,_______________ was received warmly at the airport. 10. The boy, ____________________________ is from our college
	PART *B
	I. Describing a process 16 BMTL-4 1. Describe the process involved in opening a bank account. 2. Describe the process of mending the puncture tube of your two-wheeler. 3. Describe the process involved in making a cup of tea. 4. Describe the process involved in sending an email attachment to your friend. 5. Describe the process involved in becoming successful orator. 6. Describe the process involved in m king a glass of lemon juice **Process:** Explanation in a paragraph or two- Presentation -4 Content – 8 Sentence format- 4
	Reading Comprehension (a) Read the following passage carefully and answer the questions below it: The latest buzz word in the continuing debate about the environment is “sustainable management”- that means using plants and animals for our benefit, but ensuring that enough is left alive to guarantee the survival of the species. This sounds good, but is it practical in reality? In spite of years of scientific research, no one really kno s how much damage human beings are doing to their environment. We know that, they are responsible for many problems ranging from global arming to ozone depletion, and there is no doubt that they have a devastating effect on animal and plant life on earth. About 50,000 animal and plant species are becoming extinct every year. All species depend on some way on one another for survival. If you remove one species from this complex web of inter relationships, e have little idea of the repercussions on the ecosystem in

general. What makes things more complicated is the fact that unlike global warming - which, if the political will was there, could be reduced by cutting gas emissions -preserving bio diversity-remains a difficult dilemma. There are also questions about whether sustainable management is practical as far as protecting areas of great bio-diversi y such as the world's tropical forest are concerned. In theory, the principle should be to cut a number of trees, but not so many as to completely destroy the forest.

Sustainable Management of trees requires controls on the numb r of trees which are cut down as well as investment replacing them. Most tropical forests exist in poor countries which depend on logging to makemoney. Foremost loggers in these countries, making money means cutting down as ma y trees as

Possible in the shortest time. The price of trees remains stable, varyi g by 4-5% annually, whereas theinterestratesinmostdevelopingcountriescancreate 15% or more in returns. It therefore makes little sense, and certainly no economic sense, to

Delay tree felling. One solution could be to insist that wood comes from sustainable managed forests. In theory, consumers would buy only this wood and force logging companies to go “green” or else out of business. Unfortunately, unrestricted logging is more profitable than wood from sustainable managed forests which would cost unto 5 times more to control. Consumers would not be prepared to pay the extra sum just to protect the environment. The sad fact is that there is no practical solution to protect vegetation and wildlife of tropical forests in the future. It is estimated that these forests contain anything form 50-90 percent of all animal and plant species of the earth. In one study of kilometer square area of rain forest in Peru, for example, scientists counted 1300 species of butterfly and 600 species of birds. In the entire USA only 400 species of butterfly and 700 species of birds have been recorded. Sustainable Management represents gigantic experiment. If this doesn't work, we cant move to another planet to escape. It is a case of one planet, one experiment!

Complete the following statements choosing from one of the given alternatives

(i) The extent of the damage being inflicted on our environment.......

1. can be estimated by years of scientific research.

	2. is being calculated by scientific research exactly. 3. is impossible to assess despite years of scientific research. 4. is thanks to years of scientific research, on the decrease. (ii) The term "Sustainable Management" means using plants and animals for our own benefit, but....... 1. assuring none are left alive to guarantee the survival of the species. 2. making sure that enough are left alive to guarantee survival of the species.
	The newlyweds agreed to be very ***<u>frugal</u>*** in their shopping because they wanted to save enough money to buy a house. **1. economical** 2. wasteful 3. interested
	Although Alex usually looks ***<u>unkempt,</u>*** he had a very neat appearance at his job interview. 1. orderly 2. handsome **3. messy**
5.	Paragraph writing 16M BTL3
	1. Write two paragraphs comparing the newspaper and the television as media of mass communication. Each of the paragraphs should not exceed 200 words. 2. Write two paragraphs, one describing the benefits of technology the other describing the drawbacks of technology. Each paragraph should not exceed 200 words. 3. Imagine yourself to be in the year 2050 and you are in your early 70's. The fuel position is very bad. Describe how life was fifty years ago when fuel was easily available. Write this in about 170-200 words. 4. Describe in about 170-200 words the utility, function with advantages and disadvantages of a washing machine. 5. Imagine yourself to be living in the year 2050 and you are in your early 70's. The fuel

	position is very bad. Describe how life was fifty years ago when fuel was easily available. Write this for about 170- 200 words. 6. Write two paragraphs, one describing the advantages and disadvantages of Mass media. 7. Write a paragraph on Population explosion. 8. Write a paragraph on Information Technology in India. Content- 6 Sentence completion 2 Grammar/ spellings 4 Presentation 4 a. The importance of social media in today's world. b. Donate blood and save lives. c. Student's approach to library in the current scenario. d. Going away from nature is happening naturally- Discuss. e. Outdoor and Indoor Games.
6.	
	1. Objective/ Multiple type: 1 per question 2. True or False: 1m/ Question 3. Short note: 2m if any

UNIT IV	**REPORT WRITING** 12
Listening- Listening to documentaries and making notes. **Speaking** – mechanics of presentations- **Reading** – reading for detailed comprehension- **Writing**- email etiquette- job application – cover letter –Résumé preparation(via email and hard copy)- analytical essays and issue based essays-**Vocabulary Development**- finding suitable synonyms-paraphrasing-. **Language Development-** clauses- if conditionals.	
Sr.No	**PART* A**
1	**Clauses- If conditional**2M BTL2

	1. If he communicates effectively, **he will get selected**. 2. If he had performed well, **he would have passed** 3. If I got up earlier, **I would catch the train**. 4. If the new material had come in time, **we would have transferred the goods**. 5. If you planned well, **you could finish the project**. 6. If I had a net connection, **I would send the email**. 7. If I were you, **I would enjoy the trip**. 8. If you went for a walk every day, **you would maintain your health well**. 9. If people follow traffic rules, **the city can avoid traffic congestion**. 10. If you practised hard, you **would pass** (pass) the exam easily. 11. If the traffic rules are followed, there ---------**will be**----------- (be) very less accidents. 12. If I drop this, it _______**will explode**_________ (explode). 13. If I had seen you, I __**would have invited**_ (invite) you. 14. If the child goes out in the rain, it ______ (catch) cold.**Ans : will catch** 15. If I were an astronaut, I ______ (visit) the space station.**Ans : would visit** 16. If the boys do not practice, they ______ (lose) in the finals.**Ans : will lose** 17. If there had been good rains, the corps ______ (grow) well.**Ans : would have grown** 18. If I get a new job, ______________________ **Ans : If I get a new job, I will take my family to a holy place for prayer.** 19. __________________ , she would have completed her journey. **Ans : If Rita has joined the crew, she would have completed her journey.**
3	**PART* B**
	Ten Quick Tips on Writing a Professional Email 16M BTL3 1. Always fill in the subject line with a topic that means something to your reader. Not "Decals" or "Important!" but "Deadline for New Parking Decals." 2. Put your main point in the opening sentence. Most readers won't stick around for a surprise ending. 3. Never begin a message with a vague "This." ("This needs to be done by 5:00.") Always specify what you're writing about. 4. Don't use ALL CAPITALS (no shouting!), or all lower-case letters either (unless you're e. e. cummings). 5. As a general rule, PLZ avoid textspeak (abbreviations and acronyms): *you* may be ROFLOL (rolling on the floor laughing out loud), but your reader may be left wondering WUWT (what's up with that). 6. Be brief *and* polite. If your message runs longer than two or three short paragraphs, consider (a) reducing the message, or (b) providing an attachment. But in any case, don't snap, growl, or bark. 7. Remember to say "please" and "thank you." And mean it. "Thank you for understanding why afternoon breaks have been eliminated" is prissy and petty. It's *not* polite. 8. Add a signature block with appropriate contact information (in most cases, your name, business address, and phone number, along with a legal disclaimer if required by your

company). Do you *need* to clutter the signature block with a clever quotation and artwork? Probably not.

9. Edit and proofread before hitting "send." You may think you're too busy to sweat the small stuff, but unfortunately your reader may think you're a careless dolt.
10. Finally, reply promptly to serious messages. If you need more than 24 hours to collect information or make a decision, send a brief response explaining the delay.

1. **Start with a salutation**

Your email should open by addressing the person you're writing to. Sure, you can get away with leaving out the salutation when you're dashing off an email to your friend, but business-like messages should begin with:

- *Dear Mr Jones,* or *Dear Professor Smith,* (for someone you don't know well, especially if they're a superior)
- *Dear Joe,* or *Dear Mandy,* (if you have a working relationship with the person)

It's fine to use "Hi Joe", "Hello Joe" or just the name followed by a comma ("Joe,") if you know the person well – writing "Dear Joe" to one of your team-mates will look odd!

2. Write in short paragraphs

Get straight to the point – don't waste time waffling. Split your email into two to four short paragraphs, each one dealing with a single idea. Consider using bullet-points for extra clarity, perhaps if you are:

- Listing several questions for the recipient to answer
- Suggesting a number of alternative options
- Explaining the steps that you'll be carrying out

Put a double line break, rather than an indent (tab), between paragraphs.

3. Stick to one topic

If you need to write to someone about several different issues (for example, if you're giving your boss an update on Project X, asking him for a review meeting to discuss a payrise, and telling him that you've got a doctor's appointment on Friday), then don't put them all in the same email. It's hard for people to keep track of different email threads and conversations if topics are jumbled up.

4. Use capitals appropriately

Emails should follow the same rules of punctuation as other writing. Capitals are often misused. In particular, you should:

- Never write a whole sentence (or worse, a whole email) in capitals
- Always capitalise "I" and the first letter of proper nouns (names)
- Capitaliseacronymns*(USA, BBC, RSPCA)*
- Always start sentences with a capital letter.

This makes your email easier to read: try retyping one of the emails you've received in ALL CAPS or all lower case, and see how much harder it is to follow!

5. Sign off the email

For short internal company emails, you can get away with just putting a double space after your last paragraph then typing your name. If you're writing a more formal email, though, it's essential to close it appropriately.

- Use *Yours sincerely,* (when you know the name of your addressee) and *Yours faithfully,* (when you've addressed it to "Dear Sir/Madam") for very formal emails such as job applications.

	• Use *Best regards,* or *Kind regards,* in most other situations. • Even when writing to people you know well, it's polite to sign off with something such as "All the best," "Take care," or "Have a nice day," before typing your name. **6. Use a sensible email signature** Hopefully this is common sense – but don't cram your email signature with quotes from your favourite TV show, motivational speaker or witty friend. Do include your name, email address, telephone number and postal address (where appropriate) – obviously, your company may have some guidelines on these. It makes it easy for your correspondents to find your contact details: they don't need to root through for the first message you sent them, but can just look in the footer of any of your emails. Putting it all together Compare the following two job applications. The content of the emails are identical – but who would you give the job to? *i've attached my resume i would be grateful if you could read it and get back to me at your earliest convenience. i have all the experience you are looking for – i've worked in a customer-facing environment for three years, i am competent with ms office and i enjoy working as part of a team. thanks for your time* Or *Dear Sir/Madam,* *I've attached my resume. I would be grateful if you could read it and get back to me at your earliest convenience. I have all the experience you are looking for:* • *I've worked in a customer-facing environment for three years* • *I am competent with MS office* • *I enjoy working as part of a team* *Thanks for your time.* *Yours faithfully,* *Joe Bloggs* **E-Mail Writing**16MBTL3 1. Send an email to your friend sharing your experience about your College. 2. Send an email to your mother sharing your first weekend experience with your friends. 3. Imagine yourself to be the Team Leader in TCS and send a mail to your team appreciating successful completion of the Project. **Scheme of Marks :** **Format** – 6M **Key Words** – 4M **Presentation-** 2M **Content** **-** 4M
4.	**Letter of Job Application** 16MBTL 4 From

M. Raja,
45, Ragav Apartments,
Rajaji Nagar,
Chennai – 73

To

The Executive Director,
Godrej Company Limited,
455, Greams Road,
Chennai – 600 035

Sir,

Sub: Application for the post of Production Manager – Reg.

Ref: With reference to the advertisement in "The Hindu" dated 18.02.2012

I am a Mechanical Engineering graduate. I have been working in "Prakash Furniture Ltd" as Production Manager for three years. I have managerial skills and inter-personal skills. I have enclosed my resume for your perusal.

Expecting your intimation letter

Thanking you,

Yours faithfully,

(M.Raja)

RESUME

M. Raja
45, Ragav Apartments,
Rajaji Nagar, Mobile: 9944488077
Chennai – 73 E-mail:
raja.m@gmail.com

OBJECTIVE

To pursue a challenging position in whatever I do and to contribute towards the growth of the organization.

EDUCATIONAL QUALIFICATION:

B.E	-	Mechanical Engineering – 90% ABC Engineering College, Chennai – 13 May 2008
HSC	-	Govt. Higher Secondary School - 85% Chennai – 73 May 2004

EXPERIENCE:

July 2009 – till date	-	Production Manager, Prakash Furniture Ltd, Trichy.
July 2008 – July 2009	-	Junior Production Manager, Rahul Furniture Ltd., Rasipuram, Namakkal. (Dt)

ACHIEVEMENTS:

- University gold medalist at UG Level.
- Won the best project award.
- Presented many papers in conferences and seminars.

RESPONSIBILITIES:

- Sports secretary in 12^{th}std.
- Class representative from 10^{th}std.
- Captain of college football team.

REFERENCES:

1. Dr. V. M. Periasamy,
   Principal,
   BSA Engineering College,
   Nagarkoil.

2. Mr. Ashok Kumar,
   The General Manager,
   Prakash Furniture Ltd.,
   Trichy.

PERSONAL PROFILE:

Name	: M. Raja
Date of Birth	: 12.08.1987
Age	: 29
Gender	: Male
Father's Name	: R. Manikkavasagam
Nationality	: Indian
Religion	: Hindu
Languages Known	: Tamil, English.

DECLARATION

I hereby solemnly declare that all the information made is true to the best of my knowledge and belief.

Thank you,

Yours faithfully,
Place: Chennai
Date: 20.02.12
(M. Raja)

1 .Write a letter of application for the post of an Assistant Engineer to The Human Resource Manager, HRC Communication Ltd., 390, Lake View Road, Santhome, Chennai – 600 004. Attach a separate resume with your letter. **(AU, May/June 2014)**

2.Write a letter of application for the post of Team Leader to The Human Resource Manager, Mayday Motors Ltd., 327, G.T. Naidu Road, Coimbatore. Write the details of your qualification and experience within the application letter. **(AU, May/June 2014)**

3.Write a letter of application for the post of a Junior Engineer to the Divisional Engineer, Mambalam Division, Chennai Telephones, 786, Anna Salai, Chennai – 35. Attach a suitable bio-data with the application.

4. The Chief Engineer of Public Works Department, Kancheepuram, wants to make you a member of the technical committee on Road Developments in Kancheepuram. Write a letter of thanks to him and also enclose your resume with your letter. **(AU, May/June 2013)**

5. Draft a letter of Job Application in response to the following advertisement. Candidates holding a bachelor's / master's degree with a background in engineering are required for work on company for the post of engineer. Applicants' must also possess excellent writing skills and the ability to effectively and CV to Mr.Promod Tiwari, Human Resources Dept., Exclusive software, North Main Street, Chennai – 67. **(AU, May/June2012)**

6.You have come across the following advertisement in the newspaper on 12th June 2014. Write a letter of application and detailed CV to one of the posts selected:

A leading private sector company in India needs the following engineers for the various projects in India **(AU, May/June2015)**

1. CIVIL/MECHANICAL ENGINEERS
2. ELECTRICAL / MANUFACTURING ENGINEERS
3. CHEMICAL ENGINEERS
4. COMPUTER SCIENCE ENGINEERS

1 to 3 years of experience
Should be able to work in a team
Good communication skills

Apply to
The Managing Director,
L and T Ltd.,
Bangalore – 5
Email ID : landtl4@gmail.com

7. You come across the following advertisement

(AU, May/June2015)

Company Name : Way Staffing Location : Thane, Pune Nationality : India Salary : 6.50 – 8.50 lacs Experience : 3 – 8 yrs Education : B.E. / B.Tech • IT • Manufacturing/ Engineering / R&D Posted on : 30th August 2018	Role : Technical Support Engineer Civil Engineer Electrical Engineer Industry : Engineering, Procurement Construction

8. Prepare a detailed CV to be uploaded in the website.

8. Read the following advertisement published in "The Times of India" and write a letter of application. Enclose your resume with the letter of application. **(AU, Nov/Dec, 2014)**

	Job : Software Engineer Company : Kamal Info Systems Private Limited Location: Hyderabad Eligibility : B.E. / B.Tech Skills: Capital Markets, Object Oriented Project Planning, Design Patterns in Java, C++ Send your application with the resume to: The HR Manager, Kamal Info Systems Private Limited, No.14, Greams Road, Hyderabad – 500 002. **Scheme of Marks :** **Format** – 6M **Presentation-** 4M **Content -** 6M
	UNIT V **GROUP DISCUSSION AND JOB APPLICATIONS 12**
	Listening- TED/Ink talks; **Speaking** –participating in a group discussion -**Reading**– reading and understanding technical articles **Writing**– Writing reports- minutes of a meeting- accident and survey **Vocabulary Development- verbal analogies Language Development-** reported speech
	PART* A
1	**Reported Speech**2M BTL 3 1. "I will work hard to get first class" said Lazar (D.S.) Lazar said he would work hard to get first class. (I.S.) 2. "You can do this work" said Nelson to Johnsi (D.S.) Nelson told Johnsi that he could do that work. (I.S.) 3. He says, "I am glad to be here this evening"(D.S.) He says that he is glad to be there that evening. (I.S.) 4. "I'm going to the library now" said David (D.S.) David said that he was going to the library then. (I.S.)

	5. “Don‘t talk in the class” said the teacher to the boys. (D.S.) The teacher advised the boys not to talk in the class. (I.S.) 6. “Please give me something to eat. I am hungry” the old man said to them. (D.S.) The old man requested them to give him something to eat and said that he was hungry (I.S.) 7. Mohan said to Stalin, “Why did you not attend the meeting yesterday”? (D.S.) Mohan asked Stalin why he had not attended the meeting the day before. (I.S.) 8. “How often do you go to the theatre?” said David to John. (D.S.) David asked John how often he went to the theatre. (I.S.) 9. Alas! I have broken my brother’s watch” said he. He exclaimed sorrowfully that he had broken his brother’s watch. (I.S.) 10. “How beautiful the flower is!” said Kumar. (D.S.) Kumar exclaimed joyfully that the flower was very beautiful. (I.S.) 11. “Won’t you help me to caary this box?” said I to my friend. (D.S.) I asked my friend if he would not help me to carry that box. (I.S.) 12. Mohan said to Stalin, “Why did not you attend the meeting yesterday”? (D.S.) Mohan asked Stalin why he had not attended the meeting the day before. (I.S.) 13. “How often do you go to the theatre?” said David to John. (D.S.) David asked John how often he went to the theatre. (I.S.) 14. Mohamed said to Sultan, “Do you like mangoes?” (D.S.) Mohamed asked Sultan if he liked mangoes. (I.S.) **15. The teacher has said to the pupils, “Sea-water is different from the river water.”.** The teacher has told the pupils that sea-water is different from river water. **16. David answered, “The Mines are under the ground”.** David answered that the Mines are under the ground. **17. John said to his brother, “The U.N.O. is a world organization”.** John told his brother that the U.N.O. is a world organisaiton. **18. The Science teacher told the class, “Ice floats on water.”.** The Science teacher told the class that ice floats on water. **19. “I don’t know the way. Do you?” he asked.**

	He said that he didn't know the way and asked her if she did. **20. She said, "Oh! It's a snake. Don't go near it, children."** She exclaimed with disgust that it was a snake and told the children not to go near it. **21. "I the floods get any worse we must leave the house", he said.** (must = will have to) He said that if the floods got any worse they would have to leave the house. **22. "I have just received a letter", he said; "I must go home at once".** He said that he had justreceived a letter and would have to go home at once. **23.** Angel said, "I brought a pen yesterday". (D.S) Angel said that she had bought a pen the day before. (I.S) **24. John said, "I am going to church". (D.S)** John said that he was going to church. (I.S) **25. He said, "I have been reading a novel". (D.S)** He said that he had been reading a novel. (I.S)
2	**Verbal Analogies: 2M BTL3** 1. **Sing : hum :: Talk : ______** a. murmur b. whisper c. **mumble** d. shout 2. **Liquid : liter** a**. Weight : kilogram** b. Land : seismometer c. Bushel : corn d. Fame : television 3. **If Dawn: Morning, then Dusk: ________** a. **Evening :** b. Night : c. Darkness :d. Fog **4. If Parson lives in Parsonage, then Pioneer lives in _________** a. Cottage : b.**Wagon :** c.Monastery : d. Barracks **5. If Ravens: Croak, then Ducks: __________** a. Talk :b. Gobble : c. Squeak : d. **Quack** **6. If Bears: Growl, then Asses: ______** a. Growl :b. **Bray** : c. Purr : d. Bleat **7. ______ : trail:: grain : grail** a. train : b. path : c. wheat : d. holy **8. particular : fussy :: ______ : subservient** a. meek : b. above : c. cranky : d. uptight **9. ______ : horse :: board : train** a. stable : b. shoe : c. ride : d. mount

	10. tureen : ______ ::goblet : wine **a.** napkin : b. soup : c. spoon : d. pilsner **11. son : nuclear :: ______ : extended** a. father : b. mother : c. cousin : d. daughters **12. coif : hair :: ______ : musical** a. Shower : b. close : c. praise : d. score **13. feta : Greek :: provolone : ______** a. salad : b. Swiss : c. blue : d. Italian **14. moccasin : snake :: ______ : shoe** a. alligator : b. w**aders** : c. asp : d. loafer **15. ______ : zenith :: fear : composure** a. apex : b. **heaven :** c. heights : d. nadir **16. pill : bore :: core : ______** a. **center** : b. mug : c. bar : d. placebo **17. pilfer : steal :: ______ : equip** a. return : b. damage : c. exercise : d. furnish 18. **native : aboriginal :: naïve : ______** a. learned : b. **arid** : c. unsophisticated : d. tribe **19. junket : ______ :: junk : trash** a. trounce : b. trip : c. refuse : d. trinket **20. _____ : festive :: funeral : somber** a. tension : b. soiree : c. eulogy : d. **sari** **21. fetish : fixation :: slight : ______** a. flirt : b. sloth : c. insult : d. confuse **22. hovel : dirty :: hub : ______** a. unseen : b. prideful : c. **busy** : d. shove **23. bog : ______ :: slumber : sleep** a. dream : b. **foray** : c. marsh : d. night **24. ______: segue :: throng : mass** a. **subway :** b. church : c. transition : d. line
	PART * B
3.	**Minutes of a Meeting 16M BTL 3** **1.** Write the minutes of the meeting of organizing a cultural event in the college. Discuss about the budget, responsibilities for organizing functions, Programme, guests and honor, food, stage decoration, logistics, food, publicity. As the secretary, write the minutes of meeting. **2.** Write Minutes of meeting for the class committee meeting held on 19th January 2019. **3.** Write Minutes of meeting for the research meeting over the project with the panel members held on 20th January 2019. **4.** Write Minutes of meeting for the celebration of College day on 24th of march 2018. **5.** Write Minutes of meeting for the meeting between the officer in the Environment

	Pollution Authority and the Transport Department authority regarding air pollution. **Scheme of Marks :** **Format** – 6M **Presentation-** 4M **Content** **-** 6M
4.	**Report Writing 16M BTL 4** 1. You are working as a Technical Manager in a Software Company, Hidalco Inc. There was a fire accident in your warehouse which resulted in the damage of goods stored there. Your MD asks you to investigate the cause of the accident and send a report. (2018) 2. Your college administration wants to find what students feel about your college's environment and facilities. As student advisor you have been asked to conduct a survey among students about college infrastructure and environment. Conduct a survey on these topics and submit a report to your Dean.(2018) 3. A company is planning to set up a small shoe unit in a small village 20km from Ranipet. You are asked to prepare a suitable report about the feasibility of starting the factory. Mention the availability of raw materials and labour in your area. 4. Write a survey report on the reading habits of engineering students for submission to your college principal. Also give a set of recommendations for enhancing the reading habits of technical students. 5. You are the Works Manager in Industrial Gases Limited where LPG Cylinders are filled for utilization by the consumers. Write a report about an accident that happened in the LPG section in which three workers were seriously injured. **Scheme of Marks :** **Format** – 6M **Presentation-** 4M **Content** **-** 6M formal report may include the following points 1. Title Page 2. Executive Summary 3. Abstract 4. Objective 5. Technical details 6. Cost estimation 7. Management Plan 8. Conclusion 9. Recommendations Title Page Imagine that you are going to start a language lab in your Institution. Write a detailed proposal about the need for establishing the lab to the General Manager.

	A PROPOSAL TO ESTABLISH THE LANGUAGE LAB SUBMITTED TO Mr. R. Ravichandran The General Manager ABC Group of Institutions Chennai-28 SUBMITTED BY Mr. G. Sathiaraj Department of English ABC Engineering College Chennai- 28 DATE 10th April 2013 A. Executive Summary

1. Project Title : Establishing Computer Assisted Language Lab
2. Name & Designation of the Department : Mr. G. Sathiaraj., Asst. Prof
   Department of English
   ABC Engineering College
   Chennai- 28
3. Duration of the Project : 3 Months
4. Amount Required : 20 lakhs

B. Abstract

Communication skills become inevitable in today's survival. Communication skill is expected by every IT firms. Everyone must have a good proficiency in English Language.

To meet these expectations, it is proposed to establish a computer assisted language lab in our institution. So, the student could have been provided an independent learning opportunity and acquire the language proficiency.

C. Objective

To establish Computer Assisted language lab to improve and impart the language proficiency of the learning community.

D. Technical plan

It is planned to install 60 students systems with one Teacher control server. 15 different softwares for practice.

E. Cost Estimation

Product	Cost per Unit	Required Unit	Total Cost	Remarks
P-IV computer with 360 GB HD	35000	1	35000	
P-IV computer with 180 GB HD	30000	60	1800000	
Head Phones with Mike	500	61	30500	
Language Learning Softwares	15	1 each	300000	
Split A/C 1.5 ton	25000	2	50000	

Total 1946000

F. Management Plan

1. The lab may be taken care by Department of English
2. Lab hours may be included in the Regular Time Table
3. One Technical Assistant may be appointed to assist.
4. One staff may be given in-charge.

G. Recommendations

So, It is recommended to establish a Computer Assisted Language Lab at our institution.

SYLLABUS

MA8251 ` ENGINEERING MATHEMATICS – II L T P C
3 1 0 4

OBJECTIVES:

- To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.
- To acquaint the student with the concepts of vector calculus, needed for problems in all engineering disciplines.
- To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, in application areas such as heat conduction, elasticity, fluid dynamics and flow the of electric current.
- To make the student appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

UNIT I MATRICES 9+3

Eigenvalues and Eigenvectors of a real matrix - Characteristic equation - Properties of eigenvalues and eigenvectors - Statement and applications of Cayley-Hamilton Theorem - Diagonalization of matrices - Reduction of a quadratic form to canonical form by orthogonal transformation –Nature of quadratic forms.

UNIT II VECTOR CALCULUS 9+3

Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields –Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem(excluding proofs) – Simple applications involving cubes and rectangular parallelopipeds.

UNIT III ANALYTIC FUNCTIONS 9+3

Functions of a complex variable – Analytic functions: Necessary conditions – Cauchy-Riemann equations and sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping: $w = z+k$, kz, $1/z$, z^2, e^z and bilinear transformation.

UNIT IV COMPLEX INTEGRATION 9+3

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor's and Laurent's series expansions – Singular points – Residues –

Cauchy's residue theorem – Evaluation of real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis).

UNIT V LAPLACE TRANSFORM 9+3

Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms of unit step function and impulse functions – Transform of periodic functions. Inverse Laplace transform -Statement of Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Eighth Edition, Laxmi Publications Pvt Ltd.,(2011).

2. Grewal. B.S, "Higher Engineering Mathematics", 41 st Edition, Khanna Publications, Delhi, (2011).

REFERENCES:

1. Dass, H.K., and Er. RajnishVerma," Higher Engineering Mathematics", S. Chand Private Ltd., (2011)

2. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, (2012).

3. Peter V. O'Neil," Advanced Engineering Mathematics", 7th Edition, Cengage learning, (2012).

4. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, (2008).

TABLE OF CONTENT

Subject Code: MA8251 **Year/Semester:** I /II
Subject Name: MATHEMATICS-II **Subject Handler:**

	UNIT-I MATRICES	
	Eigen values and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigen values and Eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.	
Q.No.	**PART-A**	
1	**State Cayley Hamilton theorem and give its two uses.** **(NOV/DEC 2015)(MAY/JUNE 2012)**BTL1 Every square matrix satisfies its own characteristic equation. It is used to calculate i. The positive integral powers ii. The inverse of a square matrix.	
2	**If λ_1, λ_2, …λ_n are Eigen values of a matrix A then show that** $\frac{1}{\lambda_1}, \frac{1}{\lambda_2}, \ldots \frac{1}{\lambda_n}$ **are Eigen values of A^{-1}.**BTL2 If λ_i and X_i are corresponding Eigen value and Eigen vector of A where i=1,2...,n. $AX_i =_i X_i A^{-1}(AX_i) = A^{-1}(\lambda_i X_i)$ $\Rightarrow IX_i = \lambda_i A^{-1} X_i$ $\Rightarrow X_i = \lambda_i A^{-1} X_i$ $\Rightarrow A^{-1} Xi = 1/\lambda_i X_i$ $\Rightarrow A^{-1} = 1/\lambda_i$ $\therefore 1/\lambda_i$ is an Eigen values of A^{-1}	
3	**If $\lambda_1, \lambda_2, \ldots \lambda n$ are Eigen values of an n x n matrix A then show that λ_1^3, $\lambda_2^3 \ldots$ λ_n^3 are Eigen values of A^3.**BTL2 Let λ be Eigen value of A and let X be Eigen vector of A. $\therefore$ AX = λ X $A^2X = A\lambda X = \lambda (AX) = \lambda (\lambda X) = \lambda^2 X$	

	$\therefore A^2 = \lambda$ Similarly, $A^3X = \lambda^3X \Rightarrow A^3 = \lambda^3$ $\therefore \lambda^3$ is an Eigen value of A^3.	
4	**If λ is the eigenvalue of the matrix *A*, then prove that λ^2 is the eigenvalue of A^2.**(APR/MAY 2019) Let λ be Eigen value of A and let X be Eigen vector of A. $\therefore \quad AX = \lambda X$ $A^2X = A\lambda X = \lambda (AX) = \lambda (\lambda X) = \lambda^2 X$ $\therefore A^2 = \lambda$.	
5	**Two Eigen values of A=**$\begin{pmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{pmatrix}$ **are equal and are** $\frac{1}{5}$ **times to the third. Find them.** **(NOV/DEC 2014)**BTL1 Let $\lambda_1, \lambda_2, \lambda_3$ be Eigen values of A. Given $\lambda_1 = \lambda_2 = \frac{1}{5}\lambda_3$ We know sum of Eigen values = sum of diagonal elements $\lambda_1 + \lambda_2 + \lambda_3 = 7$ $\frac{1}{5}\lambda_3 + \frac{1}{5}\lambda_3 + \lambda_3 = 7$ $\frac{7}{5}\lambda_3 = 7$ $\therefore \lambda_3 = 5$ $\therefore \lambda_1 = \lambda_2 = 1$.	
5	**Find the Eigen values of A^2 given A=**$\begin{pmatrix} 1 & 2 & 3 \\ 0 & 2 & -7 \\ 0 & 0 & 3 \end{pmatrix}$**.Also find A^3, A^{-1}, $2A^2$.**BTL1 We know the Eigen values of a triangular matrix are just the diagonal elements. Here given matrix is a upper triangular matrix $\therefore$ Eigen values of A are 1,2,3. We know that "if $\lambda_1, \lambda_2, \ldots\lambda_n$ are Eigen values of a matrix A,then $\lambda_1^m, \lambda_2^m, \ldots \lambda_n^m$ are Eigen values of A^m." $\therefore$ Eigen values of A^2 are 1,4,9. $\therefore$ Eigen values of A^3 are 1,8,27. We know that if $\lambda_1, \lambda_2, \ldots\lambda_n$ are Eigen	

	values of A then k $\lambda_1, k\lambda_2, \ldots k\lambda_n$ are Eigen values of KA $\therefore$ Eigen values of $2A^2$ are 2,8,18	
6	**If A is an orthogonal matrix Show that A^{-1} is also orthogonal.** BTL2 Let A be orthogonal matrix i.e. $A^T = A^{-1}$ Let $A^T = A^{-1} = B$ $B^T = (A^{-1})^T = (A^T)^{-1} = B^{-1}$ Therefore B is orthogonal. i.e. A^{-1} is an orthogonal matrix.	
7	**Prove that the product of 2 orthogonal matrices is an orthogonal matrix.**BTL5 Let A be an n^{th} order orthogonal matrix. $\therefore \quad AA' = A'A = I$ Let B be an n^{th} order orthogonal matrix. $BB' = B'B = I$ Now $(AB)(AB)' = AB\,B'A'$ $= AIA'$ $= AA'$ $= I$ Now $(AB)'(AB) = B'A'AB$ $= B'IB$ $= B'B$ $= I$ Since $(AB)(AB)' = (AB)'(AB) = I$. AB is orthogonal matrix.	
8	**If 1 and 2 are Eigen values of a 2 x2 matrix A, what are the Eigen values of A^2 and A^{-1}.**BTL1 Eigen values of A^2 are 1 and 4 Eigen values of A^{-1} are 1 and $\frac{1}{2}$.	
9	**If 2, 3 are the Eigen value of $A = \begin{pmatrix} 2 & 0 & 1 \\ 0 & 2 & 0 \\ b & 0 & 2 \end{pmatrix}$ then find the value of b?** **(NOV/DEC 2013)**BTL1 Given Eigen values are $\lambda_1 = 2, \lambda_3 = 3$ Sum of the Eigen values = Sum of the main diagonal elements	

	$\lambda_1+\lambda_2+\lambda_3=6$ $2+3+\lambda_3=6$ $5+\lambda_3=6$ $\lambda_3=1$ Product of the Eigen value $=\lvert A\rvert$ $(2)(3)(1)=8-2b$ $6=8-2b$ $b=1$	
10	**If the sum of two Eigen values and trace of a 3 x 3 matrix A are equal, find the value of |A|.**BTL1 Let $\lambda_1,\lambda_2,\lambda_3$ be the Eigen values of A. Then we have $\lambda_1+\lambda_2$ = trace of A $\Rightarrow\lambda_1+\lambda_2=\lambda_1+\lambda_2+\lambda_3\Rightarrow\lambda_3=0$. Hence |A| = product of Eigen values = $\lambda_1\lambda_2\lambda_3=0$	
11	**For a given matrix A of order 3, |A| = 32 and two of its Eigen values are 8 and 2. Find the sum of the Eigen values.** BTL1 Given Eigen value be $\lambda_1=8,\lambda_2=2$. Then (8)(2)(λ_3) = |A| = 32 $\Rightarrow\lambda_3$ = 2 Let the third Eigen value be λ_3 = 2 Hence the sum of the Eigen values = $\lambda_1+\lambda_2+\lambda_3=8+2+2=12$	
12	**Find the sum and product of the Eigen values of the square matrix** $A=\begin{pmatrix}8&1&6\\3&5&7\\4&9&2\end{pmatrix}$**.** **(NOV/DEC 2010)**BTL1 Sum of the Eigen values = sum of the main diagonal elements = 8+5+2=15 Product of the Eigen values = $\lvert A\rvert=8(10-63)-1(6-28)+6(27-20)=-360$	
13	**Find the sum of the Eigen values of 2A if** $A=\begin{pmatrix}8&-6&2\\-6&7&-4\\2&-4&3\end{pmatrix}$. BTL1 If λ_1, λ_2, λ_3 are the Eigen values of A, then $\lambda_1+\lambda_2+\lambda_3=18$. We know that $2\lambda_1$, $2\lambda_2$, $2\lambda_3$ are the Eigen values of 2A. Therefore the sum of Eigen values of 2A = $2(\lambda_1+\lambda_2+\lambda_3)=2(18)=36$	

14	**If the Eigen value of A are 3x3 are 2,3 and 1, then find the Eigen values of adjA. (NOV/DEC 2003)**BTL1 The Eigen values of are 2,3,1 The Eigen value of A^{-1} are $\frac{1}{2},\frac{1}{3},1$ The product of Eigen values are $(2)(3)(1)=\|A\|$ $\therefore \|A\|=6$ We know that $A^{-1}=\frac{1}{\|A\|}adjA$ $adjA=\|A\|A^{-1}$ The Eigen value of adjA are $(6)\left(\frac{1}{2}\right),(6)\left(\frac{1}{3}\right),(6)1$ $\Rightarrow 3,2,6$	
	If the eigenvalue of the matrix *A* of the order 3x3 are 2, 3 and 1, then find the determinant of *A*. (APR/ MAY 2019) The Eigen values of are 2,3,1 The product of Eigen values are $(2)(3)(1)=\|A\|$ $\therefore \|A\|=6$.	
15	**Find the sum of the squares of the Eigen values of** $A=\begin{pmatrix}3&1&4\\0&2&6\\0&0&5\end{pmatrix}$**.** **(NOV/DEC 2016)**BTL1 A is a triangular matrix. Therefore the Eigen values of A are 3, 2 and 5. The sum of squares of the Eigen values of $A^2 = 3^2 + 2^2 + 5^2 = 9 + 4 + 25 = 38$	
16	**Find the Eigen values of 2A – I, given** $A=\begin{pmatrix}-4&1\\3&-2\end{pmatrix}$**.** BTL1 $2\boldsymbol{A}-\boldsymbol{I}=\begin{pmatrix}-8&2\\6&-4\end{pmatrix}-\begin{pmatrix}1&0\\0&1\end{pmatrix}=\begin{pmatrix}-9&2\\6&-5\end{pmatrix}$ The Characteristic equation of 2A - I is given by	

	$$\left\|2\boldsymbol{A}-\boldsymbol{I}-\lambda \boldsymbol{I}\right\|=0 \Rightarrow \begin{vmatrix} -9-\lambda & 2 \\ 6 & -5-\lambda \end{vmatrix}=0$$ $\Rightarrow \lambda^2+14\lambda+33=(\lambda+11)(\lambda+3)=0$ $\Rightarrow \lambda=-3,-11$	
17	**Prove that A and A^T have the same Eigen values.** BTL5 $\|\boldsymbol{A}^T-\lambda\boldsymbol{I}\|=\|\boldsymbol{A}^T-(\lambda\boldsymbol{I})^T\|=\|(\boldsymbol{A}-\lambda\boldsymbol{I})^T\|=\|\boldsymbol{A}-\lambda\boldsymbol{I}\|$. $\Rightarrow$A and A^T have the same characteristic equation and hence they have the same Eigen values.	
18	**Prove that Similar matrices have the same characteristic roots.** BTL5 LetA and Bbe two similar matrices, then there exists a matrix P such that $B = P^{-1}AP$. Hence $\|\boldsymbol{B}-\lambda\boldsymbol{I}\|=\|\boldsymbol{P}^{-1}\boldsymbol{AP}-\boldsymbol{P}^{-1}\lambda\boldsymbol{IP}\|=\|\boldsymbol{P}^{-1}\|\|\boldsymbol{A}-\lambda\boldsymbol{I}\|\|\boldsymbol{P}\|=\|\boldsymbol{A}-\lambda\boldsymbol{I}\|\|\boldsymbol{PP}^{-1}\|$ $=\|\boldsymbol{A}-\lambda\boldsymbol{I}\|$ i.e., A and B have the same characteristic equation. Therefore, they have the same Characteristic roots.	
19	**Is the matrix** $B=\begin{pmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta` & 0 \\ 0 & 0 & 1 \end{pmatrix}$ **orthogonal? Justify.** BTL5 $$\mathbf{BB^T}=\begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}=\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}=\mathbf{I}$$ Similarly, $B^TB = I$. Hence B is orthogonal.	
20	**Use Cayley-Hamilton theorem to find** A^4-$4A^3$-$5A^2$+A+2I **where** $A=\begin{pmatrix} 1 & 2 \\ 4 & 3 \end{pmatrix}$.BTL3 $$\|\mathbf{A}-\lambda\boldsymbol{I}\|=0 \Rightarrow \begin{vmatrix} 1-\lambda & 2 \\ 4 & 3-\lambda \end{vmatrix}=0 \Rightarrow \lambda^2-4\lambda-5=0 \Rightarrow \boldsymbol{A}^2-4\boldsymbol{A}-5\boldsymbol{I}=0$$ **(**By Cayley-Hamilton Theorem) $\Rightarrow \boldsymbol{A}^2(\boldsymbol{A}^2-4\boldsymbol{A}-5\boldsymbol{I})=0 \Rightarrow \boldsymbol{A}^4-4\boldsymbol{A}^3-5\boldsymbol{A}^2=0$ $\Rightarrow A^4-4A^3-5A^2+A+2I=0+A+2I=\begin{bmatrix} 1 & 2 \\ 4 & 3 \end{bmatrix}+\begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}=\begin{bmatrix} 3 & 2 \\ 4 & 5 \end{bmatrix}$.	
21	**Can** $A=\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ **be diagonalised? Why?(MAY/JUNE 2016)** BTL1 Yes. Even if the Eigen values of A are equal, namely 1, 1, it is possible to find two linearly	

	independent Eigen vectors corresponding to the Eigen value 1.	
22	**Find the matrix of the quadratic from** $2x^2+2y^2+3z^2+2xy-4xz-4yz$. BTL1 The required matrix $A=\begin{bmatrix} coeff\ x^2 & \frac{1}{2}coeff\ \ xy & \frac{1}{2}coeff\ \ xz \\ \frac{1}{2}coeff\ \ yx & coeff\ \ y^2 & \frac{1}{2}coeff\ \ yz \\ \frac{1}{2}coeff\ \ zx & \frac{1}{2}coeff\ \ zy & coeff\ \ z^2 \end{bmatrix}$ $A=\begin{pmatrix} 2 & 1 & -2 \\ 1 & 2 & -2 \\ -2 & -2 & 3 \end{pmatrix}$	
23	**Find the nature of the quadratic form** $x_1^2+2x_2^2+x_3^2-2x_1x_2+2x_2x_3$ **.(MAY/JUNE 2010)**BTL1 $A=\begin{bmatrix} coeffx_1^2 & \frac{1}{2}coeffx_1x_2 & \frac{1}{2}coeffx_1x_3 \\ \frac{1}{2}coeffx_2x_1 & coeffx_2^2 & \frac{1}{2}coeffx_2x_3 \\ \frac{1}{2}coeffx_3x_1 & \frac{1}{2}coeffx_3x_2 & coeffx_3^2 \end{bmatrix}$ $D_1=\begin{vmatrix} 1 & -1 & 0 \\ -1 & 2 & 1 \\ 0 & 1 & 1 \end{vmatrix}=\lvert a_{11}\rvert=1$ $D_2=\begin{vmatrix} 1 & -1 & 0 \\ -1 & 2 & 1 \\ 0 & 1 & 1 \end{vmatrix}=\begin{vmatrix} 1 & -1 \\ -1 & 2 \end{vmatrix}=2-1=1$ $D_3=\lvert A\rvert=1$ The nature positive definite since all are positive values.	
24	**Write down the matrix corresponding to the quadratic form** $x^2+y^2+z^2+2zx+4\sqrt{2}yz$ BTL1	

	The required matrix $A=\begin{bmatrix} coeff\ x^2 & \frac{1}{2}coeff\ \ xy & \frac{1}{2}coeff\ xz \\ \frac{1}{2}coeff\ \ yx & coeff\ \ y^2 & \frac{1}{2}coeff\ yz \\ \frac{1}{2}coeff\ zx & \frac{1}{2}coeff\ \ zy & coeff\ z^2 \end{bmatrix}$ $A=\begin{pmatrix} 1 & 0 & 1 \\ 0 & 1 & 2\sqrt{2} \\ 1 & 2\sqrt{2} & 1 \end{pmatrix}$	
25	**Write down the Quadratic Form corresponding to the matrix** $A=\begin{pmatrix} 2 & 1 & -2 \\ 1 & 2 & -2 \\ -2 & -2 & 3 \end{pmatrix}$**.** BTL1 The Quadratic Form of the matrix is $2x^2+2y^2+3z^2+2xy-4yz-4zx$	
26	**Define index and signature of a quadratic form. Find the index and signature of the quadratic form** $x_1^2+2x_2^2-3x_3^2$ **.**BTL1 The number (p) of positive terms in the canonical form of a QF is called the index of the QF. The number of positive terms minus the number of negative terms is called the signature of the QF Index = 2 , Signature = 1	
27	**Find the constant 'a' and 'b' such that the matrix** $A=\begin{pmatrix} a & 4 \\ 1 & b \end{pmatrix}$ has 3 and -2 as eigen values. BTL1 Give the Eigen values are 3 and -2 Sum of the Eigen value of A are 'a' and 'b' Sum of the Eigen value $a+b=3-2=1$ $\therefore a+b=1$ …………………….(1) Product of the Eigen value $3(-2)=-6$ Product of the Eigen value of A are $\|A\|=ab-4$	

	$\therefore ab-4=-6$ $ab=-2$....................(2) $(1)\Rightarrow \quad b=1-a$ $(2)\Rightarrow \quad ab=-2$ $a(1-a)=-2$ $a^2-a-2=0$ $(a-2)(a+1)=0 \quad \therefore a=2\ \&\ a=-1$ $when\ \ a=2\ then\ b=-1$ $when\ \ a=-1\ then\ b=2$ $\therefore a=2, b=-1\ or\ a=-1, b=2$	
28	**Find the Eigen values of 3A+2I , where** $A=\begin{pmatrix}5&4\\0&3\end{pmatrix}$**.(MAY/JUNE 2007)**BTL1 The Eigen values of A are 5 and 2, The Eigen values of 3A+2I are 3(5)+2 and 3(2)+2 The Eigen values of 3A+2I are 17 and 8	
29	**If 3 and 5 are two Eigen valuesof the matrix** $A=\begin{pmatrix}8&-6&2\\-6&7&-4\\2&-4&3\end{pmatrix}$ **then find its thirdEigen value and hence** $\|A\|$ **.(MAY/JUNE 2018 R-17)**BTL1 Given Eigen value be $\lambda_1=3, \lambda_2=5$. Sum of the Eigen values= Trace of A $\lambda_1+\lambda_2+\lambda_3=8+7+3=18$ $\therefore \lambda_3=18-8=10$ Product of the Eigen value $\|A\|=150$	
30	**Show that Eigen values of a null matrix are zero (MAY/JUNE 2018 R-17)**BTL1 Let $A=\begin{pmatrix}0&0&0\\0&0&0\\0&0&0\end{pmatrix}$ TheCharacteristic Equation is $\lambda^3=0$ $\therefore \lambda_1=0, \lambda_2=0, \lambda_3=0$	

	PART-B
1.	**Find the Eigen values and Eigen vectors of** $\begin{pmatrix} 2 & 2 & 0 \\ 2 & 1 & 1 \\ -7 & 2 & -3 \end{pmatrix}$. **(8M)**BTL1 **Answer : Refer Page No.1.8-Dr.M.CHANDRASEKAR** • The Eigen values are $\lambda = -4, 1, 3$. **(2 M)** • Eigen vectors $X_1 = \begin{bmatrix} 1 \\ -3 \\ 13 \end{bmatrix}; X_2 = \begin{bmatrix} 2 \\ -1 \\ -4 \end{bmatrix}; X_3 = \begin{bmatrix} 2 \\ 1 \\ 4 \end{bmatrix}$ **(6M)**
2.	**Find the Eigen values and Eigen vectors of** $\begin{pmatrix} 11 & -4 & -7 \\ 7 & -2 & -5 \\ 10 & -4 & -6 \end{pmatrix}$ **(May/June-2018 R-17) (8M)** BTL1 **Answer : Refer Page No.1.21-Dr.M.CHANDRASEKAR** • The Eigen values are $\lambda = 0, 1, 2$ **(2 M)** • Eigen vectors $X_1 = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}; X_2 = \begin{bmatrix} 1 \\ -1 \\ 2 \end{bmatrix}; X_3 = \begin{bmatrix} 2 \\ 1 \\ 2 \end{bmatrix}$ **(6M)**
3.	**Find the Eigen values and Eigen vectors of** $\begin{pmatrix} 1 & 0 & -1 \\ 1 & 2 & 1 \\ 2 & 2 & 3 \end{pmatrix}$ **(DEC/JAN-2016 R-13) (8M)** BTL1 **Answer : Refer Page No.1.10-Dr.M.CHANDRASEKAR** • The Eigen values are $\lambda = 1, 2, 3$ **(2 M)** • Eigen vectors $X_1 = \begin{bmatrix} 1 \\ -1 \\ 0 \end{bmatrix}; X_2 = \begin{bmatrix} 2 \\ -1 \\ -2 \end{bmatrix}; X_3 = \begin{bmatrix} 1 \\ -1 \\ 2 \end{bmatrix}$ **(6M)**

4.	**Find the Eigen values and Eigen vectors of** $\begin{pmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{pmatrix}$ **(DEC/JAN-2014 R-13) (8M)** BTL1 **Answer : Refer Page No.1.15-Dr.M.CHANDRASEKAR** • The Eigen values are $\lambda = 1,1,5$ **(2 M)** • Eigen vectors $X_1 = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}; X_2 = \begin{bmatrix} 0 \\ 1 \\ -2 \end{bmatrix}; X_3 = \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix}$ **(6M)**	
5.	**Find the Eigen values and Eigen vectors of** $\begin{pmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{pmatrix}$ **(APR/MAY-2015 R-13) (8M)** BTL1 **Answer : Refer Page No.1.17-Dr.M.CHANDRASEKAR** • The Eigen values are $\lambda = 2,2,8$ **(2 M)** • Eigen vectors $X_1 = \begin{bmatrix} 2 \\ -1 \\ 1 \end{bmatrix}; X_2 = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}; X_3 = \begin{bmatrix} 1 \\ 2 \\ 0 \end{bmatrix}$ **(6M)**	
6.	**Find the eigenvalues and the eigenvectors of the matrix** $A = \begin{pmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{pmatrix}$ **.(APR/MAY 2019)(8M)** BTL3 • The Eigen values are $\lambda = 0,3,15$ **(4M)** • Eigen vectors $X_1 = \begin{bmatrix} 1 \\ 2 \\ 2 \end{bmatrix}; X_2 = \begin{bmatrix} 2 \\ 1 \\ -2 \end{bmatrix}; X_3 = \begin{bmatrix} 2 \\ -2 \\ 1 \end{bmatrix}$ **(4M)**	
7.	**Verify Cayley-Hamilton theorem and hence find the inverse of the matrix** $\begin{pmatrix} 1 & 2 & -1 \\ 3 & -3 & 1 \\ 2 & 1 & -2 \end{pmatrix}$ **(DEC/JAN-2014 R-13) (8M)** BTL3	

	Answer : Refer Page No.1.45-Dr.M.CHANDRASEKAR • The Characteristic Equation is $\lambda^3+4\lambda^2-4\lambda-12=0$ **(2 M)** • For Proving $A^3+4A^2-4A-12I=0$ **(3 M)** • $A^{-1}=\frac{1}{12}\begin{pmatrix}5 & 3 & -1\\ 8 & 0 & -4\\ 9 & 3 & -9\end{pmatrix}$ **(3 M)**	
8.	**Verify Cayley-Hamilton theorem and hence find the inverse of the matrix** $\begin{pmatrix}1 & 0 & 3\\ 2 & 1 & -1\\ 1 & -1 & 1\end{pmatrix}$ **(DEC/JAN-2015 R-13) (8M)** BTL3 **Answer : Refer Page No.1.47-Dr.M.CHANDRASEKAR** • The Characteristic Equation is $\lambda^3-3\lambda^2-\lambda+9=0$ **(2 M)** • For Proving $A^3-3A^2-A+9I=0$. **(3 M)** • $A^{-1}=\frac{-1}{9}\begin{pmatrix}0 & -3 & -3\\ -3 & -2 & 7\\ -3 & 1 & 1\end{pmatrix}$ **.(3 M)**	
9.	**Using Cayley-Hamilton theorem to find the inverse of the matrix** $\begin{pmatrix}1 & 2 & 1\\ 2 & 2 & 1\\ 1 & 1 & 3\end{pmatrix}$ **(May/June-2018 R-17) (8M)** BTL3 **Answer : Refer Page No.1.56-Dr.M.CHANDRASEKAR** • The Characteristic Equation is $\lambda^3-6\lambda^2+5\lambda+5=0$ **(2 M)** • For Proving $A^3-6A^2+5A+5I=0$ **(3 M)** • $A^{-1}=\frac{-1}{5}\begin{pmatrix}-5 & 5 & 0\\ 5 & -2 & -1\\ 0 & -1 & 2\end{pmatrix}$ **(3 M)**	

10.

Use Cayley-Hamilton theorem to find the A^4 **of the matrix** $\begin{pmatrix} 2 & -1 & 1 \\ 0 & 1 & 2 \\ 1 & 0 & 1 \end{pmatrix}$

(DEC/JAN-2016 R-13) (8M) BTL3

Answer : Refer Page No.1.48-Dr.M.CHANDRASEKAR

- The Characteristic Equation is $\lambda^3 - 4\lambda^2 + 4\lambda + 1 = 0$ **(2 M)**
- $A^4 = \begin{pmatrix} 22 & -19 & -5 \\ 24 & -9 & 14 \\ 19 & -12 & 3 \end{pmatrix}$ **(6 M)**

11.

Use Cayley-Hamilton theorem to find $A^8 - 5A^7 + 7A^6 - 3A^5 + A^4 - 5A^3 + 8A^2 - 2A + I$ **of** $A = \begin{pmatrix} 2 & 1 & 1 \\ 0 & 1 & 0 \\ 1 & 1 & 2 \end{pmatrix}$ **(DEC/JAN-2006,APR/MAY 2005) (8M)** BTL3

Answer : Refer Page No.1.51-Dr.M.CHANDRASEKAR

- The Characteristic Equation is $\lambda^3 - 5\lambda^2 + 7\lambda - 3 = 0$ **(2 M)**
- For Proving $A^8 - 5A^7 + 7A^6 - 3A^5 + A^4 - 5A^3 + 8A^2 - 2A + I = A^2 + A + I$ **(3 M)**
- $A^8 - 5A^7 + 7A^6 - 3A^5 + A^4 - 5A^3 + 8A^2 - 2A + I = \begin{pmatrix} 8 & 5 & 5 \\ 0 & 3 & 0 \\ 5 & 5 & 8 \end{pmatrix}$ **(3 M)**

12.

Reduce the quadratic form *2xy-2yz+2xz* into a canonical form by an orthogonal reduction. (APR/MAY 2019)(16M) BTL3

Answer : Refer Page No.1.119-Dr.G. BALAJI

- The Eigen values are $\lambda = 1, 1, -2$ **(4M)**
- Eigen vectors $X_1 = \begin{bmatrix} 1 \\ 2 \\ -1 \end{bmatrix}, X_2 = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}, X_3 = \begin{bmatrix} -1 \\ 1 \\ 1 \end{bmatrix},$ **(4M)**
- $D = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -2 \end{pmatrix}$ **(6M)**
- Canonical form = $-2y_1^2 + y_2^2 + y_3^2$. **(2M)**

13.	**Diagonalize** $A = \begin{pmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{pmatrix}$ **by means of orthogonal transformation.(12M)**BTL1 **Answer : Refer Page No.1.72-Dr.M.CHANDRASEKAR** • The Eigen values are $\lambda = 0,3,15$ **(2 M)** • Eigen vectors $X_1 = \begin{bmatrix} 1 \\ 2 \\ 2 \end{bmatrix}; X_2 = \begin{bmatrix} 2 \\ 1 \\ -2 \end{bmatrix}; X_3 = \begin{bmatrix} 2 \\ -2 \\ 1 \end{bmatrix}$ **(4M)** • $D = N^T AN = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 15 \end{pmatrix}$ **(6M)**	
14.	**Diagonalize** $A = \begin{pmatrix} 3 & 1 & 1 \\ 1 & 3 & -1 \\ 1 & -1 & 3 \end{pmatrix}$ **by means of orthogonal transformation. (12M)** BTL1 **Answer : Refer Page No.1.77-Dr.M.CHANDRASEKAR** • The Eigen values are $\lambda = 1,4,4$ **(2 M)** • Eigen vectors $X_1 = \begin{bmatrix} -1 \\ 1 \\ 1 \end{bmatrix}; X_2 = \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix}; X_3 = \begin{bmatrix} -1 \\ 1 \\ -2 \end{bmatrix}$ **(4M)** • $D = N^T AN = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 4 \end{pmatrix}$ **(6M)**	
15.	**Diagonalize** $A = \begin{pmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{pmatrix}$ **by means of orthogonal transformation.** BTL1 **(DEC/JAN-2015 R-13) (12M)** **Answer : Refer Page No.1.87-Dr.M.CHANDRASEKAR** • The Eigen values are $\lambda = 2,2,8$ **(2 M)**	

	• Eigen vectors $X_1=\begin{bmatrix}2\\-1\\1\end{bmatrix}; X_2=\begin{bmatrix}1\\1\\-1\end{bmatrix}; X_3=\begin{bmatrix}0\\1\\1\end{bmatrix}$ **(4M)** • $D=N^TAN=\begin{pmatrix}8&0&0\\0&2&0\\0&0&2\end{pmatrix}$ **(6M)**
16.	**Reduce the quadratic form** $10x_1^2+2x_2^2+5x_3^2+6x_2x_3-10x_3x_1-4x_1x_2$ **to a canonical form. Discuss its nature.(16M)** BTL1 **Answer : Refer Page No.1.99-Dr.M.CHANDRASEKAR** • The Eigen values are $\lambda=0,3,14$ **(2 M)** • Eigen vectors $X_1=\begin{bmatrix}1\\-5\\4\end{bmatrix}; X_2=\begin{bmatrix}1\\1\\1\end{bmatrix}; X_3=\begin{bmatrix}3\\-1\\-2\end{bmatrix}$ **(4M)** • $D=N^TAN=\begin{pmatrix}0&0&0\\0&3&0\\0&0&14\end{pmatrix}$ **(6M)** • Canonical form= $0y_1^2+3y_2^2+14y_3^2$ **.(2 M)** • Rank=2, Index=2, Signature=2; Nature = Positive Semi definite. **(2 M)**
17.	**Reduce the quadratic form** $6x_1^2+3x_2^2+3x_3^2-2x_2x_3+4x_3x_1-4x_1x_2$ **to a canonical form. Discuss its nature.(DEC/JAN-2016, JAN-2014 R-13) (16M)**BTL1 **Answer : Refer Page No.1.102-Dr.M.CHANDRASEKAR** • The Eigen values are $\lambda=2,2,8$ **(2 M)** • Eigen vectors $X_1=\begin{bmatrix}2\\-1\\1\end{bmatrix}; X_2=\begin{bmatrix}1\\2\\0\end{bmatrix}; X_3=\begin{bmatrix}2\\-1\\-5\end{bmatrix}$ **(4M)** • $D=N^TAN=\begin{pmatrix}2&0&0\\0&2&0\\0&0&8\end{pmatrix}$ **(6M)**

	• Canonical form= $2y_1^2+2y_2^2+8y_3^2$ **(2 M)** • Rank=3, Index=3, Signature=3; Nature = Positive definite **(2 M)**	
18.	**Reduce the quadratic form $6x_1^2+3x_2^2+3x_3^2-2x_2x_3+4x_3x_1-4x_1x_2$ to a canonical form by orthogonal reduction. (16M)**BTL1 **Answer : Refer Page No.1.104-Dr.M.CHANDRASEKAR** • The Eigen values are $\lambda=2,3,6$ **(2 M)** • Eigen vectors $X_1=\begin{bmatrix}1\\0\\-1\end{bmatrix};X_2=\begin{bmatrix}1\\1\\1\end{bmatrix};X_3=\begin{bmatrix}1\\-2\\1\end{bmatrix}$ **(4M)** • $D=N^TAN=\begin{pmatrix}2&0&0\\0&3&0\\0&0&6\end{pmatrix}$ **(8M)** • Canonical form= $2y_1^2+3y_2^2+6y_3^2$ **(2 M)**	
19.	**Reduce the quadratic form $x^2+5y^2+z^2+2xy+2yz+6zx$ to a canonical form through an orthogonal transformation. (DEC/JAN-2015 R-13) (16M)**BTL1 **Answer : Refer Page No.1.109-Dr.M.CHANDRASEKAR** • The Eigen values are $\lambda=-2,3,6$ **(2 M)** • Eigen vectors $X_1=\begin{bmatrix}-1\\0\\1\end{bmatrix};X_2=\begin{bmatrix}-1\\1\\-1\end{bmatrix};X_3=\begin{bmatrix}1\\2\\1\end{bmatrix}$ **(4M)** • $D=N^TAN=\begin{pmatrix}-2&0&0\\0&3&0\\0&0&6\end{pmatrix}$ **(8M)** • Canonical form= $-2y_1^2+3y_2^2+6y_3^2$ **(2 M)**	
20.	**Reduce the quadratic form $8x_1^2+7x_2^2+3x_3^2-8x_2x_3+4x_3x_1-12x_1x_2$ to a canonical form by orthogonal reduction. (16M)** BTL1 **Answer : Refer Page No.1.111-Dr.M.CHANDRASEKAR** • The Eigen values are $\lambda=0,3,15$ **(2 M)**	

	• Eigen vectors $X_1=\begin{bmatrix}1\\2\\2\end{bmatrix}; X_2=\begin{bmatrix}2\\1\\-2\end{bmatrix}; X_3=\begin{bmatrix}2\\-2\\1\end{bmatrix}$ **(4M)** • $D=N^TAN=\begin{pmatrix}0&0&0\\0&3&0\\0&0&15\end{pmatrix}$ **(8M)** • Canonical form= $0y_1^2+3y_2^2+15y_3^2$ **(2 M)**
21.	**Reduce the quadratic form $2x_1^2+5x_2^2+3x_3^2+4x_1x_2$ to a canonical form by orthogonal reduction. (May/June-2018 R-17) (16M)**BTL1 **Answer : Refer Page No.1.113-Dr.M.CHANDRASEKAR** • The Eigen values are $\lambda=1,3,6$ **(2 M)** • Eigen vectors $X_1=\begin{bmatrix}2\\-1\\0\end{bmatrix}; X_2=\begin{bmatrix}0\\0\\1\end{bmatrix}; X_3=\begin{bmatrix}1\\2\\0\end{bmatrix}$ **(4M)** • $D=N^TAN=\begin{pmatrix}1&0&0\\0&3&0\\0&0&6\end{pmatrix}$ **(8M)** • Canonical form= $1y_1^2+3y_2^2+6y_3^2$ **(2 M)**
22.	**Reduce the quadratic form $x_1^2+2x_2^2+x_3^2+2x_2x_3-2x_1x_2$ to a canonical form through orthogonal transformation and hence show that it is positive semi-definite. Also give a non-zero set of values (x_1,x_2,x_3) which makes this quadratic form zero (16M)** BTL1 **Answer : Refer Page No.1.121-Dr.M.CHANDRASEKAR** • The Eigen values are $\lambda=0,1,3$ **(2 M)** • Eigen vectors $X_1=\begin{bmatrix}1\\1\\-1\end{bmatrix}; X_2=\begin{bmatrix}1\\0\\1\end{bmatrix} X_3=\begin{bmatrix}-1\\2\\1\end{bmatrix}$ **(4M)** • $D=N^TAN=\begin{pmatrix}0&0&0\\0&1&0\\0&0&3\end{pmatrix}$ **(6M)**

	• Canonical form= $0y_1^2+1y_2^2+3y_3^2$ **(2 M)** • $x_1=1, x_2=1, x_3=-1$ which makes Q.F is zero **(1 M)** • For proving Positive Semi definite **(1 M)**	
	UNIT-IIVECTOR CALCULUS	
	Gradient and directional derivative – Divergence and curl – Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral – Area of a curved surface – Volume integral – Green's, Gauss divergence and Stokes theorems – Verification and application in evaluating line, surface and volume integrals.	
	PART-A	
1	**State Stokes theorem. (DEC/JAN-2015)**BTL1 The surface integral of the normal component of the curl of a vector point function $\vec{F}$ over an open surface 'S' is equal to the line integral of the tangential component of $\vec{F}$ around the closed curve 'C' bounding 'S' $\int_C \vec{F}.\vec{dr} = \iint_S (\nabla\times\vec{F}).\hat{n}\,ds$	
2	**State Gauss divergence theorem**. **(DEC/JAN-2013) (NOV/DEC-2015)**BTL1 The surface integral of the normal component of a vector function $\vec{F}$ over a closed surface S enclosing volume V is equal to the volume integral of the divergence of $\vec{F}$ taken throughout the volume V $\iint_S \vec{F}.\hat{n}\,ds = \iiint_V \nabla.\vec{F}dv$	
3	**State Green's theorem**. **(DEC/JAN-2009) (NOV/DEC-2010)**BTL1 If $u, v, \frac{\partial u}{\partial y}, \frac{\partial v}{\partial x}$ are continuous and single valued functions in the region R enclosed by the curve C, then $\int_C udx + vdy = \iint_R \left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right)dxdy$	
4	**Find curl $\vec{F}$ if $\vec{F} = xy\vec{i} + yz\vec{j} + zx\vec{k}$.**BTL1 $curl\,\vec{F} = \nabla\times\vec{F}$ $= \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ xy & yz & zx \end{vmatrix} = \vec{i}(0-y) - \vec{j}(z-0) + \vec{k}(0-x)$ $= -y\vec{i} - z\vec{j} - x\vec{k} = -(y\vec{i} + z\vec{j} + x\vec{k})$	
5	**Prove that $\vec{F} = yz\vec{i} + zx\vec{j} + xy\vec{k}$ is irrotational.**BTL5	

$$\nabla \times \vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ yz & zx & xy \end{vmatrix} = \sum \vec{i}\left[\frac{\partial}{\partial y}(xy) - \frac{\partial}{\partial z}(zx)\right]$$

$= \sum \vec{i}\,[x - x] = 0\vec{i} + 0\vec{j} + 0\vec{k} = \vec{0}$. Hence, $\vec{F}$ is irrotational.

6 **Is the position vector $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$ irrotational? Justify. (DEC/JAN-2016)** BTL5

$$\nabla \times \vec{r} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ x & y & z \end{vmatrix}$$

$$= \vec{i}\left[\frac{\partial}{\partial y}(z) - \frac{\partial}{\partial z}(y)\right] - \vec{j}\left[\frac{\partial}{\partial x}(z) - \frac{\partial}{\partial z}(x)\right] + \vec{k}\left[\frac{\partial}{\partial x}(y) - \frac{\partial}{\partial y}(x)\right]$$

$= 0\vec{i} + 0\vec{j} + 0\vec{k} = \vec{0}$.

Hence, $\vec{r}$ is irrotational.

7 **Prove that $3x^2y\vec{i} + (yz - 3xy^2)\vec{j} - \frac{z^2}{2}\vec{k}$ is a solenoidal.**BTL5

$$\nabla.\vec{F} = \frac{\partial}{\partial x}(3x^2y) + \frac{\partial}{\partial y}(yz - 3xy^2) + \frac{\partial}{\partial z}\left(-\frac{z^2}{2}\right)$$

$$= (6xy) + (z - 6xy) + \left(\frac{-2z}{2}\right) = 0$$

$\therefore$ $\vec{F}$is Solenoidal.

8 **Show that $\vec{F} = (y^2 - z^2 + 3yz - 2x)\vec{i} + (3xz + 2xy)\vec{j} + (3xy - 2xz + 2z)\vec{k}$ is both solenoidal and irrotational.**BTL2

$$\nabla.\vec{F} = \frac{\partial}{\partial x}(y^2 - z^2 + 3yz - 2x) + \frac{\partial}{\partial y}(3xz + 2xy) + \frac{\partial}{\partial z}(3xy - 2xz + 2z)$$

$$= (-2) + (2x) + (-2x + 2)$$

$$= 0$$

$\therefore$ $\vec{F}$isSolenoidal.

$$\nabla \times \vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ y^2 - z^2 + 3yz - 2x & 3xz + 2xy & 3xy - 2xz + 2z \end{vmatrix}$$

$$= \vec{i}\left[\frac{\partial}{\partial y}(3xy - 2xz + 2z) - \frac{\partial}{\partial z}(3xz + 2xy)\right]$$

$$-\vec{j}\left[\frac{\partial}{\partial x}(3xy - 2xz + 2z) - \frac{\partial}{\partial z}(y^2 - z^2 + 3yz - 2x)\right]$$

$$+\vec{k}\left[\frac{\partial}{\partial x}(3xz + 2xy) - \frac{\partial}{\partial y}(y^2 - z^2 + 3yz - 2x)\right]$$

	$= [3x-3x]\vec{i} - [(3y-2z)-(-2z+3y)]\vec{j} + [(3z+2y)-(2y+3z)]\vec{k}$ $\nabla \times \vec{F} = 0\vec{i}+0\vec{j}+0\vec{k} = \vec{0}$ Hence, $\vec{F}$ is irrotational.	
9	**Find α such that $\vec{F} = (3x-2y+z)\vec{i} + (4x+\alpha y - z)\vec{j} + (x-y+2z)\vec{k}$ is solenoidal.** BTL1 Given $\nabla.\vec{F} = 0$ $\frac{\partial}{\partial x}(3x-2y+z) + \frac{\partial}{\partial y}(4x+\alpha y - z) + \frac{\partial}{\partial z}(x-y+2z) = 0$ $3+\alpha+2 = 0$ $\alpha + 5 = 0 \therefore \alpha = -5$	
10	**Find the constants a, b, c so that $\vec{F} = (x+2y+az)\vec{i} + (bx-3y-z)\vec{j} + (4x+cy+2z)\vec{k}$ is irrotational.(DEC/JAN-2012) (May/June-2018 R-17)**BTL1 $\nabla \times \vec{F} = \vec{0}$ $\begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ x+2y+az & bx-3y-z & 4x+cy+2z \end{vmatrix} = \vec{0}$ $\vec{i}[c+1] - \vec{j}[4-a] + \vec{k}[b-2] = 0\vec{i} - 0\vec{j} + 0\vec{k}$ i.e., $c+1=0, 4-a=0, b-2=0$ $\therefore \boldsymbol{c=-1, a=4, b=2}$	
11	**Prove that div $\vec{r} = 3$ and curl $\vec{r} = \vec{0}$.(DEC/JAN-2016) (NOV/DEC-2010)** BTL5 $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$ $\nabla.\vec{r} = \frac{\partial}{\partial x}(x) + \frac{\partial}{\partial y}(y) + \frac{\partial}{\partial z}(z) = 1+1+1 = 3$ $\nabla \times \vec{r} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ x & y & z \end{vmatrix}$ $= \vec{i}\left[\frac{\partial}{\partial y}(z) - \frac{\partial}{\partial z}(y)\right] - \vec{j}\left[\frac{\partial}{\partial x}(z) - \frac{\partial}{\partial z}(x)\right] + \vec{k}\left[\frac{\partial}{\partial x}(y) - \frac{\partial}{\partial y}(x)\right]$ $\boldsymbol{= 0\vec{i} + 0\vec{j} + 0\vec{k} = \vec{0}}$	
12	**Prove that curl (grad $\emptyset$) $= \vec{0}$. (NOV/DEC-2008)** BTL5 $grad\ \emptyset = \nabla\emptyset$ $= \vec{i}\frac{\partial\emptyset}{\partial x} + \vec{j}\frac{\partial\emptyset}{\partial y} + \vec{k}\frac{\partial\emptyset}{\partial z}$ $curl\ (grad\ \emptyset) = \nabla \times (\nabla\emptyset)$	

	$= \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ \frac{\partial\phi}{\partial x} & \frac{\partial\phi}{\partial y} & \frac{\partial\phi}{\partial z} \end{vmatrix}$ $= \sum \vec{i}\left[\frac{\partial^2\phi}{\partial y\partial z} - \frac{\partial^2\phi}{\partial z\partial y}\right]$ $= \sum \overrightarrow{i[0]}$ $(Since\ mixed\ partial\ derivatives\ are\ equal)$ $= 0\vec{i} + 0\vec{j} + 0\vec{k} = \vec{0}$	
13	**In what direction from $(3, 1, -2)$ is the directional derivative of $\phi = x^2y^2z^4$ maximum? Find also the magnitude of this maximum.**BTL1 $\nabla\phi = \vec{i}\frac{\partial\phi}{\partial x} + \vec{j}\frac{\partial\phi}{\partial y} + \vec{k}\frac{\partial\phi}{\partial z}$ $= \vec{i}[2xy^2z^4] + \vec{j}[2x^2yz^4] + \vec{k}[4x^2y^2z^3]$ $\nabla\varphi_{(3,1,-2)} = \vec{i}\left[2(3)(1)(16)\right] + \vec{j}\left[2(9)(1)(16)\right] + \vec{k}\left[4(9)(1)(-8)\right]$ $= 96\vec{i} + 288\vec{j} - 288\vec{k}$ $= 96\left(\vec{i} + 3\vec{j} - 3\vec{k}\right)$ The directional derivative is maximum in the direction of $96\left(\vec{i} + 3\vec{j} - 3\vec{k}\right)$ Maximum value is $\lvert\nabla\varphi\rvert = \left\lvert 96\left(\vec{i} + 3\vec{j} - 3\vec{k}\right)\right\rvert$ $= \sqrt{92^2(1+9+9)}$ $= 96\sqrt{19}$	
14	**Find the unit vector normal to the surface $x^2 + y^2 = z$ at $(1, -2, 5)$.**BTL1 Given $\phi = x^2 + y^2 - z$ Unit normal vector $\hat{n} = \frac{\nabla\phi}{\lvert\nabla\phi\rvert}$ ………… (1) $\nabla\phi = \vec{i}\frac{\partial\phi}{\partial x} + \vec{j}\frac{\partial\phi}{\partial y} + \vec{k}\frac{\partial\phi}{\partial z}$ $= \vec{i}[2x] + \vec{j}[2y] + \vec{k}[-1]$ $\nabla\phi_{(1,-2,5)} = \vec{i}[2] + \vec{j}[-4] + \vec{k}[-1]$ $= 2\vec{i} - 4\vec{j} - \vec{k}$ $\lvert\nabla\phi\rvert = \sqrt{2^2 + (-4)^2 + (-1)^2}$ $= \sqrt{4 + 16 + 1} = \sqrt{21}$	

	$\therefore (1) \Rightarrow \hat{n} = \dfrac{2\vec{i} - 4\vec{j} - \vec{k}}{\sqrt{21}}$	
15	**Find the greatest rate of increase of $\emptyset = xyz^2$ at $(1, 0, 3)$.** BTL1 $\nabla\emptyset = \vec{i}\dfrac{\partial\emptyset}{\partial x} + \vec{j}\dfrac{\partial\emptyset}{\partial y} + \vec{k}\dfrac{\partial\emptyset}{\partial z}$ $= \vec{i}[yz^2] + \vec{j}[xz^2] + \vec{k}[2xyz]$ $\nabla\emptyset_{(1,0,3)} = 0\vec{i} + 9\vec{j} + 0\vec{k}$ $\therefore$ Greatest rate of increase= $\|\nabla\emptyset\| = \sqrt{9^2} = 9$	
16	**State the physical interpretation of the line integral. $\int_A^B \vec{F}.\vec{dr}$.** BTL1 Physically $\int_A^B \vec{F}.\overrightarrow{dr}$ denotes the total work done by the force $\vec{F}$, in displacing a particle from A to B along the curve C.	
17	**Define Solenoidal vector function. If $\vec{V} = (x+3y)\vec{i} + (y-2z)\vec{j} + (x+2\lambda z)\vec{k}$ is Solenoidal, find the value of λ.** BTL1 If div$\vec{F}$= 0, then $\vec{F}$ is said to be Solenoidal vector. $\nabla.\vec{F} = 0$. $\nabla.\vec{V} = \dfrac{\partial}{\partial x}(x+3y) + \dfrac{\partial}{\partial y}(y-2z) + \dfrac{\partial}{\partial z}(x+2\lambda z)$ $= 1+1+2\lambda$ $= 2+2\lambda$ $\nabla.\vec{V} = 0$ $2+2\lambda = 0$ $\lambda = -1$	
18	**Find grad$(r^n)$where $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$and $r = \|\vec{r}\|$.**BTL1 We know that $\dfrac{\partial r}{\partial x} = \dfrac{x}{r}$, $\dfrac{\partial r}{\partial y} = \dfrac{y}{r}$, $\dfrac{\partial r}{\partial z} = \dfrac{z}{r}$ $grad\left(r^n\right) = \sum \vec{i}\dfrac{\partial r^n}{\partial x}$ $= \sum \vec{i}(nr^{n-1})\dfrac{\partial r}{\partial x}$ $= (nr^{n-2})\vec{r}$	
19	**Find grad(r) and grad $(\frac{1}{r})$ where $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$ and $\vec{r} = \|\vec{r}\|$.** BTL1	

	$\nabla\phi = \Sigma\vec{i}\dfrac{\partial\phi}{\partial x} = \dfrac{\Sigma x\vec{i}}{r}$ $= \dfrac{\vec{r}}{r}$ $grad(\frac{1}{r}) = \Sigma\vec{i}\dfrac{\partial\left(\frac{1}{r}\right)}{\partial x} = \left(-\dfrac{1}{r^2}\right)\dfrac{\Sigma x\vec{i}}{r}$ $= \dfrac{-\vec{r}}{r^3}$	
20	**Find the unit normal to the surface** $x^2+xy+z^2=4\ at\ (1,-1,2)$ **.**BTL1 $\hat{n} = \dfrac{\nabla\phi}{\lvert\nabla\phi\rvert}$ $\nabla\phi = \Sigma\vec{i}\dfrac{\partial\phi}{\partial x}$ $Given:$ $x^2+xy+z^2=4\ \ Point(1,-1,2)$ $\nabla\phi = \vec{i}+\vec{j}+4\vec{k}$ $\lvert\nabla\phi\rvert = \sqrt{1+1+16} = \sqrt{18}$ $\hat{n} = \dfrac{\vec{i}+\vec{j}+4\vec{k}}{3\sqrt{2}}$	
21	**Prove by Green's theorem that the area bounded by a simple closed curve is** $\frac{1}{2}\int_c (xdy-ydx)$ BTL5 By Green's theorem: $\int_C udx+vdy = \iint_R \left(\dfrac{\partial v}{\partial x} - \dfrac{\partial u}{\partial y}\right)dxdy$ $u = \dfrac{-y}{2}, \mathrm{v} = \dfrac{v}{2} \Rightarrow \dfrac{\partial u}{\partial y} = \dfrac{-1}{2}, \dfrac{\partial v}{\partial x} = \dfrac{1}{2}$ Given that $\dfrac{1}{2}\int_C xdy-ydx = \iint_R \left(\dfrac{1}{2}+\dfrac{1}{2}\right)dxdy$ $= \iint_R dxdy.$ which a area bounded by a simple closed curve $'c'$	

22	**Find** $\nabla\left[\nabla.\left(\left(x^2-yz\right)\vec{i}+\left(y^2-xz\right)\vec{j}+\left(z^2-xy\right)\vec{k}\right)\right]$ **at the point (1,-1,2).**BTL1 $\nabla.\vec{F}=\frac{\partial}{\partial x}(x^2-yz)+\frac{\partial}{\partial y}(y^2-xz)+\frac{\partial}{\partial z}(z^2-xy)$ $=2x+2y+2z$ $\nabla.\vec{F}_{(1,-1,2)}=2-2+4$ $=4$ $Grad(\nabla.\vec{F})=\nabla(\nabla.\vec{F})$ $=\vec{i}\frac{\partial}{\partial x}(2x)+\vec{j}\frac{\partial}{\partial y}(2y)+\vec{k}\frac{\partial}{\partial z}(2z)$ $=2\vec{i}+2\vec{j}+2\vec{k}$	
23	**Find the directional directive of** $\phi(x,y,z)=xy^2+yz^2$ **at the point (2,-1,1) in the direction of the vector** $\vec{i}+2\vec{j}+3\vec{k}$ **.(DEC/JAN-2014)**BTL1 Directional derivative(D.D)= $\nabla\phi.\frac{\vec{a}}{\lvert\vec{a}\rvert}$ $Given:$ $\phi(x,y,z)=xy^2+z^2y,\quad \vec{a}=\vec{i}+2\vec{j}+3\vec{k}$ $\nabla\phi_{(1,-1,2)}=\vec{i}+2\vec{j}+4\vec{k},\qquad \lvert\vec{a}\rvert=\sqrt{14}$ $D.D=(\vec{i}+2\vec{j}+4\vec{k}).\frac{(\vec{i}+2\vec{j}+3\vec{k})}{\sqrt{14}}$ $=\frac{17}{\sqrt{14}}.$	
24	**If** $\vec{F}$ **is irrotational and C is closed curve then find the value of** $\int_c \vec{F}.d\vec{r}$ **.** BTL1 By Stokes theorem $\int_c \vec{F}.d\vec{r}=\iint_s\left(\nabla\times\vec{F}\right).\hat{n}ds$ Since $\vec{F}$ is irrotational $\therefore \nabla\times\vec{F}=0$ $\int_c \vec{F}.d\vec{r}=\iint_s\left(\nabla\times\vec{F}\right).\hat{n}ds$ $=\iint_s 0.\hat{n}ds$ $=0$	
	Prove that $\nabla(\log r)=\frac{\vec{r}}{r^2}$. **(NOV/DEC-2014)**.BTL5	

25	we have $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$ *and* $r = \lvert\vec{r}\rvert = \sqrt{x^2+y^2+z^2}$ $r^2 = x^2+y^2+z^2,\ \frac{\partial r}{\partial x} = \frac{x}{r},\ \frac{\partial r}{\partial y} = \frac{y}{r},\ \frac{\partial r}{\partial z} = \frac{z}{r}$ $\nabla(\log r) = \vec{i}\,\frac{\partial(\log r)}{\partial x} + \vec{j}\,\frac{\partial(\log r)}{\partial y} + \vec{k}\,\frac{\partial(\log r)}{\partial z}$ $= \vec{i}\left(\frac{1}{r}\frac{\partial r}{\partial x}\right) + \vec{j}\left(\frac{1}{r}\frac{\partial r}{\partial y}\right) + \vec{k}\left(\frac{1}{r}\frac{\partial r}{\partial z}\right)$ $= \frac{1}{r}\left[\frac{x}{r}\vec{i} + \frac{y}{r}\vec{j} + \frac{z}{r}\vec{k}\right]$ $= \frac{1}{r^2}\left[x\vec{i} + y\vec{j} + z\vec{k}\right] = \frac{\vec{r}}{r^2}$	
26	**If** $\vec{F} = (x^3)\vec{i} + (y^3)\vec{j} + (z^3)\vec{k}$ **then find div curl** $\vec{F}$. **(May/June-2018 R-17)**BTL1 $\nabla\times\vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ x^3 & y^3 & z^3 \end{vmatrix} = 0$ Therefore **div curl** $\vec{F} = 0$	
	PART-B	
1.	**Prove that** $\nabla(r^n) = \mathrm{n}r^{n-2}\,\vec{r}$. **(May/June 2003,2008) (8 M)** BTL5 **Answer : Refer Page No.2.5-Dr.M.CHANDRASEKAR** • $\frac{\partial r}{\partial x} = \frac{x}{r},\ \frac{\partial r}{\partial y} = \frac{y}{r},\ \frac{\partial r}{\partial z} = \frac{z}{r}$.**(2 M)** • $\nabla(r^n) = \vec{i}\left(nr^{n-1}\frac{\partial r}{\partial x}\right) + \vec{j}\left(nr^{n-1}\frac{\partial r}{\partial y}\right) + \vec{k}\left(nr^{n-1}\frac{\partial r}{\partial z}\right)$ **(2 M)** • $\nabla(r^n) = \frac{nr^{n-1}}{r}\left[x\vec{i} + y\vec{j} + z\vec{k}\right] = nr^{n-2}\vec{r}$ **(4M)**	
2.	**Prove that** $\mathrm{Curl}\,(\mathrm{Curl}\,\vec{F}) = \nabla(div\,\vec{F}) - \nabla^2\,\vec{F}$. **(May/June 2003,2008) (8 M)** BTL5 **Answer : Refer Page No.2.36-Dr.M.CHANDRASEKAR**	

	• $\nabla\times(\nabla\times\vec{F}) = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ \frac{\partial F_3}{\partial y}-\frac{\partial F_2}{\partial z} & \frac{\partial F_1}{\partial z}-\frac{\partial F_3}{\partial x} & \frac{\partial F_2}{\partial x}-\frac{\partial F_1}{\partial y} \end{vmatrix}$ **(3M)** • $\nabla\times(\nabla\times\vec{F}) = \sum\left\{\frac{\partial}{\partial x}(div\,\vec{F}) - \nabla^2\,\vec{F}_1\right\}\vec{i}$ **(3M)** • For proving $\text{Curl}\,(\text{Curl}\,\vec{F}) = \nabla(div\,\vec{F}) - \nabla^2\,\vec{F}$ **(2M)**	
3.	**Prove that** $\vec{F} = (y^2\cos x + z^3)\,\vec{i} + (2y\sin x - 4)\,\vec{j} + 3xz^2\,\vec{k}$ **is irrotational and find its scalar potential.** **(8 M)**BTL5 **Answer : Refer Page No.2.33-Dr.M.CHANDRASEKAR** • $\nabla\times\vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ y^2\cos x + z^3 & 2y\sin x - 4 & 3xz^2 \end{vmatrix} = 0$ **(2 M)** $\phi_1 = y^2\sin x + xz^3 + f(y,z)$ • $\phi_2 = y^2\sin x - 4y + f(x,z)$ **(4M)** $\phi_3 = xz^3 + f(x,y)$ • $\phi = y^2\sin x + xz^3 - 4y + c$ **.(2M)**	
4.	**Prove that** $\vec{F} = (6xy + z^3)\,\vec{i} + (3x^2 - z)\,\vec{j} + (3xz^2 - y)\,\vec{k}$ **is irrotational and find its scalar potential.(NOV/DEC 2015,R-13)(8 M)** BTL5 **Answer : Refer Page No.2.32-Dr.M.CHANDRASEKAR** • $\nabla\times\vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ (6xy + z^3) & (3x^2 - z) & (3xz^2 - y) \end{vmatrix} = 0$ **(2 M)** $\phi_1 = 3x^2y + xz^3 + f(y,z)$ • $\phi_2 = 3x^2y - yz + f(x,z)$ **(4M)** $\phi_3 = xz^3 - yz + f(x,y)$	

	• $\phi = 3x^2y + xz^3 - yz + c$ **(2M)**	
5.	**Prove that** $\vec{F} = (y^2 + 2xz^2)\,\vec{i} + (2xy - z)\,\vec{j} + (2zx^2 - y + 2z)\,\vec{k}$ **is irrotational and find its scalar potential. (8 M)** BTL5 **Answer : Refer Page No.2.47-Dr.M.CHANDRASEKAR** • $\nabla \times \vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ (y^2+2xz^2) & (2xy-z) & (2zx^2-y+2z) \end{vmatrix} = 0$ **(2 M)** $\phi_1 = xy^2 + x^2z^2 + f(y,z)$ • $\phi_2 = xy^2 - yz + f(x,z)$ **(4M)** $\phi_3 = x^2z^2 + xy^2 - yz + f(x,y)$ • $\phi = x^2z^2 + xy^2 - yz + c$ **(2M)**	
6.	**Prove that** $\vec{F} = (y+z)\,\vec{i} + (z+x)\,\vec{j} + (x+y)\,\vec{k}$ **is irrotational and find its scalar potential. (8 M)** BTL5 **Answer : Refer Page No.2.46-Dr.M.CHANDRASEKAR** • $\nabla \times \vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ (y+z) & (z+x) & (x+y) \end{vmatrix} = 0$ **(2 M)** $\phi_1 = xy + xz + f(y,z)$ • $\phi_2 = xy + yz + f(x,z)$ **(4M)** $\phi_3 = xz + yz + f(x,y)$ • $\phi = xz + xy + yz + c$ **(2M)**	
7.	**Evaluate by Green's theorem** $\int_C (xy + x^2)dx + (x^2 + y^2)dy$ **where C is the square formed by** $x = -1, x = 1, y = -1, y = 1$ **(May/June 2016 R-13) (8 M)**BTL1 **Answer : Refer Page No.2.75-Dr.M.CHANDRASEKAR** • $\int_C udx + vdy = \iint_R \left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} \right) dxdy$ $u = xy + x^2, \mathrm{v} = x^2 + y^2 \Rightarrow \frac{\partial u}{\partial y} = x, \frac{\partial v}{\partial x} = 2x$ **(4M)**	

	• $\int_C (xy+x^2)dx+(x^2+y^2)dy = \int_{-1}^{1}\int_{-1}^{1} x\,dx\,dy$ **(2M)** • $\int_C (xy+x^2)dx+(x^2+y^2)dy = 0$ **(2M)**	
8.	**Verify Green's theorem $\int_C (xy+y^2)dx+(x^2)dy$ where C is the closed curve of the region bounded by $y=x$ and $y=x^2$ (May/June 2013 R-13) (8 M)** BTL3 **Answer : Refer Page No.2.78-Dr.M.CHANDRASEKAR** • $\int_C udx+vdy = \iint_R \left(\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}\right)dxdy$ $u = xy+y^2, \mathrm{v} = x^2 \Rightarrow \frac{\partial u}{\partial y} = x+2y, \frac{\partial v}{\partial x} = 2x$ **(2M)** • $\iint_R \left(\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}\right)dxdy = \int_0^1\int_y^{\sqrt{y}} (x-2y)dx\,dy = \frac{-1}{20}$ **(2M)** • $\int_C (xy+y^2)dx+(x^2)dy = \text{Along OA} + \text{Along AO} = \int_0^1 (x^4+3x^3)dx + \int_1^0 (3x^2)dx$ **(2M)** • $\int_C (xy+y^2)dx+(x^2)dy = \frac{19}{20}-1 = \frac{-1}{20}$ **(2M)**	
9.	**Verify Green's theorem $\int_C (x^2-xy^3)dx+(\mathrm{y}^2-2\,\mathrm{xy})dy$ where C is the square with vertices (0,0),(2,0),(2,2),(0,2) (May/June 2003) (8 M)** BTL3 **Answer : Refer Page No.2.80-Dr.M.CHANDRASEKAR** • $\int_C udx+vdy = \iint_R \left(\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}\right)dxdy$ $u = x^2-xy^3, \mathrm{v} = \mathrm{y}^2-2\,\mathrm{xy} \Rightarrow \frac{\partial u}{\partial y} = -3xy^2, \frac{\partial v}{\partial x} = -2y$ **(2M)** • $\iint_R \left(\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}\right)dxdy = \int_0^2\int_0^2 (3x\,y^2-2y)dx\,dy = 8$ **(2M)**	

	• $\int_C (x^2 - xy^3)dx + (y^2 - 2xy)dy = \text{Along OA} + \text{Along AB} + \text{Along BC} + \text{Along CO}$ $= \int_0^2 (x^2)dx + \int_0^2 (y^2 - 4y)dy + \int_2^0 (x^2 - 8x)dx + \int_2^0 (y^2)dy$ **(2M)** • $\int_C (x^2 - xy^3)dx + (y^2 - 2xy)dy = \frac{8}{3} - \frac{16}{3} + \frac{40}{3} - \frac{8}{3} = 8$ **(2M)**	
10.	**Evaluate by Green's theorem $\int_C (y - \sin x)dx + (\cos x)dy$ where C is the triangle OAB where $O = (0,0), A = \left(\frac{\pi}{2}, 0\right), B = \left(\frac{\pi}{2}, 1\right)$ (May/June 2015 R-13) (8 M)** BTL3 **Answer : Refer Page No.2.82-Dr.M.CHANDRASEKAR** • $\int_C udx + vdy = \iint_R \left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right) dxdy$ $u = y - \sin x, v = \cos x \Rightarrow \frac{\partial u}{\partial y} = 1, \frac{\partial v}{\partial x} = -\sin x$ **(4M)** • $\int_C (y - \sin x)dx + (\cos x)dy = \int_0^{\frac{\pi}{2}} \int_0^{\frac{2x}{\pi}} (-\sin x - 1)\, dx\, dy$ **(2M)** • $\int_C (y - \sin x)dx + (\cos x)dy = -\left(\frac{\pi^2 + 8}{4\pi}\right)$ **(2M)**	
11.	**Apply Green's theorem to evaluate $\int_C (3x^2 - 8y^2)dx + (4y - 6xy)dy$ where C is the boundary of the region defined by x=0,y=0 and x+y=1 (NOV/DEC 2014 R-13) (8 M)** BTL3 **Answer : Refer Page No.2.83-Dr.M.CHANDRASEKAR** • $\int_C udx + vdy = \iint_R \left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right) dxdy$ $u = -8y^2 + 3x^2, v = 4y - 6xy \Rightarrow \frac{\partial u}{\partial y} = -16y, \frac{\partial v}{\partial x} = -6y$ **(4M)** • $\int_C (3x^2 - 8y^2)dx + (4y - 6xy)dy = \int_0^1 \int_0^{1-y} 10y\, dx\, dy$ **(2M)** • $\int_C (3x^2 - 8y^2)dx + (4y - 6xy)dy = \frac{5}{3}$ **(2M)**	

12.	**Verify Gauss Divergence theorem** $\vec{F}= xy^2\vec{i} + yz^2\vec{j} + zx^2\vec{k}$ over **the region bounded by** $x=0, x=1, y=0, y=2, z=0, z=3$ **(May/June 2012 R-08)(16 M)** BTL3 **Answer : Refer Page No.2.96-Dr.M.CHANDRASEKAR** • $\iint_S \vec{F}.\hat{n}\,ds = \iiint_V \nabla.\vec{F}dv$ **(2M)** • $\nabla.\vec{F} = y^2 + x^2 + z^2$ **(2M)** • $\iiint_V \nabla.\vec{F}dv = \int_0^3\int_0^2\int_0^1 (y^2+x^2+z^2)dxdydz = 28$ **(4M)** • $\iint_S \vec{F}.\hat{n}\,ds = 8+0+18+0+2+0 = 28$ **(8M)**	
13.	**Verify Gauss Divergence theorem** $\vec{F}= (x^2-yz)\vec{i} + (y^2-zx)\vec{j} + (z^2-xy)\vec{k}$ over **the rectangular Parallelopiped** $0 \le x \le a,\ 0 \le y \le b,\ 0 \le z \le c$ **(May/June 2009 R-08) (16 M)**BTL3 **Answer : Refer Page No.2.99-Dr.M.CHANDRASEKAR** • $\iint_S \vec{F}.\hat{n}\,ds = \iiint_V \nabla.\vec{F}dv$ **(2M)** • $\nabla.\vec{F} = 2x+2y+2z$ **(2M)** • $\iiint_V \nabla.\vec{F}dv = 2\int_0^c\int_0^b\int_0^a (x+y+z)dxdydz = abc(\mathrm{a+b+c})$ **(4M)** • $\iint_S \vec{F}.\hat{n}\,ds = \left(a^2bc - \frac{b^2c^2}{4}\right) + \left(\frac{b^2c^2}{4}\right) + \left(b^2ac - \frac{a^2c^2}{4}\right) + \left(\frac{a^2c^2}{4}\right) + \left(c^2ba - \frac{b^2a^2}{4}\right) + \left(\frac{b^2a^2}{4}\right)$ **(8M)** $\iint_S \vec{F}.\hat{n}\,ds = abc(\mathrm{a+b+c})$	
14.	**Verify Gauss Divergence theorem for** $\vec{F}= x^3\vec{i} + y^3\vec{j} + z^3\vec{k}$ over **the cube bounded by** $x=0, x=a, y=0, y=a, z=0, z=a$ **(May/June 2014 R-13) (May/June-2018 R-17)(16 M)** BTL3 **Answer : Refer Page No.2.106-Dr.M.CHANDRASEKAR**	

	• $\iint_S \vec{F}.\hat{n}\,ds = \iiint_V \nabla.\vec{F}dv$ **(2M)** • $\nabla.\vec{F} = 3y^2 + 3x^2 + 3z^2$ **(2M)** • $\iiint_V \nabla.\vec{F}dv = \int_0^a\int_0^a\int_0^a (3y^2 + 3x^2 + 3z^2)dxdydz = 3a^5$ **(4M)** • $\iint_S \vec{F}.\hat{n}\,ds = a^5 + 0 + a^5 + 0 + a^5 + 0 = 3a^5$ **(8M)**	
15.	**Verify Gauss Divergence theorem for** $\vec{F} = 4xz\vec{i} - y^2\vec{j} + zy\vec{k}$ over **the region bounded by** $x = 0, x = 1, y = 0, y = 1, z = 0, z = 1$ **(May/June 2012 R-08) (16 M)** BTL3 **Answer : Refer Page No.2.109-Dr.M.CHANDRASEKAR** • $\iint_S \vec{F}.\hat{n}\,ds = \iiint_V \nabla.\vec{F}dv$ **(2M)** • $\nabla.\vec{F} = 4z - y$ **(2M)** • $\iiint_V \nabla.\vec{F}dv = \int_0^1\int_0^1\int_0^1 (4z - y)dxdydz = \frac{3}{2}$ **(4M)** • $\iint_S \vec{F}.\hat{n}\,ds = 2 + 0 - 1 + 0 + \frac{1}{2} + 0 = \frac{3}{2}$ **(8M)**	
16.	**Verify Gauss Divergence theorem for** $\vec{F} = y\vec{i} + x\vec{j} + z^2\vec{k}$ over **the cylindrical region bounded by** $x^2 + y^2 = 9, z = 0$ and $z = 2$ **(Dec/Jan 2015 R-13) (16 M)**BTL3 **Answer : Refer Page No.2.103-Dr.M.CHANDRASEKAR** • $\iint_S \vec{F}.\hat{n}\,ds = \iiint_V \nabla.\vec{F}dv$ **(2M)** • $\nabla.\vec{F} = 2z$ **(2M)** • $\iiint_V \nabla.\vec{F}dv = \int_{-3}^{3}\int_{-\sqrt{9-x^2}}^{\sqrt{9-x^2}}\int_0^2 2z\ dxdydz = 36\pi$ **(4M)** • $\iint_S \vec{F}.\hat{n}\,ds = 0 + 36\pi + 0 = 36\pi$ **(8M)**	
17.	**Verify Stokes theorem for** $\vec{F} = (x^2 + y^2)\vec{i} - 2xy\vec{j}$ **taken around the rectangle bounded by** $x = \pm a, y = 0, y = b$ **(May/June 2004) (16 M)**BTL3 **Answer : Refer Page No.2.122-Dr.M.CHANDRASEKAR**	

	• $\int_C \overrightarrow{F}.\overrightarrow{dr} = \iint_S (\nabla \times \overrightarrow{F}).\ \hat{n}\, ds$ **(2M)** • $\nabla \times \vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ (x^2+y^2) & -2xy & 0 \end{vmatrix} = -4y\vec{k}$ **(2M)** • $\iint_S (\nabla \times \overrightarrow{F}).\ \hat{n}\, ds = \int_0^b \int_{-a}^{a} (-4\,y)dxdy = -4ab^2$ **(4M)** • $\int_C \overrightarrow{F}.\overrightarrow{dr} = AB+BC+CD+DA = \left(\frac{2a^3}{3}\right) - \left(ab^2\right) - \left(2ab^2 + \frac{2a^3}{3}\right) - \left(ab^2\right) = -4ab^2$ **(8 M)**	
18.	**Verify Stokes theorem for** $\vec{F} = (x^2 - y^2)\vec{i} + 2xy\vec{j}$ **taken around the rectangle bounded by** $x=0, x=a, y=0, y=b$ **(May/June 2004) (16 M)**BTL3 **Answer : Refer Page No.2.124-Dr.M.CHANDRASEKAR** • $\int_C \overrightarrow{F}.\overrightarrow{dr} = \iint_S (\nabla \times \overrightarrow{F}).\ \hat{n}\, ds$ **(2M)** • $\nabla \times \vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ (x^2-y^2) & 2xy & 0 \end{vmatrix} = 4y\vec{k}$ **(2M)** • $\iint_S (\nabla \times \overrightarrow{F}).\ \hat{n}\, ds = \int_0^b \int_0^a (4\,y)dxdy = 2ab^2$ **(4M)** • $\int_C \overrightarrow{F}.\overrightarrow{dr} = OA+AB+BC+CO = \left(\frac{a^3}{3}\right) + \left(ab^2\right) + \left(ab^2 - \frac{a^3}{3}\right) + \left(0\right) = 2ab^2$ **(8 M)**	
19.	**Verify Stokes theorem for** $\vec{F} = x^2\vec{i} + xy\vec{j}$ **integrated around the square in z=0 plane whose sides are along the lines** $x=0, x=a, y=0, y=a$ **(May/June 2008) (16 M)** BTL3 **Answer : Refer Page No.2.126-Dr.M.CHANDRASEKAR** • $\int_C \overrightarrow{F}.\overrightarrow{dr} = \iint_S (\nabla \times \overrightarrow{F}).\ \hat{n}\, ds$ **(2M)**	

	• $\nabla\times\vec{F}=\begin{vmatrix}\vec{i} & \vec{j} & \vec{k}\\ \partial/\partial x & \partial/\partial y & \partial/\partial z\\ x^2 & xy & 0\end{vmatrix}=y\vec{k}$ **(2M)** • $\iint_S(\nabla\times\overrightarrow{F}).\hat{n}\,ds=\int_0^a\int_0^a(\mathrm{y})dxdy=\frac{a^3}{2}$ **(4M)** • $\int_C\overrightarrow{F}.\overrightarrow{dr}=OA+AB+BC+CO=\left(\frac{a^3}{3}\right)+\left(\frac{a^3}{2}\right)+\left(-\frac{a^3}{3}\right)=\left(\frac{a^3}{2}\right)$ **(8 M)**	
20.	**Verify Stokes theorem for** $\vec{\mathrm{F}}=(y-z+2)\vec{i}+(yz+4)\vec{j}-xz\vec{k}$ **where S is the open surface of the cube** $x=0,x=2,y=0,y=2,z=0,z=2$ **above the xy-plane (May/June 2005) (May/June-2018 R-17)(16 M)** BTL3 **Answer : Refer Page No.2.132-Dr.M.CHANDRASEKAR** • $\int_C\overrightarrow{F}.\overrightarrow{dr}=\iint_S(\nabla\times\overrightarrow{F}).\hat{n}\,ds$ **(2M)** • $\nabla\times\vec{F}=\begin{vmatrix}\vec{i} & \vec{j} & \vec{k}\\ \partial/\partial x & \partial/\partial y & \partial/\partial z\\ y-z+2 & yz+4 & -xz\end{vmatrix}=-y\vec{i}+(z-1)\vec{j}-\vec{k}$ **(2M)** • $\iint_S(\nabla\times\overrightarrow{F}).\hat{n}\,ds=(-4)+(4)+(4)+(-4)+(-4)=-4$ **(4M)** • $\int_C\overrightarrow{F}.\overrightarrow{dr}=OA+AC+CB+BO=(4)+(8)+(-8)+(-8)=(-4)$ **(8 M)**	
21.	**Using Stokes theorem to Evaluate** $\int_C\overrightarrow{F}.\overrightarrow{dr}$ **where** $\vec{\mathrm{F}}=(y^2)\vec{i}+(\mathrm{x}^2)\vec{j}-(x+z)\vec{k}$ **and C is the boundary of the triangle with vertices (0,0,0), (1,0,0) and (1,1,0) (8 M)**BTL3 **Answer : Refer Page No.2.137-Dr.M.CHANDRASEKAR** • $\int_C\overrightarrow{F}.\overrightarrow{dr}=\iint_S(\nabla\times\overrightarrow{F}).\hat{n}\,ds$ **(2M)** • $\nabla\times\vec{F}=\begin{vmatrix}\vec{i} & \vec{j} & \vec{k}\\ \partial/\partial x & \partial/\partial y & \partial/\partial z\\ y^2 & x^2 & -(x+z)\end{vmatrix}=\vec{j}+2(x-y)\vec{k}$ **(2M)**	

	• $\iint_S (\nabla \times \overrightarrow{F}).\ \hat{n}\, ds = \int_0^1 \int_0^x 2(x-y)\, dy dx = \frac{1}{3}$ **(4M)**
	UNIT-IIIANALYTIC FUNCTIONS
	Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates – Properties – Harmonic conjugates – Construction of analytic function – Conformal mapping – Mapping by $w = z + c, cz, \frac{1}{z}, z^2$ – Bilinear transformation
	PART-A
1.	**Show that the function** $f(z) = \bar{z}$ **is no where differentiable. (DEC/JAN-2013) (NOV/DEC-2015)**BTL2 Given $w = f(z) = \bar{z}$ $\therefore u + iv = x - iy \Rightarrow u = x, v = -y$ $u_x = 1, v_x = 0$ $u_y = 1, v_y = -1$ $\therefore u_x \neq v_y$ So C-R equations are not satisfied for any x and y. $\therefore f(z)$ is not differentiable anywhere.Hence not analytic anywhere.
2	**Test the analyticity of the function** $w = \sin z$.BTL4 Given $w = \sin z$ $u + iy = \sin(x + iy)$ $= \sin x \cos iy + \cos x \sin(iy)$ $= \sin x \cosh y + i \cos x \sinh y$ $\Rightarrow\ u = \sin x \cosh y\ ;\quad v = \cos x \sinh y$ $\therefore\ u_x = \cos x \cosh y;\quad v_x = -\sin x \sinh y$ $u_y = \sin x \sinh y\ ;\quad v_y = \cos x \cosh y$ $\therefore u_x = v_y,\quad u_y = -v_x$ So C-R equations are satisfied forall any x and y and $u_x, ,u_y, v_x, v_y$ are continuous $\therefore f(z)$ is analytic everywhere.
3	**Find the constants a,b,c if** $f(z) = x + ay + i(bx + cy)$ **is analytic. (DEC/JAN-2014)** BTL1 Let $u + iv = f(z)$ Since $f(z)$ is analytic, u and v satisfy the C-R Equations.

	$u_x = v_y, \quad u_y = -v_x$ $here\, u = x + ay, v = bx + cy$ $u_x = 1, \; v_x = b$ $u_y = a, \; v_y = c$ $\therefore u_x = v_y \Rightarrow c = 1;$ $u_y = -v_x \Rightarrow a = -b$
4	**Show that** $u = 2x - x^3 + 3xy^2$ **is harmonic**BTL2 Given $u = 2x - x^3 + 3xy^2$ $u_x = 2 - 3x^2 + 3y^2; u_y = 6xy$ $u_{xx} = -6x; \qquad u_{yy} = 6x$ $\therefore u_{xx} + u_{yy} = -6x + 6x = 0.$ Therefore u is harmonic
5	**Show that the function** $u = y + e^x \cos y$ **is harmonic.**BTL2 Given $u = y + e^x \cos y$ $u_x = e^x \cos y, \; u_y = 1 + e^x(-\sin y)$ $u_{xx} = e^x \cos y, \; u_{yy} = -e^x \cos y$ $u_{xx} + u_{yy} = e^x \cos y - e^x \cos y = 0$ Therefore u is harmonic
6	**Show that** $x^2 + iy^3$ **is not analytic anywhere.**BTL2 Let $u + iv = x^2 + iy^3$ $\therefore u = x^2, \quad v = y^3$ $u_x = 2x, \; v_x = 0$ $u_y = 0, \; v_y = 3y^2$ $\therefore u_x \neq v_y, \; u_y = -v_x$ $\therefore$ The function is not analytic. But, when $x = 0, y = 0$ the C-R Equations are satisfied.
7	**For the conformal mapping** $f(z) = z^2$, **find the scale factor at** $z = i$ .BTL1 Given

	$f(z)=z^2,$ $\therefore f'(z)=2z$ Scale factor at $z=i$ is $\lvert f'(i)\rvert = \lvert 2i\rvert = 2$	
8	**Find the image of** $x=2$ **under the transformation** $w=\frac{1}{z}$ .BTL1 Given $w=\frac{1}{z}\Rightarrow z=\frac{1}{w}=\frac{\overline{w}}{w\overline{w}}$ $\Rightarrow \quad x+iy=\frac{u-iv}{u^2+v^2}$ $\therefore x=\frac{u}{u^2+v^2}$ $\therefore$ The image of $x=2$ *is* $\frac{u}{u^2+v^2}=2\Rightarrow u^2+v^2-\frac{u}{2}=0$ which is a circle in the w – plane.	
9	**Find the image of** $x=k$ **under the transformation** $w=\frac{1}{z}$ **.**BTL1 Given $w=\frac{1}{z}\Rightarrow z=\frac{1}{w}=\frac{\overline{w}}{w\overline{w}}$ $\Rightarrow \quad x+iy=\frac{u-iv}{u^2+v^2}$ $\therefore x=\frac{u}{u^2+v^2}$ $\therefore$ The image of $x=k$ is $\frac{u}{u^2+v^2}=k\Rightarrow u^2+v^2-\frac{u}{k}=0$ which is a circle in the w – plane	
10	**Find the image of the circle** $\lvert z\rvert=2$ **under the transformation** $w=3z$ **.(NOV/DEC-2014)** BTL1 Given $w=3z$ $\lvert w\rvert=3\lvert z\rvert$ $=3\times 2$ $=6$ $\therefore$ The image of the circle $\lvert z\rvert=2$ is the circle $\lvert w\rvert=6$ in the w-plane. $\therefore \sqrt{u^2+v^2}=6,$ $\Rightarrow u^2+v^2=36,$ which is a circle	
11	**Find the image of the circle** $\lvert z\rvert=2$ **under the transformation** $w=z+3+2i$ .BTL1 Given $w=z+3+2i$	

	$u+iv=x+iy+3+2i$ $\therefore\ u=x+3 \Rightarrow\ x=u-3$ $v=y+2 \Rightarrow\ y=v-2$ $\lvert z\rvert=2 \Rightarrow \sqrt{x^2+y^2}=2$ $\Rightarrow\ x^2+y^2=4$ $\Rightarrow (u-3)^2+(v-2)^2=4$	
12	**Find the image of the line** $x-y+1=0$ **under the map** $\mathrm{w}=\frac{1}{z}$**.**BTL1 Given $\mathrm{w}=\frac{1}{z} \Rightarrow z=\frac{1}{\mathrm{w}}=\frac{\overline{w}}{w\overline{w}}$ $\Rightarrow\ x+iy=\frac{u-iv}{u^2+v^2}$ $\therefore x=\frac{u}{u^2+v^2}\ , y=\frac{-v}{u^2+v^2}$ The image of the line $x-y+1=0$ is $\frac{u}{u^2+v^2}+\frac{v}{u^2+v^2}+1=0$ $\Rightarrow u^2+v^2+u+v=0$ which is a circle in the w−plane	
13	**Findthe fixed points of the transformation** $\mathrm{w}=\frac{6z-9}{z}$**.**BTL1 The given transformation $\mathrm{w}=\frac{6z-9}{z}$**.** The fixed points are given points by $\mathrm{w}=z$ $\Rightarrow\ z=\frac{6z-9}{z}$ $\Rightarrow\ z^2=6z-9$ $\Rightarrow\ z^2-6z-9=0$ $\Rightarrow\ (z-3)^2=0$ $\Rightarrow\ z=3,3$	
14	**Find the fixed points of the mapping** $\mathrm{w}=\frac{3-z}{1+z}$**.**BTL1 The given maps $\mathrm{w}=\frac{3-z}{1+z}$ The fixed points are given by $\mathrm{w}=z$	

	$\therefore \quad z=\frac{3-z}{1+z} \Rightarrow z+z^2=3-z$ $\Rightarrow z+z^2-3+z=0$ $\Rightarrow z^2+2z-3=0$ $\Rightarrow (z+3)(z-1)=0$ $\Rightarrow z=-3,1$	
15	**Find the fixed points of the mapping** $w=\frac{2z+6}{z+7}$. **(DEC/JAN-2015)**BTL1 The given map is $w=\frac{2z+6}{z+7}$. The fixed points are given by $w=z$ $\therefore \quad z=\frac{2z+6}{z+7} \Rightarrow 7z+z^2=2z+6$ $\Rightarrow 7z+z^2-2z+6=0$ $\Rightarrow z^2+5z-6=0$ $\Rightarrow (z+6)(z-1)=0$ $\Rightarrow z=1,-6$	
16	**Find the bilinear map which maps points** $\infty, i, 0$ **of the z plane onto** $0, i, \infty$ **of the w-plane.** BTL1 Given $z_1=\infty, z_2=i, z_3=0$ which are mapped onto $w_1=0, w_2=i, w_3=\infty$ Since $z_1=\infty$ & $w_3=\infty$, omitting the factors involving z_1 & w_3 The Bilinear map is, $\frac{w-w_1}{w_2-w_1}=\frac{z_2-z_3}{z-z_3}$ $\frac{w-0}{i-0}=\frac{i-0}{z}$ $\Rightarrow w=-\frac{1}{z}$	
17	**Define the Conformal Mapping**.BTL1 A transformation that preserves angles between every pair of curves through a Point, both in magnitude and sense, is said to be conformal at that point.	
18	**State sufficient condition for analytic function. (DEC/JAN-2016)** BTL1 If the partial derivatives u_x, u_y, v_x, and v_y areall continuous in D and $u_x=v_y$, $u_y=-v_x$.Then the function *f(z)*is analytic in a domain D.	
19	**Find the constants a, b if $f(z)=x+2ay+i(3x+by)$ is analytic.**BTL1 Given $f(z)=x+2ay+i(3x+by)$ is analytic.	

	$\Rightarrow u_x = v_y,\ \ u_y = -v_x$ ....(1) Here $u = x + 2ay$ and $v = 3x + by$ Thus (1) gives $1 = b$ and $2a = -3$ $\Rightarrow a = -\frac{3}{2}$ and $b = -1$	
20	**State the Cauchy Riemann equations in polar coordinates satisfied by an analytic Function.** BTL1 Cauchy Riemann equations in polar coordinates are given by $u_r = \frac{1}{r}v_\theta$ and $v_r = -\frac{1}{r}u_\theta$ where u and v are functions of r *and* θ.	
21	**Find the critical points of the transformation $w = 1 + \frac{2}{z}$. (NOV/DEC-2016)** BTL1 The critical points of the transformation are obtained by $f'(z) = 2z$ $Hence\ -\frac{2}{z^2} = 0$ $\Rightarrow -\frac{2}{0} = z^2$ $\Rightarrow z = \infty$ is the critical point of the given transformation.	
22	**Find the image of the region $x > c$, where $c > 0$ under the transformation $w = \frac{1}{z}$.** BTL1 $$w = \frac{1}{z}. \Rightarrow z = \frac{1}{w}$$ Let $z = x + iy$ and $w = u + iv$ $$x + iy = \frac{1}{u + iv} = \frac{u - iv}{(u + iv)(u - iv)} = \frac{u - iv}{u^2 + v^2}$$ $$\therefore x = \frac{u}{u^2 + v^2}\ and\ y = \frac{-v}{u^2 + v^2}$$ $$x > c \Rightarrow x = \frac{u}{u^2 + v^2} > c$$ $$u > cu^2 + cv^2$$ $$u^2 + v^2 < \frac{u}{c}$$ $$u^2 + v^2 - \frac{u}{c} < 0.$$ This refers to the inside of the circle center $(\frac{1}{2c}, 0)$ and radius $\frac{1}{2c}$.	
23	**Show that an analytic function with constant real part is constant.** BTL2 Let $f(z) = u + iv$ be analytic. $$\Rightarrow u_x = v_y\ and\ u_y = -v_x$$ Given that $u = constant. = c(say). \Rightarrow u_x = 0\ \ and\ \ v_y = 0 \Rightarrow u_y = 0\ \ and\ \ -v_x = 0$	

	$\Rightarrow$v is independent of x and y.$\Rightarrow v$ is constant $\Rightarrow f(z) = u + iv = c + ic$ is a constant.	
24	**Find the critical points of the transformation$w^2 = (z-\alpha)(z-\beta)$.(DEC/JAN-2010) (NOV/DEC-2016)**BTL1 Let $w^2 = (z-\alpha)(z-\beta)$. Then,$2w\frac{dw}{dz} = (z-\alpha).1 + (z-\beta).1$ The Critical points of $w = f(z)$ is given by, $\frac{dw}{dz} = 0 \Rightarrow (z-\alpha).1 + (z-\beta).1=0$ $\Rightarrow z = \frac{\alpha+\beta}{2}$. Also,$\frac{dz}{dw} = 0 \Rightarrow \frac{2w}{(z-\alpha)+(z-\beta)} = 0. \Rightarrow w = 0, (z-\alpha)+(z-\beta) = 0 \Rightarrow z = \alpha, \beta$. The critical points are $z = \alpha, \beta, \frac{\alpha+\beta}{2}$.	
25	**Write cross ratio of four points. (NOV/DEC-2018)** BTL1 The cross ratio of four points.$\frac{(w_1-w_2)(w_3-w_4)}{(w_2-w_3)(w_4-w_1)} = \frac{(z_1-z_2)(z_3-z_4)}{(z_2-z_3)(z_4-z_1)}$is invariant under the bilinear transformation	
26	**Verify f(z)= z^3 is analytic or not.** BTL3 Let $f(z) = u + iv = z^3 = (x+iy)^3$ $$u + iv = (x^3 - 3xy^2) + i(3x^2y - y^3)$$ $$u = (x^3 - 3xy^2) \text{and } v = (3x^2y - y^3)$$ $$u_x = (3x^2 - 3y^2) \text{ and } u_y = -6xy$$ $$v_x = 6xy \text{ and } v_y = (3x^2 - 3y^2)$$ $u_x = v_y$and$u_y = -v_x$.Hence the C-R Equations are satisfied. Therefore f(z)= z^3 is analytic	
27	**If $f(z) = u + iv$ is an analytic function ,prove that u is a harmonic function.**BTL5 $f(z) = u + iv$be analytic.$\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$; $\frac{\partial u}{\partial y} = \frac{-\partial v}{\partial x}$ ... ... (1) Now, $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = \frac{\partial}{\partial x}\left(\frac{\partial u}{\partial x}\right) + \frac{\partial}{\partial y}\left(\frac{\partial u}{\partial y}\right) = \frac{\partial}{\partial x}\left(\frac{\partial v}{\partial y}\right) + \frac{\partial}{\partial y}\left(\frac{-\partial v}{\partial x}\right)$ (since by (1)) $$= \frac{\partial^2 v}{\partial x \partial y} - \frac{\partial^2 v}{\partial y \partial x} = 0$$ $\therefore u$ is harmonic	
28	**If $f(z) = r^2(\cos 2\theta + i \sin p\theta)$ is an analytic function ,then find the value of p(MAY/JUNE 2018 R-17)** BTL5 C-R Equations are $u_r = \left(\frac{1}{r}\right)v_\theta$, $u_\theta = -rv_r$	

	$u_r = 2r\cos 2\theta,\ u_\theta = -2r^2 \sin 2\theta$ $v_r = 2r \sin p\theta,\ u_\theta = pr^2 \cos p\theta$ $\Rightarrow p = 2$	
29	**Examine whether the function $u = xy^2$ can be real part of an analytic function (MAY/JUNE 2018 R-17)**BTL5 Here $u_{xx} + u_{yy} = 0 - 2x = -2x \neq 0$ It couldn't satisfies harmonic condition. Hence $u = xy^2$ cannot be real part of an analytic function	
	PART-B	
1.	**If $f(z)$ is an analytic function, Prove that** $\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}\right)\lvert f(z)\rvert^2 = 4\lvert f'(z)\rvert^2$ **(NOV/DEC 2014) (8 M)**BTL5 **Answer : Refer Page No.3.31-Dr.M.CHANDRASEKAR** • C-R Equations are $u_x = v_y$, $u_y = -v_x$ **(2M)** • $\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}\right)\lvert f(z)\rvert^2 = 2\left[\left(\frac{\partial u}{\partial x}\right)^2 + \left(\frac{\partial v}{\partial x}\right)^2 + \left(\frac{\partial u}{\partial y}\right)^2 + \left(\frac{\partial v}{\partial y}\right)^2\right]$ **(4M)** • $\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}\right)\lvert f(z)\rvert^2 = 4\left[\left(\frac{\partial u}{\partial x}\right)^2 + \left(\frac{\partial v}{\partial x}\right)^2\right] = 4\lvert f'(z)\rvert^2$ **(2M)**	
2.	**If $f(z) = u + iv$ is analytic, Prove that** $\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}\right)\log\lvert f(z)\rvert = 0$ **.(MAY/JUNE 2002) (8M)**BTL5 **Answer : Refer Page No.3.33-Dr.M.CHANDRASEKAR** • C-R Equations are $u_x = v_y$, $u_y = -v_x$ **(2M)** • $\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}\right)\log\lvert f(z)\rvert = \frac{(u^2+v^2)[u_x^2 + v_x^2 + u_y^2 + v_y^2 + u(u_{xx}+u_{yy}) + v(v_{xx}+v_{yy}) - 2[(uu_x + vv_x)^2 + (uu_y + vv_y)^2]}{(u^2+v^2)^2}$ **(4M)**	

	Since the function f(z) is analytic, it satisfies C-R equations and hence • the function is harmonic. **(2 M)** $\therefore\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right)\log\lvert f(z)\rvert=0$	
3.	**Prove that** $u=x^2-y^2, v=\frac{-y}{x^2+y^2}$ are harmonic but $u+iv$ **is not regular function. (NOV/DEC 2013) (8 M)**BTL5 **Answer : Refer Page No.3.44-Dr.M.CHANDRASEKAR** • For Proving u is harmonic $u_{xx}+u_{yy}=2-2=0$ **(2M)** • For Proving v is harmonic $v_{xx}+v_{yy}=\left(\frac{2y^3-6x^2y}{(x^2+y^2)^3}\right)+\left(-\frac{(2y^3-6x^2y)}{(x^2+y^2)^3}\right)=0$ **(2 M)** • But $u_x\neq v_y$, $u_y\neq -v_x \Rightarrow f(z)=u+iv$ is not a regular function. **(2 M)**	
4.	**If** $f(z)=u+iv$ **is analytic, Prove that** $\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right)\lvert u\rvert^p=p(p-1)(u^{p-2})\lvert f'(z)\rvert^2$ **(MAY/JUNE 2002) (MAY/JUNE 2018 R-17) (8 M)** BTL5 **Answer : Refer Page No.3.36-Dr.M.CHANDRASEKAR** • C-R Equations are $u_x=v_y$, $u_y=-v_x$ **(2M)** • $\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right)\lvert u\rvert^p=pu^{p-1}\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right)+(p-1)pu^{p-2}\left(\left(\frac{\partial u}{\partial x}\right)^2+\left(\frac{\partial u}{\partial y}\right)^2\right)$ **(4M)** • $\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right)\lvert u\rvert^p=p(p-1)(u^{p-2})\lvert f'(z)\rvert^2$ **(2M)**	
5.	**In a two dimensional flow, the stream function is** $\psi=\tan^{-1}\left(\frac{y}{x}\right)$ **Find the velocityPotential** ϕ **. (NOV/DEC 2016) (8 M)**BTL1 **Answer : Refer Page No.3.50-Dr.M.CHANDRASEKAR** • $\frac{\partial\psi}{\partial x}=\frac{-y}{x^2+y^2}$; $\frac{\partial\psi}{\partial y}=\frac{x}{x^2+y^2}$ **(2M)**	

	• $\phi = \int \left(\frac{\partial \psi}{\partial y} dx - \frac{\partial \psi}{\partial x} dy \right)$ **(2 M)** • $\phi = \log(x^2 + y^2) + \mathrm{c}$ **(4M)**	
6.	**Show that the function** $u = \frac{1}{2}\log(x^2 + y^2)$ **is harmonic and find its harmonic conjugate (MAY/JUNE 2016) (8 M)** BTL2 **Answer : Refer Page No.3.52-Dr.M.CHANDRASEKAR** • $\frac{\partial u}{\partial x} = \frac{x}{x^2 + y^2}; \ \frac{\partial u}{\partial y} = \frac{y}{x^2 + y^2}$ **(2M)** • For Proving u is harmonic $u_{xx} + u_{yy} = \left(\frac{y^2 - x^2}{(x^2 + y^2)^2} \right) + \left(-\frac{y^2 - x^2}{(x^2 + y^2)^2} \right) = 0$ **(2 M)** • $\mathrm{v} = \tan^{-1}\left(\frac{y}{x} \right) + c$ **(4M)**	
7.	**Prove that** $e^x[x\cos y - y\sin y]$ **can be the real part of an analytic function and determineits harmonic conjugate (NOV/DEC 2013) (8 M)** BTL5 **Answer : Refer Page No.3.55-Dr.M.CHANDRASEKAR** • $\frac{\partial u}{\partial x} = e^x x\cos y + e^x \cos y - e^x y\sin y$ $\frac{\partial u}{\partial y} = -e^x x\sin y - e^x \, \mathrm{y}\cos y - e^x \sin y$ **(2M)** • For Proving u is harmonic $u_{xx} + u_{yy} = \left(e^x x\cos y + 2e^x \cos y - e^x y\sin y\right) + \left(-e^x x\cos y - 2e^x \cos y + e^x y\sin y\right) = 0$ **(2 M)** • $\mathrm{v} = e^x x\sin y + e^x \, \mathrm{y}\cos y + c$ **(4M)**	
8.	**Find an analytic function** $f(z) = u + iv$ **whose real part is** $e^x[x\cos y - y\sin y]$ **(8 M)** BTL1 **Answer : Refer Page No.3.64-Dr.M.CHANDRASEKAR** • $\frac{\partial u}{\partial x} = e^x x\cos y + e^x \cos y - e^x y\sin y$ $\frac{\partial u}{\partial y} = -e^x x\sin y - e^x \, \mathrm{y}\cos y - e^x \sin y$ **(2M)**	

	• $\frac{\partial u}{\partial x}(z,0) = e^z + ze^z$ $\frac{\partial u}{\partial y}(z,0) = 0$ **(2 M)** $f(z) = ze^z + c$ **(4M)**	
9.	**Find an analytic function** $f(z) = u + iv$ **whose real part is** $e^{2x}[x\cos 2y - y\sin 2y]$ **(8 M)** BTL1 **Answer : Refer Page No.3.66-Dr.M.CHANDRASEKAR** • $\frac{\partial u}{\partial x} = 2e^{2x}x\cos 2y + e^{2x}\cos 2y - 2e^{2x}y\sin 2y$ $\frac{\partial u}{\partial y} = -2e^{2x}x\sin 2y - 2e^{2x}\,y\cos 2y - e^{2x}\sin 2y$ **(2M)** • $\frac{\partial u}{\partial x}(z,0) = e^{2z} + 2ze^{2z}$ $\frac{\partial u}{\partial y}(z,0) = 0$ **(2 M)** • $f(z) = ze^{2z} + c$ **(4M)**	
10.	**Find an analytic function** $f(z) = u + iv$ **if** $u - v = e^x[\cos y - \sin y]$ **(MAY/JUNE 2018 R-17)(8 M)**BTL1 **Answer : Refer Page No.3.76-Dr.M.CHANDRASEKAR** • $\frac{\partial U}{\partial x} = e^x\cos y - e^x\sin y$ $\frac{\partial U}{\partial y} = -e^x\cos y - e^x\sin y$ **(2M)** • $\frac{\partial U}{\partial x}(z,0) = e^z$ $\frac{\partial V}{\partial y}(z,0) = -e^z$ **(2 M)** • $F(z) = (1+i)f(z)$ $f(z) = e^z + c$ **(4M)**	
11.	**Prove that the function** $v = e^{-x}[x\cos y + y\sin y]$ **is harmonic and determine the corresponding analytic function** $f(z) = u + iv$ **(8 M)** BTL5 **Answer : Refer Page No.3.69-Dr.M.CHANDRASEKAR**	

	• $\frac{\partial v}{\partial x} = -e^{-x}x\cos y + e^{-x}\cos y - e^{-x}y\sin y$ $\frac{\partial v}{\partial y} = -e^{-x}x\sin y + e^{-x}\, y\cos y + e^{-x}\sin y$ **(2M)** • For Proving u is harmonic $v_{xx} + v_{yy} = \left(e^{-x}[(x-2)\cos y + y\sin y]\right) + \left(e^{-x}[(2-x)\cos y - y\sin y]\right) = 0$ **(2 M)** • $\frac{\partial v}{\partial x}(z,0) = e^{-z}(1-z)$ $\frac{\partial v}{\partial y}(z,0) = 0$ **(2 M)** • $f(z) = ize^{-z} + c$ **(2M)**	
12.	**Given that** $u = \frac{\sin 2x}{\cosh 2y - \cos 2x}$ **find the analytic function whose real part is u.** **(NOV/DEC 2014)(MAY/JUNE 2006) (8 M)** BTL1 **Answer : Refer Page No.3.71-Dr.M.CHANDRASEKAR** • $\frac{\partial u}{\partial x}(z,0) = -\text{cosec}^2 z$ $\frac{\partial u}{\partial y}(z,0) = 0$ **(4M)** • $f(z) = \cot z + c$ **(4M)**	
13.	**If** $f(z) = u + iv$ **is analytic, find** $f(z)$ **given that** $u + v = \frac{\sin 2x}{\cosh 2y - \cos 2x}$ **(NOV/DEC 2015) (8 M)**BTL1 **Answer : Refer Page No.3.74-Dr.M.CHANDRASEKAR** • $\frac{\partial V}{\partial x}(z,0) = -\text{cosec}^2 z$ $\frac{\partial V}{\partial y}(z,0) = 0$ **(4M)** • $f(z) = \left(\frac{1+i}{2}\right)\cot z + c$ **(4M)**	
14.	**Find the image of** $\lvert z-3 \rvert = 3$ **under the mapping** $w = \frac{1}{z}$	

	(NOV/DEC 2010) (8 M) BTL1 **Answer : Refer Page No.3.108-Dr.M.CHANDRASEKAR** • $x=\frac{u}{u^2+v^2}$ & $y=\frac{-v}{u^2+v^2}$ **(4M)** • The image of the circle $\lvert z-3\rvert=3$ is the straight line $u=\frac{1}{6}$ **(4M)**
15.	**Find the image of** $\lvert z+i\rvert=1$ **under the mapping** $w=\frac{1}{z}$ **(NOV/DEC 2013) (8 M)**BTL1 **Answer : Refer Page No.3.109-Dr.M.CHANDRASEKAR** • $x=\frac{u}{u^2+v^2}$ & $y=\frac{-v}{u^2+v^2}$ **(4M)** • The image of the circle $\lvert z+i\rvert=1$ is the straight line $v=\frac{1}{2}$ **(4M)**
16.	**Find the image of** $1<y<2$ **under the mapping** $w=\frac{1}{z}$ **(MAY/JUNE 2014) (8 M)**BTL1 **Answer : Refer Page No.3.110-Dr.M.CHANDRASEKAR** • $x=\frac{u}{u^2+v^2}$ & $y=\frac{-v}{u^2+v^2}$ **(4M)** • $1<y<2$ is mapped onto the region between the circles $u^2+v^2+v=0$ and $2(u^2+v^2)+v=0$ **(4M)**
17.	**Find the image of** $\lvert z-2i\rvert=2$ **under the mapping** $w=\frac{1}{z}$ **(NOV/DEC 2007) (MAY/JUNE 2018 R-17) (8 M)** BTL1 **Answer : Refer Page No.3.112-Dr.M.CHANDRASEKAR** • $x=\frac{u}{u^2+v^2}$ & $y=\frac{-v}{u^2+v^2}$ **(4M)** • The image of the circle $\lvert z-2i\rvert=2$ is the straight line $v=-\frac{1}{4}$ **(4M)**
18.	**Find the bilinear transformation which maps** $-1,-i,1$ **in the z-plane** $\infty,i,0$ **in the w-planerespectively. (8 M)**BTL1 **Answer : Refer Page No.3.132-Dr.M.CHANDRASEKAR**

	• $\frac{(w-w_1)(w_2-w_3)}{(w-w_3)(w_2-w_1)}=\frac{(z-z_1)(z_2-z_3)}{(z-z_3)(z_2-z_1)}$ **(2M)** • $w=\frac{(1-z)}{(1+z)}$ **(6M)**	
19.	**Find the bilinear transformation which maps** $\infty, i, 0$ **onto** $0, i, \infty$ **respectively. (8 M)** BTL1 **Answer : Refer Page No.3.133-Dr.M.CHANDRASEKAR** • $\frac{(w-w_1)(w_2-w_3)}{(w-w_3)(w_2-w_1)}=\frac{(z-z_1)(z_2-z_3)}{(z-z_3)(z_2-z_1)}$ **(2M)** • $w=\frac{-1}{z}$ **(6M)**	
20.	**Find the bilinear transformation which maps** $z=1,0,-1$ **onto** $w=\infty,-1,0$ **respectively. (8 M)** BTL1 **Answer : Refer Page No.3.133-Dr.M.CHANDRASEKAR** • $\frac{(w-w_1)(w_2-w_3)}{(w-w_3)(w_2-w_1)}=\frac{(z-z_1)(z_2-z_3)}{(z-z_3)(z_2-z_1)}$ **(2M)** • $w=\frac{z+1}{z-1}$ **(6M)**	
21.	**Find the bilinear transformation which maps** $-1,0,1$ **onto** $-1,-i,1$ **respectively. Show that under this transformation the upper half of the z-plane maps onto the interior of the unit circle** $\|w\|=1$ **(MAY/JUNE 2018 R-17) (8 M)** BTL1 **Answer : Refer Page No.3.134-Dr.M.CHANDRASEKAR** • $\frac{(w-w_1)(w_2-w_3)}{(w-w_3)(w_2-w_1)}=\frac{(z-z_1)(z_2-z_3)}{(z-z_3)(z_2-z_1)}$ **(2M)** • $w=\frac{1-iz}{z-i}$ **(2M)** • $x=\frac{2u}{u^2+(v-1)^2}$ & $y=\frac{-(u^2+v^2-1)}{u^2+(v-1)^2}$ **(2M)** • For provingthe upper half of the z-plane maps onto the interior of the unit circle $\|w\|\le 1$ **(2M)**	
	UNIT IV- COMPLEX INTEGRATION	

	Line integral – Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour.	
Q.No.	**PART-A**	
1	**State Cauchy integral theorem. (NOV/DEC 2014)(MAY/JUNE 2016)** BTL1 If a function $f(z)$ is analytic and its derivative $f'(z)$ is continuous at all points inside and on a simple closed curve C, then $\int_C f(z)dz = 0$.	
2	**State Cauchy integral formula.** BTL1 If $f(z)$ is analytic inside and on a simple closed curve C in the region R and if 'a' is any point in R then $\int_C \frac{f(z)}{z-a}dz = 2\pi i f(a)$ where the integration around C taken in the positive direction.	
3	**State Cauchy integral formula for derivatives. (NOV/DEC 2010)**BTL1 If a function f(z) is analytic within and on a simple closed curve c and 'a' is any point lying in it, then $\int_C \frac{f(z)}{(z-a)^{n+1}}dz = \begin{cases} \frac{2\pi i}{n!} f^n(a) \text{ ; a lies inside c} \\ 0 \text{ ; a lies outside c} \end{cases}$	
4	**State Cauchy Residue Theorem (NOV/DEC 2012)**BTL1 If f (z) is analytic at all points inside and on a simple closed curve C except at a Finite number of points $z_1, z_2, z_3, ..., z_n$ inside C then $\int_C f(z)dz = 2\pi i[\text{sum of residues of } f(z)]$	
5	**Evaluate $\int_C \frac{dz}{z-2}$ where C is the square with vertices (0,0), (1,0), (1,1), (0,1).**BTL5 Given C is the square with vertices (0,0), (1,0), (1,1), (0,1). ie) x=1,y=1.Since $\int_C \frac{dz}{z-2}$. Equating the denominator to zero. $z-2=0, \Rightarrow z=2$. Which lies outside C.	
6	**Evaluate $\int_C \frac{3z^2+7z+1}{z-3}dz$ where C is $\lvert z\rvert = 2$.** BTL5 Given $\lvert z\rvert = 2$ that is, $x^2+y^2=2^2$ with center (0,0) and radius 2. Given $\int_C \frac{3z^2+7z+1}{z-3}dz$. Equating the denominator to zero. $(z-3)^2 = 0 \Rightarrow z = 3$ which lies outside C.	

	$\therefore$ By Cauchy's integral formula $\int_C \frac{3z^2+7z+1}{z-3}dz = 0$.	
7	**Evaluate** $\int_C \frac{\cos \pi z}{z-1} dz$ **where C is** $\lvert z\rvert = 2$.BTL5 Given $\lvert z\rvert = 2$ that is, $x^2 + y^2 = 2^2$ with center (0,0) and radius 2. Given $\int_C \frac{\cos \pi z}{z-1} dz$. Equating the denominator to zero. $z-1=0, \Rightarrow z=1$. Which lies inside C. $\therefore$ By Cauchy's integral formula $\int_C \frac{dz}{z-a} = 2\pi i\, f(a)$. $Here\;\; a=1, f(z)=\cos \pi z \Rightarrow f(a)=f(1)=\cos \pi = -1$. $\therefore \int_C \frac{\cos \pi z}{z-1} dz = 2\pi i(-1) = -2\pi i$.	
8	**Evaluate** $\int_C \tan z\, dz$ **where C is** $\lvert z\rvert = 2$ **(NOV/DEC 2015)**BTL5 Given $\lvert z\rvert = 2$ that is, $x^2 + y^2 = 2^2$ with center (0,0) and radius 2. Given $\int_C \tan z\, dz = \int_C \frac{\sin z}{\cos z} dz$. Equating the denominator to zero. Cos z = 0 = $\cos\frac{\pi}{2} \Rightarrow z = \frac{\pi}{2}$ =1.732 . Which lies inside C. $\therefore$ By Cauchy's integral formula $\int_C \frac{dz}{z-a} = 2\pi i\, f(a)$. $Here\;\; a=\frac{\pi}{2}, f(z)=\sin z \Rightarrow f(a)=f(\frac{\pi}{2})=\sin\frac{\pi}{2}=1$. $\therefore \int_C \tan z\, dz = 2\pi i(1) = 2\pi i$	
9	**Evaluate the integral** $\int_C \left(z^2+2z\right)dz$ **where C is** $\lvert z\rvert = 1$.BTL5 Given $\lvert z\rvert = 1$. that is, $x^2 + y^2 = 1$ with centre (0,0)and radius 1. $f(z) = z^2+2z$ is a function which is analytic in the region bounded by C Hence by Cauchy's theorem $\int_C \left(z^2+2z\right)dz = 0$.	
10	**Find the contour C:** $\lvert z\rvert < 1$ **for which** $\int_C \frac{e^z}{(z+1)^2(z+1)}dz$ **=0.**BTL1 $\int_C \frac{e^z}{(z+1)^2(z+1)}dz$ **=0** when $\lvert z\rvert < 1$. [since the points lies outside the contour, then the integral value is 0.]	

11	**Evaluate** $\int_C \frac{dz}{(z-3)^2}$ **where C is** $\lvert z\rvert = 1$BTL5 Given $\lvert z\rvert = 1$. that is,) $x^2+y^2=1$ with center (0,0) and radius 1. $\int_C \frac{dz}{(z-3)^2}$. Equating the denominator to zero.$(z-3)^2=0 \Rightarrow z=3$ which lies outside C. $\therefore$ By Cauchy's integral formula for derivatives $\int_C \frac{dz}{(z-3)^2}=0$.	
12	**Evaluate** $\int_c \frac{e^z dz}{z-2}$ **, where C is the unit circle with centre as origin.**BTL5 **(MAY/JUNE 2009)** $f(z)=\frac{e^z}{z-2}$ z=2 lies outside C. $f(z)$ is analytic inside and on C. $f'(z)$ is continuous in C, By Cauchy's integral theorem $\int_c f(z)dz=0$	
13	**Define Taylor's series.**BTL1 If $f(z)$ is analytic inside a circle C with its centre at z = a then, For all z inside c, $f(z)=f(a)+\frac{f'(a)}{1!}(z-a)+\frac{f''(a)}{2!}(z-a)^2+............+\frac{f^n(a)}{n!}(z-a)^n+.......+\infty$.	
14	**Define Laurent's series.**BTL1 If C_1 and C_2 are two concentric circles with centre "a" and radii r_1 and r_2 ($r_1<r_2$) and if $f(z)$ is analyticon C_1 and C_2 and in the annulus region between them, then at any point z in R $f(z)=\sum_{n=0}^{\infty} a_n(z-a)^n+\sum_{n=1}^{\infty}\frac{b_n}{(z-a)^n}$, where $a_n=\frac{1}{2\pi i}\int_{C_1}\frac{f(z)}{(z-a)^{n+1}}dz$ *and* $b_n=\frac{1}{2\pi i}\int_{C_2}\frac{f(z)}{(z-a)^{1-n}}dz$ The integrals being taken in the anticlockwise direction.	
15	**Define Essential singularity.**BTL1 A singular point z =a is called an essential singular point of $f(z)$ if the Laurent's series of $f(z)$ containing negative powers of z.	
16	**Discuss the nature of singularities** $f(z)=e^{\frac{1}{z}}$ **.(NOV/DEC 2015)(MAY/JUNE 2012)** BTL6	

	$f(z)=e^{\frac{1}{z}}=1+\frac{\left(\frac{1}{z}\right)}{1!}+\frac{\left(\frac{1}{z}\right)^2}{2!}+\frac{\left(\frac{1}{z}\right)^3}{3!}+....$ $=1+z^{-1}+\frac{z^{-2}}{2!}+\frac{z^{-3}}{3!}+...$ Thereforez =0 is an essential singularity, since the principal part contains negative powers of z.	
17	**Define removable singularity.** BTL1 A singular point z=a is called a removable singular point of $f(z)$, if the Laurent's series of $f(z)$ containing positive powers of z.	
18	**Find the nature of the singularity** $f(z)=\frac{\sin z}{z}$ .BTL1 $f(z)=\frac{\sin z}{z}=\frac{1}{z}\left(z-\frac{z^3}{3!}+\frac{z^5}{5!}+......\right)=1-\frac{z^2}{3!}+\frac{z^4}{5!}$ **-....** There is no negative power of z. Therefore $z=0$ is a removable singularity.	
19	**Define isolated singularity with an example.**BTL1 A point $z=z_0$ is said to be isolated singularity of $f(z)$ i) If $f(z)$ is not analytic at $z=z_0$, ii)There exist neighborhoods of $z=z_0$ containing no other singularity Example: $f(z)=\frac{1}{(z-1)(z-2)}$ has two isolated singularity namely z =1 and z =2.	
20	**Find the singularities of** $f(z)=\frac{z^2+4}{z^2+2z+2}$ **.**BTL1 Given $f(z)=\frac{z^2+4}{z^2+2z+2}$ **.** [The singularities are poles] The poles of $f(z)$ are given by equating the denominator to zero. $z^2+2z+2=0,\quad z=\frac{-2\pm\sqrt{4-8}}{2}=-1\pm i$. Which is a pole of order 1.	
21	**Find the singularities of the function** $f(z)=\frac{\cot\pi z}{(z-a)^3}$ **.**BTL1 Given $f(z)=\frac{\cot\pi z}{(z-a)^3}=\frac{\cos\pi z}{\sin\pi z(z-a)^3}$ $i.e.\sin\pi z(z-a)^3=0 \quad\Rightarrow\quad \sin\pi z=0 \quad (or)(z-a)^3=0$ Now$(z-a)^3=0$ $z=a$ is a pole of order 3 and then $\sin\pi z=0$ $\pi z=n\pi\Rightarrow\quad z=\pm n,\quad n=0,1,2,3.......$ $z=\pm n$ are simple poles.	

22	**State nature of the singularities of** $f(z)=\sin\left(\frac{1}{z+1}\right)$ **.**BTL1 Given $f(z)=\sin\left(\frac{1}{z+1}\right)$ $\sin\left(\frac{1}{z+1}\right)=\left(\frac{1}{z+1}\right)-\frac{\left(\frac{1}{z+1}\right)^3}{3!}+\frac{\left(\frac{1}{z+1}\right)^5}{5!}+.......=\left(\frac{1}{z+1}\right)-\frac{1}{3!}\left(\frac{1}{z+1}\right)^3+\frac{1}{5!}\left(\frac{1}{z+1}\right)^5-........$ Z=-1 is an essential singularity.	
23	**Find the zeros of the function** $f(z)=\tan z$ **and its pole. (NOV/DEC 2016)**BTL1 Given $f(z)=\tan z=\frac{\sin z}{\cos z}=\frac{P(z)}{Q(z)}$ The poles are given by $\cos z=0$ $z=(2n+1)\frac{\pi}{2}$ *where* $n=0,\pm1,\pm2,\pm3,....$ $\operatorname{Res}\left[f(z),a\right]=\frac{P(a)}{Q'(a)}$ Now $\frac{P(z)}{Q'(z)}=\frac{\sin z}{-\sin z}=-1$ $\operatorname{Res}\left[f(z),(2n+1)\frac{\pi}{2}\right]=-1$ *where* $n=0,\pm1,\pm2,\pm3,....$ Hence the residue of each pole is -1	
24	**Find the zeros of the function** $f(z)=\cot z$ **and it's pole .**BTL1 Given $f(z)=\cot z=\frac{\cos z}{\sin z}=\frac{P(z)}{Q(z)}$ The poles are given by $\sin z=0$ $z=n\pi$ *where* $n=0,\pm1,\pm2,\pm3,....$ Residue of f(z) at $z=n\pi$ is $\frac{P[n\pi]}{Q'[n\pi]}$ $\frac{P(z)}{Q'(z)}=\frac{\cos z}{\cos z}$ $\frac{P(z)}{Q'(z)}=\frac{\cos(2n+1)\frac{\pi}{2}}{\cos(2n+1)\frac{\pi}{2}}=1$ *where* $n=0,\pm1,\pm2,\pm3,....$	
25	**Find residue of** $f(z)=\frac{z^2}{(z-1)^2(z+2)}$ **and at its simple pole.** BTL1	

	Given $f(z)=\dfrac{z^2}{(z-1)^2(z+2)}$ The poles of f(z) are given by $(z-1)^2(z+2)=0$ $z=1$ is a pole of order 2 and $z=-2$ is a pole order 1[Simple pole] Residue of f(z) at z=-2: [simple Pole] $\text{Res}\left[f(z)\right]_{z=a}=\lim\limits_{z\to a}(z-a)f(z)$ $\text{Res}\left[f(z)\right]_{z=-2}=\lim\limits_{z\to -2}(z+2)\dfrac{z^2}{(z-1)^2(z+2)}=\lim\limits_{z\to -2}\dfrac{z^2}{(z-1)^2}=\dfrac{4}{9}$	
26	**Evaluate** $\int_C \dfrac{3z^2+7z+1}{(z+1)}dz$ **where C is the circle** $\lvert z\rvert=\dfrac{1}{2}$ **(MAY/JUNE 2018 R-17)** BTL3 Here z=-1 lies outside C. Therefore $\begin{cases} f(z) \text{ is analytic inside and on C.} \\ \text{And } f'(z) \text{ is Continuous inside C} \end{cases}$ $\therefore \int_C f(z)dz=0$	
27	**If C is the circle** $\lvert z\rvert=3$ and if $g(z_0)=\int_C \dfrac{2z^2-z-2}{(z-z_0)}dz$ then find g(2) **(MAY/JUNE 2018 R-17)** BTL3 $\int_C f(z)dz=2\pi i$ [sum of the residues] Here $z=2$ is a pole order 1[Simple pole] $\left\{\text{Res } f(z)_{at\, z=2}\right\}=\lim\limits_{z\to 2}(z-2)\left[\dfrac{2z^2-z-2}{(z-2)}\right]=4$ $\int_C \dfrac{2z^2-z-2}{(z-2)}dz = 8\pi i$	
	PART-B	
1.	**Use Cauchy's integral formula to evaluate** $\int_C \dfrac{\sin\pi z^2+\cos\pi z^2}{(z-1)(z-2)}dz$ **where C is the circle** $\lvert z\rvert=3$ **(MAY/JUNE 2016) (8 M)**BTL3 **Answer : Refer Page No.4.10-Dr.M.CHANDRASEKAR** • $\dfrac{\sin\pi z^2+\cos\pi z^2}{(z-1)(z-2)}=\dfrac{1}{(z-2)}-\dfrac{1}{(z-1)}$ **(2M)**	

	• $\int_C \frac{f(z)}{(z-a)}dz = 2\pi i\ f(a)$ **(2M)** • $\int_C \frac{\sin \pi z^2 + \cos \pi z^2}{(z-1)(z-2)}dz = 4\pi i$ **(4M)**	
2.	**Use Cauchy's integral formula to evaluate** $\int_C \frac{z+4}{(z^2+2z+5)}dz$ **where C is the circle** $\lvert z+1-i \rvert = 3$ **(NOV/DEC 2006) (NOV/DEC 2014) (8 M)**BTL3 **Answer : Refer Page No.4.16-Dr.M.CHANDRASEKAR** • $\frac{z+4}{(z^2+2z+5)} = \frac{\left(\frac{3+2i}{4i}\right)}{z-(-1+2\mathrm{i})} + \frac{\left(\frac{3-2i}{-4i}\right)}{z-(-1-2\mathrm{i})}$ **(2M)** • $\int_C \frac{f(z)}{(z-a)}dz = 2\pi i\ f(a)$ **(2M)** • $\int_C \frac{z+4}{(z^2+2z+5)}dz = \frac{\pi(3+2i)}{2}$ **(4M)**	
3.	**Use Cauchy's integral formula to evaluate** $\int_C \frac{z}{(z-1)(z-2)}dz$ **where C is the circle** $\lvert z-2 \rvert = \frac{1}{2}$ **(MAY/JUNE 2015) (8 M)**BTL3 **Answer : Refer Page No.4.24-Dr.M.CHANDRASEKAR** • $\int_C \frac{f(z)}{(z-a)}dz = 2\pi i\ f(a)$ **(2M)** • $\int_C \frac{z}{(z-1)(z-2)}dz = 4\pi i$ **(6M)**	
4.	**Use Cauchy's integral formula to evaluate** $\int_C \frac{z+1}{(z-3)(z-1)}dz$ **where C is the circle** $\lvert z \rvert = 2$ **(MAY/JUNE 2016) (8 M)** BTL3 **Answer : Refer Page No.4.29-Dr.M.CHANDRASEKAR** • $\int_C \frac{f(z)}{(z-a)}dz = 2\pi i\ f(a)$ **(2M)**	

	• $\int_C \frac{z+1}{(z-3)(z-1)}dz = -2\pi i$ **(6M)**	
5.	**Use Cauchy's integral formula to evaluate** $\int_C \frac{z-1}{(z-2)(z+1)^2}dz$ **where C is the circle** $\|z-i\|=2$ **(8 M)** BTL3 **Answer : Refer Page No.4.31-Dr.M.CHANDRASEKAR** • $\int_C \frac{f(z)}{(z-a)^{n+1}}dz = \begin{cases} \frac{2\pi i}{n!} f^n(a) \text{ ; a lies inside c} \\ 0 \text{ ; a lies outside c} \end{cases}$ **(2M)** • $\int_C \frac{z-1}{(z-2)(z+1)^2}dz = -\frac{2\pi i}{9}$ **(6M)**	
6.	**Use Cauchy's integral formula to evaluate** $\int_C \frac{z^2}{(z^2+1)^2}dz$ **where C is the circle** $\|z-i\|=1$ **(MAY/JUNE 2018 R-17)(8 M)**BTL3 **Answer : Refer Page No.4.30-Dr.M.CHANDRASEKAR** • $\int_C \frac{f(z)}{(z-a)^{n+1}}dz = \begin{cases} \frac{2\pi i}{n!} f^n(a) \text{ ; a lies inside c} \\ 0 \text{ ; a lies outside c} \end{cases}$ **(2M)** • $\int_C \frac{z^2}{(z^2+1)^2}dz = \frac{\pi}{2}$ **(6M)**	
7.	**Use Cauchy's integral formula to evaluate** $\int_C \frac{z+1}{(z^2+2z+4)}dz$ **where C is the circle** $\|z+1+i\|=2$. **(8 M)** BTL3 **Answer : Refer Page No.4.39-Dr.M.CHANDRASEKAR** • $\int_C \frac{f(z)}{(z-a)}dz = 2\pi i\ f(a)$ **.(2M)** • $\int_C \frac{z+1}{(z^2+2z+4)}dz = \pi i$ **(6M)**	
8.	**Expand** $\frac{z^2-1}{(z+2)(z+3)}$ **in the appropriate series in the regions** $(i)\ 2<\|z\|<3 \quad (ii)\ \|z\|>3$ **using Laurent's series. (8 M)**BTL2 **Answer : Refer Page No.4.51-Dr.M.CHANDRASEKAR**	

	• $f(z)=1+\frac{3}{z+2}-\frac{8}{z+3}$ **(2M)** (i) In $2<\|z\|<3,$ • $f(z)=1+\frac{3}{z}\sum_{n=0}^{\infty}(-1)^n\left(\frac{2}{z}\right)^n-\frac{8}{3}\sum_{n=0}^{\infty}(-1)^n\left(\frac{z}{3}\right)^n$ **(3M)** (ii) In $\|z\|>3,$ • $f(z)=1+\frac{3}{z}\sum_{n=0}^{\infty}(-1)^n\left(\frac{2}{z}\right)^n-\frac{8}{z}\sum_{n=0}^{\infty}(-1)^n\left(\frac{3}{z}\right)^n$ **(3M)**	
9.	**Expand** $f(z)=\frac{7z-2}{z(z-2)(z+1)}$ **in Laurent's series in the regions** $(i)\,2<\|z\|<3 \quad (ii)\,\|z\|>3$ **(8 M)**BTL2 **Answer : Refer Page No.4.52-Dr.M.CHANDRASEKAR** • $f(z)=\frac{1}{z}+\frac{2}{z-2}-\frac{3}{z+1}$ **(2M)** (i) In $2<\|z\|<3,$ • $f(z)=\frac{1}{z}+\sum_{n=0}^{\infty}\left(\frac{2}{z}\right)^{n+1}+3\sum_{n=0}^{\infty}(-1)^{n+1}\left(\frac{1}{z}\right)^{n+1}$ **(3M)** (ii) In $\|z\|>3,$ • $f(z)=\frac{1}{z}+\sum_{n=0}^{\infty}\left(\frac{2}{z}\right)^{n+1}+3\sum_{n=0}^{\infty}(-1)^{n+1}\left(\frac{1}{z}\right)^{n+1}$ **(3M)**	
10.	**Expand** $f(z)=\frac{7z-2}{z(z-2)(z+1)}$ **in Laurent's series in the region** $(i)\|z\|<2 \quad (ii)\,1<\|z+1\|<3$ **(MAY/JUNE 2014) (8 M)**BTL2 **Answer : Refer Page No.4.52-Dr.M.CHANDRASEKAR** • $f(z)=\frac{1}{z}+\frac{2}{z-2}-\frac{3}{z+1}$ **(2M)** (i) In $\|z\|<2,$ • $f(z)=\frac{1}{z}-\sum_{n=0}^{\infty}\left(\frac{z}{2}\right)^n-3\sum_{n=0}^{\infty}(z)^n$ **(3M)**	

	(ii) In $1<\|z+1\|<3,$ • $f(z)=\frac{-3}{z+1}+\sum_{n=1}^{\infty}\left(\frac{1}{z+1}\right)^n-\frac{2}{3}\sum_{n=0}^{\infty}\left(\frac{z+1}{3}\right)^n$ **(3M)**	
11.	**Expand** $f(z)=\frac{6z+5}{z(z-2)(z+1)}$ **in Laurent's series in the region** $1<\|z+1\|<3$ **(MAY/JUNE 2018 R-17) (8 M)**BTL2 **Answer : Refer Page No.4.56-Dr.M.CHANDRASEKAR** • $f(z)=\frac{-5}{2z}+\frac{17}{6(z-2)}-\frac{1}{3(z+1)}$ **(2M)** In $1<\|z+1\|<3,$ • $f(z)=\frac{-1}{3(z+1)}-\frac{5}{2(z+1)}\sum_{n=0}^{\infty}\left(\frac{1}{z+1}\right)^n-\frac{17}{8}\sum_{n=0}^{\infty}\left(\frac{z+1}{3}\right)^n$ **(6M)**	
12.	**Expand** $f(z)=\frac{1}{(z-1)(z-2)}$ **in Laurent's series in the region** $(i)\|z\|>2 \quad (ii)\ 0<\|z-1\|<1$ **(NOV/DEC 2014) (8 M)**BTL2 **Answer : Refer Page No.4.57-Dr.M.CHANDRASEKAR** • $f(z)=\frac{-1}{z-1}+\frac{1}{z-2}$ **(2M)** (i) In $\|z\|>2,$ • $f(z)=-\sum_{n=0}^{\infty}\left(\frac{1}{z}\right)^n+\frac{1}{z}\sum_{n=0}^{\infty}\left(\frac{2}{z}\right)^n$ **(3M)** (ii) In $0<\|z-1\|<1,$ • $f(z)=\frac{-1}{z-1}+\sum_{n=0}^{\infty}(z-1)^n$ **(3M)**	
13.	**Use Cauchy's Residue theorem to evaluate** $\int_C \frac{\sin\pi z^2+\cos\pi z^2}{(z-1)^2(z-2)}dz$ **where C is the circle** $\|z\|=3$ **(NOV/DEC 2015) (8 M)**BTL3 **Answer : Refer Page No.4.96-Dr.M.CHANDRASEKAR** • $\int_C f(z)dz=2\pi i\ [\text{sum of the residues}]$ **(2M)**	

	• $\left\{\text{Res } f(z)_{at\, z=2}\right\} = 1$ $\left\{\text{Res } f(z)_{at\, z=1}\right\} = -2\pi + 1$ **(4M)** • $\int_C \frac{\sin \pi z^2 + \cos \pi z^2}{(z-1)^2 (z-2)} dz = 4\pi i(1-\pi)$ **(2M)**
14.	**Use Cauchy's Residue theorem to evaluate** $\int_C \frac{12z-7}{(z-1)^2(2z+3)} dz$ **where C is the circle** $\lvert z \rvert = 2$ **(8 M)**BTL3 **Answer : Refer Page No.4.92-Dr.M.CHANDRASEKAR** • $\int_C f(z)dz = 2\pi\text{i [sum of the residues]}$ **(2M)** • $\left\{\text{Res } f(z)_{at\, z=-3/2}\right\} = -4$ **(4M)** $\left\{\text{Res } f(z)_{at\, z=1}\right\} = 4$ • $\int_C \frac{12z-7}{(z-1)^2(2z+3)} dz = 0$ **(2M)**
15.	**Use Cauchy's Residue theorem to evaluate** $\int_C \frac{z^2}{(z+1)^2(z^2+4)} dz$ **where C is the circle** $\lvert z \rvert = 3$ **(8 M)** BTL3 **Answer : Refer Page No.4.99-Dr.M.CHANDRASEKAR** • $\int_C f(z)dz = 2\pi\text{i [sum of the residues]}$ **(2M)** $\left\{\text{Res } f(z)_{at\, z=-1}\right\} = -\frac{8}{25}$ • $\left\{\text{Res } f(z)_{at\, z=2i}\right\} = \frac{-4}{(1+2i)^2(4i)}$ **(4M)** $\left\{\text{Res } f(z)_{at\, z=-2i}\right\} = \frac{-4}{(1-2i)^2(-4i)}$ • $\int_C \frac{z^2}{(z+1)^2(z^2+4)} dz = 0$ **(2M)**
16.	**Use Cauchy's Residue theorem to evaluate** $\int_C \frac{dz}{(z^2+4)^2}$ **where C is the circle** $\lvert z - i \rvert = 2$ **(8 M)**BTL3

	Answer : Refer Page No.4.100-Dr.M.CHANDRASEKAR • $\int_C f(z)dz = 2\pi i$ [sum of the residues] **(2M)** • $\left\{\text{Res } f(z)_{at\, z=2i}\right\} = \frac{1}{32i}$ **(4M)** $\left\{\text{Res } f(z)_{at\, z=-2i}\right\} = 0$ • $\int_C \frac{dz}{(z^2+4)^2} = \frac{\pi}{16}$ **(2M)**	
17.	**Evaluate** $\int_0^{2\pi} \frac{\cos 2\theta}{5+4\cos\theta} d\theta$ **by using Contour integration (MAY/JUNE 2018 R-17) (16M)**BTL5 **Answer : Refer Page No.4.105-Dr.M.CHANDRASEKAR** • $\int_0^{2\pi} \frac{\cos 2\theta}{5+4\cos\theta} d\theta = \frac{1}{4i} \int_C \frac{(z^2+1)dz}{z^2(z+1/2)(z+2)}$ **(4M)** • $\int_C f(z)dz = 2\pi i$ [sum of the residues] **(2M)** $\left\{\text{Res } f(z)_{at\, z=0}\right\} = \frac{-5}{2}$ • $\left\{\text{Res } f(z)_{at\, z=-1/2}\right\} = \frac{17}{6}$ **(8M)** $\left\{\text{Res } f(z)_{at\, z=-2}\right\} = 0$ • $\int_0^{2\pi} \frac{\cos 2\theta}{5+4\cos\theta} d\theta = \frac{\pi}{6}$ **(2M)**	
18.	**Prove that** $\int_0^{2\pi} \frac{d\theta}{5+4\sin\theta} = \frac{2\pi}{3}$ **by using Contour integration. (NOV/DEC 2006) (8 M)** BTL5 **Answer : Refer Page No.4.120-Dr.M.CHANDRASEKAR** • $\int_0^{2\pi} \frac{d\theta}{5+4\sin\theta} = \int_C \frac{dz}{(z+2i)(2z+i)}$ **(3M)** • $\int_C f(z)dz = 2\pi i$ [sum of the residues] **(1M)**	

	• $\left\{\text{Res } f(z)_{at\, z=-i/2}\right\} = \dfrac{1}{3i}$ **(3M)** $\left\{\text{Res } f(z)_{at\, z=-2i}\right\} = 0$ • $\displaystyle\int_0^{2\pi} \frac{d\theta}{5+4\sin\theta} = \frac{2\pi}{3}$ **(1M)**	
19.	**Evaluate** $\displaystyle\int_0^{2\pi} \frac{d\theta}{13+5\sin\theta}$ **by using Contour integration. (NOV/DEC 2014) (8 M)** BTL5 **Answer : Refer Page No.4.123-Dr.M.CHANDRASEKAR** • $\displaystyle\int_0^{2\pi} \frac{d\theta}{13+5\sin\theta} = \int_C \frac{2dz}{(5z+i)(2+5i)}$ **(3M)** • $\displaystyle\int_C f(z)dz = 2\pi i\ [\text{sum of the residues}]$ **(1M)** $\left\{\text{Res } f(z)_{at\, z=5i}\right\} = 0$ • $\left\{\text{Res } f(z)_{at\, z=-\frac{i}{5}}\right\} = \dfrac{1}{12i}$ **(3M)** • $\displaystyle\int_0^{2\pi} \frac{d\theta}{13+5\sin\theta} = \frac{\pi}{6}$ **(1M)**	
20.	**Evaluate** $\displaystyle\int_{-\infty}^{\infty} \frac{x^2dx}{(x^2+1)(x^2+4)}$ **by using Contour integration. (NOV/DEC 2008) (8 M)** BTL5 **Answer : Refer Page No.4.92-Dr.G.BALAJI** • $\displaystyle\int_{-\infty}^{\infty} \frac{x^2dx}{(x^2+1)(x^2+4)} = \int_C \frac{z^2}{(z^2+1)(z^2+4)}dz$ **(1M)** • $\displaystyle\int_C f(z)dz = 2\pi i\ [\text{sum of the residues}]$ **(1M)** • $\left\{\text{Res } f(z)_{at\, z=i}\right\} = \dfrac{i}{6}$ **(3M)** $\left\{\text{Res } f(z)_{at\, z=2i}\right\} = -\dfrac{i}{3}$ • $\displaystyle\int_{-\infty}^{\infty} \frac{x^2dx}{(x^2+1)(x^2+4)} = \frac{\pi}{3}$ **(3M)**	

21.	**Evaluate** $\int_0^\infty \frac{\cos mx}{(x^2+a^2)}dx$ **by using Contour integration. (NOV/DEC 2016) (8 M)**BTL5 **Answer : Refer Page No.4.101-Dr.G.BALAJI** • $\int_0^\infty \frac{\cos mx\,dx}{(x^2+a^2)} = R.P\ of\ \int_C \frac{e^{mz}}{(z^2+a^2)}dz$ **(1M)** • $\int_C f(z)dz = 2\pi i\ [\text{sum of the residues}]$ **(1M)** • $\left\{\text{Res } f(z)_{at\,z=ai}\right\} = \frac{e^{-ma}}{2ai}$ **(3M)** • $\int_0^\infty \frac{\cos mx}{(x^2+a^2)}dx = \frac{\pi e^{-ma}}{2a}$ **(3M)**

	UNIT V LAPLACETRANSFORMS
	Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constantcoefficients.
	PART * A
Q.No.	**Questions**
1.	**State the sufficient condition for the existence of Laplace transforms.** **(OR) State the conditions under which the Laplace Transform of $f(t)$ exisits.** **(APR/MAY 2015, 2017 R-13)**BTL1 The Laplace transform of $f(t)$ exists if a) $f(t)$ is piecewise continuous in $[a,b]$ where $a>0$. b) $f(t)$is of exponential order.
2.	**Is the linearity property applicable to $L\left[\frac{1-cost}{t}\right]$?Reason out?**BTL5 Given, $L\left[\frac{1-cost}{t}\right] = L\left[\frac{1}{t}\right] - L\left[\frac{cos\,t}{t}\right]$by linearity property, provided the result exists. $L\left[\frac{1}{t}\right]$does not exist. Since $\lim_{t\to 0}\frac{1}{t} = \frac{1}{0} = \infty$. $L\left[\frac{cos\,t}{t}\right]$does not exist. Since, $\lim_{t\to 0}\frac{\cos t}{t} = \frac{1}{0} = \infty$.

	$\therefore$ Linearity property is not applicable to $\boldsymbol{L}\left[\frac{\mathbf{1-cost}}{\boldsymbol{t}}\right]$.
3.	**If $\boldsymbol{L}$[F(t)]=$\boldsymbol{F(s)}$, Prove that $\boldsymbol{L}\left[\boldsymbol{f}\left(\frac{\boldsymbol{t}}{\mathbf{5}}\right)\right] = \mathbf{5}\boldsymbol{F}(\mathbf{5}\boldsymbol{s})$.**BTL5 $L[f(t)] = \int_0^\infty e^{-st} f(t)dt$ $put \quad \frac{t}{5} = u \Rightarrow 5du = dt$ $L\left[f\left(\frac{t}{5}\right)\right] = \int_0^\infty e^{-(5s)u} f(u)5du$ $= 5\int_0^\infty e^{-(5s)u} f(u)du = 5F(5s)$
4	**Find the Laplace transform of unit step function.**BTL1 The unit step function is $u_a(t) = \begin{cases} 0 & t < a \\ 1 & t > a, \end{cases} \quad a \geq 0$ The Laplace transform $L[f(t)] = \int_0^\infty e^{-st} f(t)dt = \int_a^\infty e^{-st}(1)dt = \left[\frac{e^{-st}}{-s}\right]_a^\infty = -\frac{1}{s}\left[e^{-\infty} - e^{-as}\right] = \frac{e^{-as}}{s}$.
5	**Prove that $L\left(\int_0^t f(t)dt\right) = \frac{F(s)}{s}$ where $\boldsymbol{L}[\boldsymbol{f}(\boldsymbol{t})] = \boldsymbol{F}(\boldsymbol{s})$. [DEC 2016 R-13]**BTL5 Let $F(t) = \int_0^t f(t)dt$ $F'(t) = f(t)$ $L[F'(t)] = sL[F(t)] - F(0) = sL[F(t)] - 0$ $L[f(t)] = sL[F(t)] = sL[\int_0^t f(t)dt]$ $\therefore L\left(\int_0^t f(t)dt\right) = \frac{F(s)}{s}$
6	**Does $L\left[\frac{\cos at}{t}\right]$ exist?** BTL4 $\underset{t\to 0}{Lt}\frac{f(t)}{t} = \underset{t\to 0}{Lt}\frac{\cos at}{t} = \frac{1}{0} = \infty$ $\therefore L\left[\frac{\cos at}{t}\right] does \quad not \quad exist.$
7	**Obtain the Laplace transform of $\boldsymbol{sin2t - 2tcos2t}$.**BTL3

	$L[\sin 2t - 2t\cos 2t] = L[\sin 2t] - 2L[t\cos 2t] = L[\sin 2t] - 2\left(-\frac{d}{ds}L[\cos 2t]\right)$ $= \frac{2}{s^2+4} + 2\frac{d}{ds}\left(\frac{s}{s^2+4}\right) = \frac{2}{s^2+4} + 2\left(\frac{(s^2+4)(1)-s(2s)}{(s^2+4)^2}\right)$ $= \frac{2(s^2+4)+2(4-s^2)}{(s^2+4)^2} = \frac{16}{(s^2+4)^2}.$
8	**Find** $L^{-1}\left[\frac{s+2}{s^2+2s+2}\right]$**.**BTL4 $L^{-1}\left[\frac{s+2}{s^2+2s+2}\right] = L^{-1}\left[\frac{(s+1)+1}{(s+1)^2+1}\right]\{\because L^{-1}[F(s+a)] = e^{-at}L^{-1}[F(s)]\}$ $= L^{-1}\left[\frac{(s+1)}{(s+1)^2+1}\right] + L^{-1}\left[\frac{1}{(s+1)^2+1}\right]$ $= e^{-t}\left(L^{-1}\left[\frac{s}{s^2+1}\right] + L^{-1}\left[\frac{1}{s^2+1}\right]\right)$ $= e^{-t}(\cos t + \sin t).$
9	**What is the Laplace transform of $f(t), 0 < t < 10$ with $f(t) = f(t+10)$**?BTL3 Given $f(t)$ is a periodic function with period p. $L[f(t)] = \frac{1}{1-e^{-ps}}\int_0^p e^{-st}f(t)dt$ $put \quad p = 10, \quad L[f(t)] = \frac{1}{1-e^{-10s}}\int_0^{10} e^{-st}f(t)dt$
10	**State and Prove Linearity property. [MAY/JUNE 2016]**BTL1 $Statement: \quad L[af(t) \pm bg(t)] = aL[f(t)] \pm bL[g(t)]$ $proof: \quad L[f(t)] = \int_0^\infty e^{-st}f(t)dt$ $L[af(t) \pm bg(t)] = \int_0^\infty e^{-st}L[af(t) \pm bg(t)]dt$ $= \int_0^\infty e^{-st}af(t)dt \pm \int_0^\infty e^{-st}bg(t)dt$ $= a\int_0^\infty e^{-st}f(t)dt \pm b\int_0^\infty e^{-st}g(t)dt$ $= aL[f(t)] \pm bL[g(t)].$
11	**Find** $L^{-1}\left(\frac{S}{S^2+4S+5}\right)$**. [MAY/JUNE 2016]**BTL3

	$L^{-1}\left(\frac{S}{S^2+4S+5}\right)=L^{-1}\left(\frac{(S+2)-2}{(S+2)^2+1}\right)=e^{-2t}L^{-1}\left(\frac{S-2}{S^2+1}\right)$ $=e^{-2t}\left[L^{-1}\left(\frac{S-2}{S^2+1}\right)-2L^{-1}\left(\frac{1}{S^2+1}\right)\right]=e^{-2t}[\cos t-2\sin t].$
12	**Find** $L[te^{-3t}\cos 2t]$**.**BTL3 We know that $L[t\cos at]=\frac{s^2-a^2}{(s^2+a^2)^2}$, $L[te^{-3t}\cos 2t]=\left[\frac{s^2-2^2}{(s^2+2^2)^2}\right]_{s\to s+3}=\frac{(s+3)^2-2^2}{((s+3)^2+2^2)^2}$
13	**Find**$\boldsymbol{L^{-1}}\left[\tan^{-1}\left(\frac{1}{s}\right)\right]$**.** BTL3 $Let \quad F(s)=\tan^{-1}\left(\frac{1}{s}\right)$ $F'(s)=\frac{1}{1+\left(1/s\right)^2}\left(\frac{-1}{s^2}\right)=\frac{-1}{s^2+1}$ $By \quad property \quad L^{-1}\left[F'(s)\right]=-L^{-1}\left[\frac{1}{s^2+1}\right]=-\sin t$ $\therefore L^{-1}\left[F'(s)\right]=-\sin t;$ $L^{-1}\left[F(s)\right]=\frac{-1}{t}L^{-1}\left[F'(s)\right]$ $\mathrm{L}^{-1}\left[\tan^{-1}\left(\frac{1}{s}\right)\right]=\frac{\sin t}{t}.$
14	**Solve using Laplace transform** $\frac{dy}{dt}+y=e^{-t}$ **given that** $\boldsymbol{y(0)=0}$.BTL3 Taking Laplace transform on both sides, we get $L[y'(t)]+L[y(t)]=L[e^{-t}]$ $sL[y(t)]-y(0)+L[y(t)]=L[e^{-t}]$ $sL[y(t)]-0+L[y(t)]=\frac{1}{s+1}$

	$(s+1)L[y(t)] = \frac{1}{s+1}$ $L[y(t)] = \left(\frac{1}{(s+1)^2}\right)$ $\therefore y(t) = L^{-1}\left(\frac{1}{(s+1)^2}\right) = e^{-t}L\left(\frac{1}{s^{2}}\right) = e^{-t}t.$ $\{\because L[e^{-at}f(t)] = F(s+a)\}$
15	**Given an example for a function that do not have Laplace transform.**BTL5 Consider $\boldsymbol{f(t) = e^{t^2}}$, since $\underset{t\to\infty}{Lt}\, e^{-st}e^{t^2} = \infty$, hence $\boldsymbol{e^{t^2}}$ is not exponential order. Hence $\boldsymbol{f(t) = e^{t^2}}$ does not have Laplace transform.
16	**Can $\boldsymbol{F(s) =}$ $\frac{s^3}{(s+1)^2}$ be the Laplace transform of some $\boldsymbol{f(t)}$?**BTL5 $\underset{s\to\infty}{Lt}\, F(s) = \underset{s\to\infty}{Lt}\, \frac{s^3}{(s+1)^2} \neq 0$ Hence $\boldsymbol{F(s)}$ cannot be Laplace transform of $\boldsymbol{f(t)}$.
17	**Evaluate** $\int_0^t \sin u \cos(t-u)du$ **using Laplace Transform.**BTL3 $Let \quad L\left[\int_0^t \sin u \cos(t-u)du\right] = L[\sin t * \cos t]$ $= L[\sin t]L[\cos t] \qquad (by \quad convolution \quad theorem)$ $= \frac{1}{(s^2+1)}\frac{s}{(s^2+1)} = \frac{s}{(s^2+1)^2}.$ $\int_0^t \sin u \cos(t-u)du = L^{-1}\left[\frac{s}{(s^2+1)^2}\right] = \frac{1}{2}L^{-1}\left[\frac{2s}{(s^2+1)^2}\right] = \frac{t}{2}\sin t.$ $\left[\because L^{-1}\left(\frac{2s}{(s^2+1)^2}\right) = t\sin at\right].$
18	**Given an example for a function having Laplace transform but not satisfying the continuity condition.**BTL1 $f(t) = t^{\frac{-1}{2}}$ has Laplace transform even though it does not satisfy the continuity condition. (i.e.) It is not piecewise continuous in $(0,\infty)$ $\quad as \underset{t\to 0}{Lt}\, f(t) = \infty.$
19	**Define a Periodic function with example.**BTL1 $\boldsymbol{f(t)}$ for all $\boldsymbol{t}$. The least value of $\boldsymbol{p > 0}$ is called the period of $\boldsymbol{f(t)}$. For example, $\boldsymbol{\sin t}$ and $\boldsymbol{\cos t}$ are periodic functions with period $2\boldsymbol{\pi}$.
20	**If $\boldsymbol{L[f(t)] = F(s)}$, find $\boldsymbol{L[f(at)]}$. [APR/MAY 2018 R-17]**BTL5

	$L[f(at)] = \int_0^\infty e^{-st} f(at)dt$ $put \qquad u = at$ $L[f(at)] = \int_0^\infty e^{-\left(\frac{s}{a}\right)u} f(u)\frac{du}{a} = \frac{1}{a}\int_0^\infty e^{-\left(\frac{s}{a}\right)u} f(u)du = \frac{1}{a}F\left(\frac{s}{a}\right).$
21	**Find the Laplace transform of $\frac{t}{e^t}$. [APR/MAY 2018 R-17]**BTL3 $L\left[\frac{t}{e^t}\right] = L[e^{-t}t] = \left[\frac{1}{s^2}\right]_{s\to s+1} = \frac{1}{(s+1)^2}$.
22	**State Convolution theorem on Laplace Transform. [MAY/JUNE 2017 R-13]**BTL1 The Laplace transform of convolution of two functions is equal to the product of their Laplace transform. (i.e) $L[f(t)*g(t)] = L[f(t)]L[g(t)]$.
23	**Find** $L\left[\frac{1}{\sqrt{t}}\right]$. **[APR/MAY 2017 R-13]**BTL3 We know that, $L[t^n] = \frac{\Gamma(n+1)}{s^{n+1}}$ $L\left[\frac{1}{\sqrt{t}}\right] = L[t^{-1/2}]$ $= \frac{\Gamma(-1/2+1)}{s^{-1/2+1}}$ $= \frac{\Gamma(1/2)}{s^{1/2}} = \sqrt{\frac{\pi}{s}}.$
24	**Find the Laplace transform $sin^3(2t)$.**BTL3 $L[\sin^3(2t)] = \frac{1}{4}L[3\sin 2t - \sin 6t]$ $= \frac{3}{4}L[\sin 2t] - \frac{1}{4}L[\sin 6t]$ $\{\because \sin^3 t = \frac{1}{4}[3\sin t - \sin 3t]\}$ $= \frac{3}{4}\left(\frac{2}{s^2+4}\right) - \frac{1}{4}\left(\frac{6}{s^2+36}\right)$ $= \frac{6}{4}\left\{\left(\frac{1}{s^2+4}\right) - \left(\frac{1}{s^2+36}\right)\right\}$
25	**Find the Laplace transform of $e^{-2t}t^{1/2}$.**BTL3

	$L(e^{-2t}t^{1/2}) = L[t^{1/2}]_{s\to s+2}$ $\because if \quad L[f(t)] = F(s), \quad then \quad l[e^{-at}f(t)] = F(s)/_{s\to s+2}$ $\left[\dfrac{\Gamma\left(\frac{1}{2}+1\right)}{s^{\frac{3}{2}}}\right]_{s\to s+2} = \left[\dfrac{\frac{1}{2}\Gamma\left(\frac{1}{2}\right)}{s^{\frac{3}{2}}}\right]_{s\to s+2}$ $= \dfrac{\frac{1}{2}\sqrt{\pi}}{(s+2)^{\frac{3}{2}}} \qquad \left(\because \Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}, \quad \Gamma n+1 = n\Gamma n\right).$
26	**Does** $L\left[\dfrac{\cos at}{t}\right]$ **exist?** BTL5 $\underset{t\to 0}{Lt}\dfrac{f(t)}{t} = \underset{t\to 0}{Lt}\dfrac{\cos at}{t} = \dfrac{1}{0} = \infty$ $\therefore L\left[\dfrac{\cos at}{t}\right] does \quad not \quad exist.$
27	**Using Laplace transform, Evaluate** $\int_0^\infty te^{-2t}\sin t\,dt$ **. [APR/MAY 2015 R-13]** BTL3 $\int_0^\infty e^{-2t}f(t)dt = \left[\int_0^\infty e^{-st}f(t)dt\right]_{s=2} = [L[t\sin t]]_{s=2} = \left[-\dfrac{d}{ds}L[\sin t]\right]_{s=2} = -\dfrac{d}{ds}\left(\dfrac{1}{s^2+1}\right) = \dfrac{4}{25}$
	Part*B
1	**Find** **1)** $L[\frac{sinh2t}{t}]$. **2)** $L[\frac{e^{-t}sint}{t}]$ **3)** $L[\frac{cosat-\cos bt}{t}]$. **[APR/MAY 2011,2015, NOV/DEC 2012,2016 R-13] (12M)** BTL3 **Answer: Refer Page No:5.35-Dr. G. Balaji.** 1) $L\left[\dfrac{\sinh 2t}{t}\right] = \int_s^\infty L[\sinh 2t]ds = \int_s^\infty \dfrac{2}{s^2-4}ds = 2\left[\dfrac{1}{2(2)}\log\left(\dfrac{s-2}{s+2}\right)\right]_s^\infty$ $= \dfrac{1}{2}\left[\log\dfrac{s+2}{s-2}\right] = \log\sqrt{s+2/s-2} \qquad (4M)$ 2)

	$L\left[\frac{e^{-t}\sin t}{t}\right] = \left[L\left[\sin t/t\right]\right]_{s\to s+1}$ $= \left[\cot^{-1} s\right]_{s\to(s+1)} = \cot^{-1}(s+1). \qquad (3M)$ 3) $L\left[\frac{\cos at - \cos bt}{t}\right] = \int_s^\infty L[\cos at - \cos bt]ds$ $= \int_s^\infty \left[\frac{s}{s^2+a^2} - \frac{s}{s^2+b^2}\right]ds = \frac{1}{2}\left[\log(s^2+a^2) - \log(s^2+b^2)\right]_s^\infty = \frac{1}{2}\log\frac{s^2+b^2}{s^2+a^2}. \qquad (5M)$
2	**1) State and prove Initial Value and Final value theorem. [APR/MAY 2017 R-13]** **2) Verify the initial and Final value theorem for $f(t) = 1 + e^t(\sin t + \cos t)$. [NOV/DEC 2009, MAY/JUNE 2012R-13]** **3) Using the initial value theorem, find $\underset{s\to\infty}{Lt}\, sL[f(t)]$ for the function $f(t) = e^{-t}\cos t$. [NOV/DEC 2016 R-13] (16M)**BTL3 **Answer: Refer Page No:5.40-Dr. G. Balaji.** 1) <u>Initial Value theorem Statement:</u> $L[f(t)] = F(s),\quad then \quad \underset{t\to 0}{Lt}\, f(t) = \underset{s\to\infty}{Lt}\, sF(s).$ $\Pr oof: We \quad know \quad that \quad L[f'(t)] = sL[f(t)] - f(0) = sF(s) - f(0)$ $= \int_0^\infty e^{-st} f'(t)dt$ $\underset{s\to\infty}{Lt}\left[sF(s) - f(0)\right] = \underset{s\to\infty}{Lt}\int_0^\infty e^{-st} f'(t)dt = \underset{s\to\infty}{Lt}\, sF(s) - f(0) = 0$ $hence \quad \underset{t\to 0}{Lt}\, f(t) = \underset{s\to\infty}{Lt}\, sF(s). \qquad (2M)$ <u>Final Value theorem Statement:</u> $L[f(t)] = F(s),\quad then \quad \underset{t\to\infty}{Lt}\, f(t) = \underset{s\to 0}{Lt}\, sF(s).$ $\Pr oof: We \quad know \quad that \quad l[f'(t)] = sL[f(t)] - f(0) = sF(s) - f(0)$ $= \int_0^\infty e^{-st} f'(t)dt$ $\underset{s\to 0}{Lt}\left[sF(s) - f(0)\right] = \underset{s\to 0}{Lt}\int_0^\infty e^{-st} f'(t)dt = \underset{s\to 0}{Lt}\, sF(s) - f(0) = f(\infty) - f(0)$ $hence \quad \underset{t\to\infty}{Lt}\, f(t) = \underset{s\to 0}{Lt}\, sF(s). \qquad (2M)$ 2) $f(t) = 1 + e^t(\sin t + \cos t)$ Initial Value theorem state that $L[f(t)] = F(s),\quad then \quad \underset{t\to 0}{Lt}\, f(t) = \underset{s\to\infty}{Lt}\, sF(s).$

	$L[f(t)] = L[1+e^{t}(\sin t+\cos t)]$ $= \frac{1}{s} + \frac{1}{(s+1)^2+1} + \frac{s+1}{(s+1)^2+1}$ $LHS = \lim_{t\to 0} f(t) = 2.$ $RHS = \underset{s\to\infty}{Lim}\left[1+\frac{s(s+2)}{(s+1)^2+1}\right] = 2 \qquad (4M)$ $LHS = RHS$ Hence, Initial Value theorem verified. Final Value theorem state that $L[f(t)] = F(s),\ then \ \underset{t\to\infty}{Lt} f(t) = \underset{s\to 0}{Lt} sF(s).$ $LHS = \lim_{t\to\infty} f(t) = 1.$ $RHS = \underset{s\to 0}{Lim}\left[1+\frac{s(s+2)}{(s+1)^2+1}\right] = 1 \qquad (4M)$ $LHS = RHS$ 3) Initial Value theorem Statement: $L[f(t)] = F(s),\ then \ \underset{t\to 0}{Lt} f(t) = \underset{s\to\infty}{Lt} sF(s).$ $f(t) = e^{-t}\cos t$ $\lim_{t\to 0} f(t) = 1$ $\lim_{s\to\infty} sF(s) = 1 \qquad (4M)$ Hence proved.
3	**Using convolution theorem find** $L^{-1}\left[\frac{1}{(s+a)(s+b)}\right]$**. [APR/MAY 2011 R-13] (8M)**BTL3 **Answer: Refer Page No:5.77-Dr. G. Balaji.** $L^{-1}\left[\frac{1}{(s+a)(s+b)}\right] = L^{-1}\left[\left(\frac{1}{(s+a)}\right)\left(\frac{1}{(s+b)}\right)\right]$ $= L^{-1}\left(\frac{1}{(s+a)}\right) * L^{-1}\left(\frac{1}{(s+b)}\right)$ $= e^{-at} * e^{-bt} \qquad (3M)$ $= \int_0^t e^{-at}e^{-b(t-u)}du$ $= e^{-bt}\left[\frac{e^{-(a-b)u}}{-(a-b)}\right]_{u=0}^{u=t} \qquad (3M)$ $= \frac{e^{-bt}-e^{-at}}{a-b}. \qquad (2M)$

	Note: **Using convolution theorem find** $L^{-1}\left[\frac{1}{(s+1)(s+2)}\right]$**. [NOV/DEC 2007,2012 R-13] (8M)** **Hint:** In the above problem put $a = 2, b = 1$.
4	**Find the Laplace inverse of** $\left[\frac{s^2}{(s^2+a^2)^2}\right]$ **using convolution theorem. [NOV/DEC 2011R-13] (8M)**BTL3 **Answer: Refer Page No:5.84-Dr. G. Balaji.** $L^{-1}\left[\frac{s^2}{(s^2+a^2)^2}\right] = L^{-1}\left[\left(\frac{s}{(s^2+a^2)}\right)\left(\frac{s}{(s^2+a^2)}\right)\right]$ $= L^{-1}\left(\frac{s}{(s^2+a^2)}\right) * L^{-1}\left(\frac{s}{(s^2+a^2)}\right)$ $= \cos at * \cos at \qquad (3M)$ $= \int_0^t \cos au \cos a(t-u) du$ $= \frac{1}{2}\int_0^t [\cos(au+at-au)+\cos(au-at+au)]du \qquad (2M)$ $= \frac{1}{2}\left[[(\cos at)u] + \left[\frac{\sin[2au-at]}{2a}\right]\right]_{u=0}^{u=t}$ $= \frac{1}{2}\left[t\cos at + \frac{\sin at}{a}\right]$ $L^{-1}\left[\frac{s^2}{(s^2+a^2)^2}\right] = \frac{1}{2a}[\sin at + at\cos at]. \qquad (3M)$ Note: **Using Convolution theorem, find** $L^{-1}\left[\frac{s^2}{(s^2+4)^2}\right]$**. [NOV/DEC 2012 R-13] (8M)** **Hint:** In the problem put $a = 2$.
5	**Using convolution theorem find** $L^{-1}\left[\frac{s}{(s^2+a^2)^2}\right]$**. [NOV/DEC 2013, APR/MAY 2017 R-13] (8M)**BTL3

	Answer: Refer Page No:5.83-Dr. G. Balaji. $L^{-1}\left[\frac{s}{(s^2+a^2)^2}\right]=L^{-1}\left[\left(\frac{s}{(s^2+a^2)}\right)\left(\frac{1}{(s^2+a^2)}\right)\right]$ $=L^{-1}\left(\frac{s}{(s^2+a^2)}\right)*\frac{1}{a}L^{-1}\left(\frac{a}{(s^2+a^2)}\right)$ $=\cos at*\frac{1}{a}\sin at \qquad (3M)$ $=\frac{1}{a}\int_0^t \cos au \sin a(t-u)du$ $=\frac{1}{2a}\int_0^t [\sin(at-au+au)+\sin(at-au-au)]du \qquad (2M)$ $=\frac{1}{2a}\left[\left[(\sin at)u\right]+\left[\frac{-\cos[a(t-2u)]}{-2a}\right]\right]_0^t$ $=\frac{1}{2a}\left[t\sin at+\frac{\cos at}{2a}-\frac{\cos at}{2a}\right]$ $L^{-1}\left[\frac{s}{(s^2+a^2)^2}\right]=\frac{1}{2a}t\sin at. \qquad (3M)$
6	**Using convolution theorem find** $L^{-1}\left[\frac{s}{(s^2+a^2)(s^2+b^2)}\right]$**. [MAY/JUNE 2016 R-13] (8M)**BTL3 **Answer: Refer Page No:5.81-Dr. G. Balaji.** $L^{-1}\left[\frac{s}{(s^2+a^2)(s^2+b^2)}\right]=L^{-1}\left[\left(\frac{s}{(s^2+a^2)}\right)\left(\frac{1}{(s^2+b^2)}\right)\right]$ $=L^{-1}\left(\frac{s}{(s^2+a^2)}\right)*L^{-1}\left(\frac{1}{(s^2+b^2)}\right)$ $=\cos at*\frac{1}{b}\sin bt \qquad (3M)$ $=\frac{1}{b}\int_0^t \cos au \sin b(t-u)du$ $=\frac{1}{2b}\int_0^t [\sin(au+bt-bu)+\sin(bt-bu-au)]du \qquad (2M)$

	$= \frac{1}{2b}\left[\left[\frac{-\cos[(a-b)u+bt}{a-b}\right]+\left[\frac{-\cos[bt-(a+b)u]}{-(a+b)}\right]\right]_0^t$ $= \frac{1}{2b}\left[\cos at\left(\frac{1}{a+b}-\frac{1}{a-b}\right)-\cos bt\left(\frac{1}{a+b}-\frac{1}{a-b}\right)\right]$ $L^{-1}\left[\frac{s}{(s^2+a^2)(s^2+b^2)}\right]=\frac{\cos at-\cos bt}{b^2-a^2}.$ $(3M)$ Note: **Using convolution theorem find** $L^{-1}\left[\frac{s}{(s^2+1)(s^2+4)}\right]$**. [MAY/JUNE 2015,2016 R-13] (8M)** **Hint:** In the above problem put $a=1, b=2$, **Using convolution theorem find** $L^{-1}\left[\frac{s}{(s^2+4)(s^2+9)}\right]$**. [MAY/JUNE 2015,2016 R-13] (8M)** **Hint:** In the above problem put $=2, b=3$.
7	**Find** $L^{-1}\left[\frac{s^2}{(s^2+a^2)(s^2+b^2)}\right]$ **using convolution theorem. [APR/MAY 2014, 2015,2016, NOV/DEC 2014, 2016 R-13] (8M)**BTL3 **Answer: Refer Page No:5.86-Dr. G. Balaji.** $L^{-1}\left[\frac{s^2}{(s^2+a^2)(s^2+b^2)}\right]=L^{-1}\left[\left(\frac{s}{(s^2+a^2)}\right)\left(\frac{s}{(s^2+b^2)}\right)\right]$ $=L^{-1}\left(\frac{s}{(s^2+a^2)}\right)*L^{-1}\left(\frac{s}{(s^2+b^2)}\right)$ $=\cos at*\cos bt$ $(3M)$ $=\int_0^t \cos au\cos b(t-u)du$

	$= \frac{1}{2}\int_0^t [\cos(au+bt-bu)+\cos(au-bt+bu)]du \qquad (2M)$ $= \frac{1}{2}\left[\left[\frac{\sin[(a-b)u+bt}{a-b}\right]+\left[\frac{\sin[(a+b)u-bt}{a+b}\right]\right]_0^t$ $= \frac{1}{2}\left[\sin at\left(\frac{1}{a-b}+\frac{1}{a+b}\right)+\sin bt\left(\frac{1}{a+b}-\frac{1}{a-b}\right)\right]$ $L^{-1}\left[\frac{s^2}{(s^2+a^2)(s^2+b^2)}\right]=\frac{a\sin at-b\sin bt}{a^2-b^2}. \qquad (3M)$ Note: **Find** $L^{-1}\left[\frac{s^2}{(s^2+1)(s^2+4)}\right]$ **using convolution theorem. [APR/MAY 2017 R-13] (8M)** **Hint:** In the above problem put $a = 1$ & $b = 2$.
8	**Find the Laplace transform of the rectangular wave given by** $f(t)=\begin{cases} k & ,0<t<b \\ -k & ,b<t<2b \end{cases}$. **[APR/MAY 2008, 2015 R-13] (8M)**BTL5 **Answer: Refer Page No:5.92-Dr. G. Balaji.** Given, $f(t)=\begin{cases} k & ,0<t<b \\ -k & ,b<t<2b \end{cases}$. This function is periodic in the interval $(0,2b)$ with period $2b$. $L[f(t)]=\frac{1}{1-e^{-ps}}\int_0^p e^{-st}f(t)dt$ $L[f(t)]=\frac{1}{1-e^{-2bs}}\int_0^{2b} e^{-st}f(t)dt$ $=\frac{1}{1-e^{-2bs}}\left[\int_0^b e^{-st}(k)dt+\int_b^{2b} e^{-st}(-k)dt\right] \qquad (2M)$ $=\frac{k}{1-e^{-2bs}}\left[\left[\frac{e^{-st}}{-s}\right]_0^b-\left[\frac{e^{-st}}{-s}\right]_b^{2b}\right] \qquad (2M)$

	$=\frac{k}{s}\frac{1}{1-e^{-2bs}}\left[1-2e^{-bs}+e^{-2bs}\right]$ $=\frac{k}{s}\frac{\left[1-e^{-bs}\right]^2}{\left(1-e^{-bs}\right)\left(1+e^{-bs}\right)}$ $(2M)$ $=\frac{k}{s}\tanh\left[\frac{bs}{2}\right]$ $(2M)$ Note: **Find the Laplace transform of the rectangular wave given by** $f(t)=\begin{cases}1 & ,0<t<b\\ -1 & ,b<t<2b\end{cases}$. **[APR/MAY 2013, 2014 R-13] (8M)** **Hint:** In the above problem put $k=1$. **Find the Laplace transform of the rectangular wave given by** $f(t)=\begin{cases}E & ,0<t<a\\ -E & ,a<t<2a\end{cases}$ **for all** $\boldsymbol{f(t+2a)=f(t)}$ **[NOV/DEC 2010 R-13] (8M)** **Hint:** In that above solved problem put $k=E$and $b=a$.
9	**Find the Laplace transform of a square wave function given by** $f(t)=\begin{cases}E & for\quad 0\le t\le a/2\\ -E & for\quad a/2\le t\le a\end{cases}$ **and** $\boldsymbol{f(t+a)=f(t)}$. **[NOV/DEC 2011, 2016, MAY/JUNE 2016 R-13] (8M)**BTL5 **Answer: Refer Page No:5.95-Dr. G. Balaji.** $L[f(t)]=\frac{1}{1-e^{-ps}}\int_0^p e^{-st}f(t)dt$ $L[f(t)]=\frac{1}{1-e^{-as}}\int_0^a e^{-st}f(t)dt$ $=\frac{1}{1-e^{-as}}\left[\int_0^{a/2}e^{-st}(E)dt+\int_{a/2}^{a}e^{-st}(-E)dt\right]$ $(2M)$ $=\frac{E}{1-e^{-as}}\left[\left[\frac{e^{-st}}{-s}\right]_0^{a/2}-\left[\frac{e^{-st}}{-s}\right]_{a/2}^{a}\right]$ $(2M)$

$$= \frac{E}{s}\frac{1}{1-e^{-as}}\left[1-2e^{-as/2}+e^{-sa}\right]$$

$$= \frac{E}{s}\frac{\left[1-e^{-as/2}\right]^2}{\left(1-e^{-as/2}\right)\left(1+e^{-as/2}\right)} \qquad (2M)$$

$$= \frac{E}{s}\tanh\left[\frac{as}{4}\right] \qquad (2M)$$

10

Find the Laplace Transform of triangular wave function $\begin{cases} t & , \ 0<t<a \\ 2a-t & , \ a<t<2a \end{cases}$ **with** $\boldsymbol{f(t+2a)=f(t)}$. **[APR/MAY 2000, 2008, 2015, 2016, MAY/JUNE 2006, 2009, 2012, NOV/DEC 2005, 2009, 2014 R-13] (8M)**BTL5

Answer: Refer Page No:5.94-Dr. G. Balaji.

$$L[f(t)] = \frac{1}{1-e^{-2as}}\int_0^{2a} e^{-st} f(t)dt$$

$$= \frac{1}{1-e^{-2as}}\left[\int_0^a e^{-st}t\,dt + \int_a^{2a} e^{-st}(2a-t)dt\right] \qquad (2M)$$

$$L[f(t)] = \frac{1}{1-e^{-2as}}\left[\frac{-ae^{-as}}{s} - \frac{e^{-as}}{s^2} + \frac{1}{s^2} + \frac{ae^{-as}}{s} + \frac{e^{-2as}}{s^2} - \frac{e^{-as}}{s^2}\right] \qquad (3M)$$

$$L[f(t)] = \frac{1}{1-e^{-2as}}\left[\frac{1-2e^{-as}+e^{-2as}}{s^2}\right]$$

$$= \frac{1}{s^2}\frac{(1-e^{-as})^2}{(1-e^{-as})(1+e^{-as})}$$

$$= \frac{1}{s^2}\frac{(1-e^{-as})}{(1+e^{-as})}.$$

$$= \frac{1}{s^2}\tanh\left[\frac{as}{2}\right]. \qquad (3M)$$

11

Using Laplace transform technique, solve $\boldsymbol{y''+y'=t^2+2t}$, given $\boldsymbol{y=4, y'=-2}$ when $\boldsymbol{t=0}$. [NOV/DEC 2013, MAY/JUNE 2016 R-13] (8M)BTL 3

Answer: Refer Page No:5.109-Dr. G. Balaji.

Given: $y''+y'=t^2+2t$, $y=4, y'=-2$ when $t=0$,

	$L[y''(t)]+L[y'(t)]=L[t^2]+2L[t]$ $s^2L[y(t)]-sy(0)-y'(0)+sL[y(t)]-y(0)=\frac{2}{s^3}+2\frac{1}{s^2}$ $(2M)$ $(s^2+s)L[y(t)]=4s+2+\frac{2+2s}{s^3}=\frac{4s^4+2s^3+2+2s}{s^3}$ $L[y(t)]=\frac{4s^4+2s^3+2+2s}{s^3(s^2+s)}$ $L[y(t)]=\frac{4}{s+1}+\frac{2}{s(s+1)}+\frac{2}{s^4}$ $(3M)$ $L[y(t)]=\frac{2}{s}+\frac{2}{s+1}+\frac{2}{s^4}$ $y(t)=2L^{-1}\left[\frac{1}{s}\right]+2L^{-1}\left[\frac{1}{s+1}\right]+2L^{-1}\left[\frac{1}{s^4}\right]$ $y(t)=2+2e^{-t}+\frac{1}{3}t^3.$ $(3M)$
12	**Solve** $\frac{d^2y}{dt^2}+4y=\sin 2t$, **given** $y(0)=3$, **and** $y'(0)=4$. **[MAY/JUNE 2014 R-13] (8M)**BTL 3 **Answer: Refer Page No:5.106-Dr. G. Balaji.** Given: $\frac{d^2y}{dt^2}+4y=\sin 2t$, $y(0)=3$, and $y'(0)=4$. $L[y''(t)]+4L[y(t)]=L[\sin 2t]$ $[s^2L[y(t)]-sy(0)-y'(0)]+4L[y(t)]=\frac{2}{s^2+4}$ $[s^2+4]L[y(t)]=\frac{2}{s^2+4}+3s+4$ $(3M)$ $L[y(t)]=\frac{2}{(s^2+4)^2}+\frac{3s}{s^2+4}+\frac{4}{s^2+4}$ $y(t)=\frac{2}{8}L^{-1}\left[\frac{(s^2+2^2)-(s^2-2^2)}{(s^2+2^2)^2}\right]+3\cos 2t+\frac{4}{2}\sin 2t.$ $(3M)$ $y(t)=\frac{1}{8}\sin 2t-\frac{1}{4}t\cos 2t+3\cos 2t+2\sin 2t.$ $(2M)$
13	**Solve** $\frac{d^2x}{dt^2}-3\frac{dx}{dt}+2x=2$ **given** $x=0$ **and** $\frac{dx}{dt}=5$ **for** $t=0$ **using Laplace transform method. [APR/MAY 2011, NOV/ DEC 2012 R-13] (8M)**BTL 3 **Answer: Refer Page No:5.100-Dr. G. Balaji.** Given: $\frac{d^2x}{dt^2}-3\frac{dx}{dt}+2x=2$ given $x=0$ and $\frac{dx}{dt}=5$for $t=0$.

	$L[x''(t)]-3L[x'(t)]+2L[x(t)]=L[2]$ $[s^2L[x(t)]-sx(0)-x'(0)]-3[sL[x(t)]-x(0)]+2L[x(t)]=2L[1]$ $[s^2-3s+2]L[x(t)]=\frac{2}{s}+5$ $L[x(t)]=\frac{2+5s}{s(s^2-3s+2)}$ $(2M)$ $L[x(t)]=\frac{1}{s}+\frac{(-7)}{s-1}+\frac{6}{(s-2)}$ $x(t)=L^{-1}\left[\frac{1}{s}\right]-7L^{-1}\left[\frac{1}{s-1}\right]+6L^{-1}\left[\frac{1}{(s-2)}\right]$ $(3M)$ $x(t)=1-7e^t+6e^{2t}$ $(3M)$
14	**Solve using Laplace transform, $x''-2x'+x=e^t$ when $x(0)=2, x'(0)=-1$. [NOV/DEC 2015, APRIL 2017 R-13] (8M).**BTL 3 **Answer: Refer Page No:5.103-Dr. G. Balaji.** Given: $x''(t)-2x'(t)+x(t)=e^t$ $x(0)=2; x'(0)=-1$ $[s^2L[x(t)]-sx(0)-x'(0)]-2[sL[x(t)]-x(0)]+L[x(t)]=L(e^t)$ $L[x(t)](s-1)^2=\frac{1}{s-1}+2s-2-3.$ $(3M)$ $L[x(t)]=\frac{1}{(s-1)^3}+\frac{2(s-1)}{(s-1)^2}-\frac{3}{(s-1)^2}$ $x(t)=L^{-1}\left[\frac{1}{(s-1)^3}\right]+2L^{-1}\left[\frac{1}{(s-1)}\right]-3L^{-1}\left[\frac{1}{(s-1)^2}\right]$ $=e^t\frac{t^2}{2}+2e^t-3e^tt$ $(5M)$
15	**Solve by using L.T$(D^2+9)y=\cos 2t$, given that if $y(0)=1, y\left(\frac{\pi}{2}\right)=-1$. [NOV/DEC 2004, MAY/JUNE 2009, APR/MAY 2015, DEC/JAN 2016 R-13] (8M)**BTL 3 **Answer: Refer Page No: 5.99-Dr. G. Balaji.** Given: $(D^2+9)y=\cos 2t.$ $y''(t)+9y(t)=\cos 2t.$ $L(y''(t))+9L(y(t))=L(\cos 2t).$ $[s^2L[y(t)]-sy(0)-y'(0)]+9L[y(t)]=\frac{s}{s^2+4}.$ $(2M)$ $(s^2+9)L[y(t)]=\frac{s}{s^2+4}+s+k.$

	$L[y(t)]=\frac{s}{(s^2+4)((s^2+9)}+\frac{s+k}{(s^2+9)}.$ $L[y(t)]=\frac{1}{5}\frac{s}{s^2+4}+\frac{4}{5}\frac{s}{s^2+9}+\frac{k}{s^2+9} \quad (2M)$ $y(t)=\frac{1}{5}\cos 2t+\frac{4}{5}\cos 3t+\frac{k}{3}\sin 3t. \quad (2M)$ $\because y\left(\frac{\pi}{2}\right)=-1$ $\therefore y\left(\frac{\pi}{2}\right)=\frac{1}{5}\cos 2\left(\frac{\pi}{2}\right)+\frac{4}{5}\cos 3\left(\frac{\pi}{2}\right)+\frac{k}{3}\sin 3\left(\frac{\pi}{2}\right)=-1$ $k=\frac{12}{5}.$ $y(t)=\frac{1}{5}\cos 2t+\frac{4}{5}\cos 3t+\frac{4}{5}\sin 3t. \quad (2M)$
16	**Find the Laplace transform of theHalf-sine wave rectifier function given by** $f(t)=\begin{cases}\sin\omega t & for\quad 0\le t\le \pi/\omega\\ 0 & for\quad \pi/\omega\le t\le 2\pi/\omega\end{cases}$ **. [NOV/DEC 2012, 2016,2019 MAY/JUNE 2017, 2019 R-13] (8M)**BTL5 **Answer: Refer Page No:5.95-Dr. G. Balaji.** $L[f(t)]=\frac{1}{1-e^{-ps}}\int_0^p e^{-st}f(t)dt$ $L[f(t)]=\frac{1}{1-e^{-as}}\int_0^{2\pi/\omega} e^{-st}f(t)dt$ $=\frac{1}{1-e^{-2\pi/\omega s}}\left[\int_0^{\pi/\omega} e^{-st}(\sin\omega t)dt+\int_{\pi/\omega}^{2\pi/\omega} e^{-st}(0)dt\right] \quad (2M)$ $=\frac{1}{1-e^{-2\pi/\omega s}}\left[\frac{e^{-st}}{s^2+\omega^2}[-s\sin\omega t-\omega\cos\omega t\right]_0^{\pi/\omega} \quad (2M)$ $=\frac{1}{1-e^{-2\pi/\omega s}}\left[\frac{e^{-st}\omega+\omega}{s^2+\omega^2}\right]$ $=\frac{\omega}{[1-e^{-\pi/\omega s}][[s^2+\omega^2]]} \quad (2M)$

PH8253 PHYSICS FOR ELECTRONICS ENGINEERING L T P C
(Common to BME, ME, CC, ECE, EEE, E&I, ICE) **3 0 0 3**

OBJECTIVES:

- ✓ To understand the essential principles of Physics of semiconductor device and Electron transport properties. Become proficient in magnetic, dielectric and optical properties of materials and nano devices.

UNIT I ELECTRICAL PROPERTIES OF MATERIALS 9

Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression - Wiedemann-Franz law – Success and failures - electrons in metals – Particle in a three dimensional box – degenerate states – Fermi- Dirac statistics – Density of energy states – Electron in periodic potential: Bloch thorem – metals and insulators - Energy bands in solids– tight binding approximation - Electron effective mass – concept of hole.

UNIT II SEMICONDUCTOR PHYSICS 9

Intrinsic Semiconductors – Energy band diagram – direct and indirect semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Carrier transport: Velocity-electric field relations – drift and diffusion transport - Einstein‘s relation – Hall effect and devices – Zener and avalanche breakdown in p-n junctions - Ohmic contacts – tunnel diode - Schottky diode – MOS capacitor - power transistor.

UNIT III MAGNETIC AND DIELECTRIC PROPERTIES OF MATERIALS 9

Magnetism in materials – magnetic field and induction – magnetization - magnetic permeability and susceptibility–types of magnetic materials – microscopic classification of magnetic materials - Ferromagnetism: origin and exchange interaction- saturation magnetization and Curie temperature – Domain Theory. Dielectric materials: Polarization processes – dielectric loss – internal field – Clausius-Mosotti relation- dielectric breakdown – high-k dielectrics.

UNIT IV OPTICAL PROPERTIES OF MATERIALS **9**

Classification of optical materials – carrier generation and recombination processes - Absorption emission and scattering of light in metals, insulators and Semiconductors (concepts only) - photo current in a P- N diode – solar cell –photo detectors - LED – Organic LED – Laser diodes – excitons - quantum confined Stark effect – quantum dot laser.

UNIT V NANOELECTRONIC DEVICES **9**

Introduction - electron density in bulk material – Size dependence of Fermi energy– quantum confinement – quantum structures - Density of states in quantum well, quantum wire and quantum dot structures –Zener-Bloch oscillations – resonant tunneling – quantum interference effects – mesoscopic structures: conductance fluctuations and coherent transport – Coulomb blockade effects - Single electron phenomena and Single electron Transistor – magnetic semiconductors– spintronics - Carbon nanotubes: Properties and applications. **TOTAL :45 PERIODS**

OUTCOMES:

At the end of the course, the students will able to

- ✓ Gain knowledge on classical and quantum electron theories, and energy band structuues,
- ✓ Acquire knowledge on basics of semiconductor physics and its applications in various devices,
- ✓ Get knowledge on magnetic and dielectric properties of materials,
- ✓ Have the necessary understanding on the functioning of optical materials for optoelectronics,
- ✓ Understand the basics of quantum structures and their applications in spintronics and carbon electronics.

TEXT BOOKS:

1. Kasap, S.O. ―Principles of Electronic Materials and Devices‖, McGraw-Hill Education, 2007.
2. Umesh K Mishra & Jasprit Singh, ―Semiconductor Device Physics and Design‖, Springer, 2008.
3. Wahab, M.A. ―Solid State Physics: Structure and Properties of Materials‖. Narosa Publishing House, 2009.

REFERENCES:

1. Garcia, N. & Damask, A. ―Physics for Computer Science Students‖. Springer-Verlag, 2012.
2. Hanson, G.W. ―Fundamentals of Nanoelectronics‖. Pearson Education, 2009

Subject Code: PH8253 **Year/Semester: I /02**

Subject Name: PHYSICS FOR ELECTRONICS ENGINEERING

Subject Handler: Mrs.A.JAYANTHI

UNIT I ELECTRICAL PROPERTIES OF MATERIALS

Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression - Wiedemann-Franz law – Success and failures - electrons in metals – Particle in a three dimensional box – degenerate states – Fermi- Dirac statistics – Density of energy states – Electron in periodic potential: Bloch theorem – metals and insulators - Energy bands in solids– tight binding approximation - Electron effective mass – concept of hole.

Q. No.	PART – A

1. **List out the properties of metallic conductors.** BTL1(May 2011, Dec 2012)

- Metallic conductors have high electric and thermal conductivities.
- Metallic conductor obey Ohm's law,
- They have low electrical resistivity.
- Resistivity (ρ) α Temperature (T)
- Near absolute zero, ρ tends to zero.
- Resistivity is inversely proportional to Pressure (i.e.) ρ α 1/p

Examples : all metals

2 **Define mean free path.** BTL1(June 2009, June 2012)

The average distance traveled by a free electron between two successive collisions in the presence of an applied field. $\lambda = V_d \times \tau_C$

3 **Define relaxation time and collision time.** BTL1(June 2012)

Relaxation time (τ) : The average time taken by a free electron to reach its equilibrium position from its disturbed position due to the application of an external electric field.

Collision time (τ_c) : The average time taken by a free electron between two successive collisions. $\tau_C = \lambda / V_d$

4 **Define drift velocity of electrons and give its formula.** BTL1(June 2010, June 2011)

The average velocity acquired by free electrons when they are drifted towards the positive terminal of the xternal electric field. Its unit is m/S.

$$V_d = (Ee\tau / m)$$

5 **What are the differences between Drift velocity and thermal velocity of an electron?** BTL1(June 2010)

S. No.	Drift velocity	Thermal velocity
1.	Drift velocity is the average velocity acquired by the free electron. In the presence of electric field.	Thermal velocity is the velocity of an electron without any external field.
2.	The electrons moving with drift velocity moves in the direction opposite to that of the field direction	The direction of the electrons moving with thermal velocity is random
3.	The velocity is very less (0.5 m/s)	The velocity is very high (10^6 m/s)

6 **Distinguish electrical (drift) conductivity and thermal conductivity of an electron.** BTL4 (April 2002)

S. No	Electrical (Drift) conductivity	Thermal conductivity
1.	Electrical conductivity is based on the no of free electrons	Thermal conductivity is based on both free electrons and phonons

2.	It is the quantity of electric charge flowing per unit time across unit area in for unit applied electric field.	It is the amount of heat flowing per unit time through the material having unit area of cross-section maintaining unit temperature gradient.
3.	Electrical conductivity takes place from higher potential side to lower potential side	Thermal conductivity takes place from hot end to cold end
4.	Its unit is $\Omega^{-1}m^{-1}$	Its unit is $Wm^{-1}k^{-1}$

7	**Define mobility of electrons.** BTL1(June 2011) The drift velocity (V_d) acquired by the free electron per unit electric field (E) applied on it. ItsUnit is $m^2 V^{-1} s^{-1}$.
8	**Define current density.** BTL1 The amount of current flowing per unit area of cross section normal to the direction of flow. Its unit is Am^{-2}. (J=I/A)
9	**Define electrical conductivity (σ).** BTL1(April 2002) The amount of charge conducted per unit time, per unit area per unit electric field strength. It has the unit $\Omega^{-1}m^{-1}$. $$\sigma = \frac{q}{AEt}$$
10	**Define thermal conductivity (K). Give its unit.** BTL1(April 2002) Thermal conductivity of a material is defined as the amount of heat flowing per unit time through the material having unit area of cross-section maintaining unit temperature gradient. Its unit is $Wm^{-1}K^{-1}$ $$K = \frac{Q}{A\frac{dT}{dx}t}$$
11	**Define thermal conductivity (K). Give its unit.** BTL1 The amount of heat flowing per unit time through the material having unit area of cross-section maintaining unit temperature gradient. Its unit is $Wm^{-1}K^{-1}$ $$K = \frac{Q}{A\frac{dT}{dx}t}$$
12	**State Wiedemann – Franz Law.** BTL1(June 2007,2009, Dec 2009, May 2011) The ratio of thermal conductivity (K) to electrical conductivity (σ) of a metal is directly proportional to the absolute temperature (T) of the metal. (i.e) $\frac{K}{\sigma} \propto T$ $\quad ie \ \frac{K}{\sigma} = LT$ L = Lorentz number = $1.12 \times 10^{-8}\ W\Omega K^{-2}$ at 293K.
13	**What is Lorentz number? Give the value of Lorenz number and state whether it holds good for all metals and at all temperatures?** BTL4 The ratio between thermal conductivity (K) to the product of electrical conductivity (σ) and absolute temperature (T) of the metal. It is a constant. (i.e) $L = \frac{K}{\sigma T}$; Where, $L = \frac{3}{2}\left(\frac{K_B}{e}\right)^e = 1.12\ x\ 10^{-8}\ W\Omega K^{-2}\ at\ 293\ K,$ $where\ K_B\ is\ Boltzman\ constant, e - Charge\ of\ electron$
14	**State the postulates of classical free electron theory or what are the special features of classical free electron theory of metals?** BTL1(June 2009, May 2011) • A metal is composed of atoms in which electrons revolve around the nucleus at its centre. • The free electrons (electron gas) of atoms are free to move about the whole volume of the metal like the molecule of a perfect gas in a container. • In the absence of an electric field, the free electrons move in random directions, making collision with each other or with positive ion core. All the collisions are elastic collisions. • When an external electric filed is applied, the electrons are accelerated towards positive potential with a

	constant velocity known as drift velocity (V_d). • Free electrons obey Maxwell distribution and kinetic theory of gases
15	**What are the merits of classical free electron theory?** BTL1(June 2005, June 2007, May 2011) • Explains the electrical and thermal conductivities of metals. • Used to derive Wiedemann - Franz law. • Explains the optical properties of metals. • Used to verify ohm's law.
16	**Mention the drawbacks of classical free electron theory.** BTL2(May 2011) • The electrical conductivity of semiconductors and insulators cannot be explained by this theory. • Classical theory states that all free electrons absorb the supplied energy, but quantum theory states that only a few electrons absorb the supplied energy. • By Classical theory Lorentz Number ($L = K / \sigma T$) is a constant at all temperatures but by quantum theory it is not constant at low temperatures. • The value of specific heat of a metal is 4.5R but experimental value is only 3R, where R is a universal gas constant. • The susceptibility of a paramagnetic material is inversely proportional to temperature. But experimental results show that it is independent to temperature. This theory cannot be used to explain the Ferro-magnetism. • Photo-electric effect, Compton Effect and black body radiation cannot be explained by this theory.
17	**Mention the important features of quantum free electron theory of metals.** BTL2 • Explains the electrical & thermal conductivity and specific heat capacity of metals. • Can be used to explain photoelectric effect, Compton Effect, Black body radiation
18	**Write Fermi-Dirac distribution function and give its importance.** BTL1(April 2003, Nov.2003, May 2011) Represents the probability of an electron occupying a given energy level at absolute temperature. It is also called as Fermi factor or Fermi distribution (FD) function. It is given by $F(E) = \frac{1}{1+e^{(E-E_F)/KT}}$ Where, E is energy of the level whose occupancy is being considered. E_F is Fermi energy or Fermi level of the system and k is Boltzmann's Constant & T is absolute temperature. The probability value F (E) lies between 0 and 1. • Used to analyse the occupancy of electron in a given energy leave To find Fermi energy levelu
19	**Define Fermi energy level and Fermi energy with their importance.** BTL1(June 2012, June 2010) **Fermi level** The highest energy level of the filled state at 0 K. **Fermi energy** The maximum energy of filled states at 0K. **Importance of Fermi energy** • Gives the information about the filled electrons state and empty states. • At 0 K, below EF electrons filled and above EF it will be empty. • It acts as a reference level which separates the vacant and filled states at 0 K. When the temperature is increased, few electrons gain the thermal energy and they go to higher energy levels.
20	**What is the effect of temperature on Fermi function? (or) How Fermi energy varies with respect to temperature?** BTL1(June 2010, May 2011)

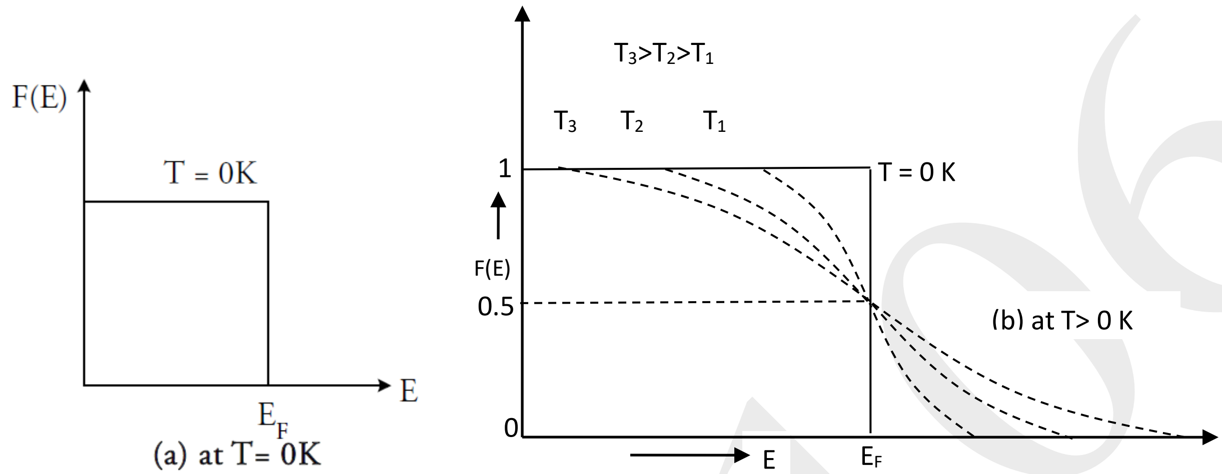
$$F(E) = \frac{1}{1+e^{(E-E_F)/KT}}$$

Where, E_F is called Fermi energy.

Case 1: In metals at 0K if $E < E_F$, F (E) = 1, (i.e) 100% chance for occupation of electron in E.

Case 2: If $E>E_F$, F (E) = 0, (i.e) 0% chance for occupation of electron in E.

Case 3: IF T > OK, at E_F, F (E) = ½, (i.e) 50% chance for occupation of electron in E.



21 **Define density of states with example.** BTL1(Dec 2003)

The number of available electron states per unit volume in an energy interval E and E + dE. It is denoted by Z (E). It is given by

$$Z(E)\,dE = \frac{\text{Number of energy states available between E and E+dE in a metal piece } (N(E)dE)}{\text{Volume of that metal piece } (V)}$$

22 **Define carrier concentration in metals.** BTL1

The number of free electrons per unit volume. It can be obtained by multiplying density of states and probability of electrons occupancy in the energy band.

$$n_c = \int_{Energy\ band} Z(E)dE\ F(E)$$

23 **A uniform silver wire has a resistivity of 1.54 x 10^{-8} Ω m at room temperature, for an electric field along the wire of 1 V cm^{-1}. Compute the average drift velocity of electron assuming that there is 5.8 x 10^{28} conduction electron m^{-3}. Also calculate the mobility. (April 2003)** BTL4

Given data

Conduction electron concentration n = 5.8 X 10^{28} m^{-3}

Resistivity ρ = 1.54 x 10^{-8} Ω m

Electric field E = 1 V / cm = $\frac{1}{10^{-2}}$ V / m = 100 V / m

Formula

Mobility $\mu = \frac{\sigma}{ne} = \frac{1}{\rho\, n\, e}$

	Drift velocity $V_d = \mu E$ $\mu = \frac{1}{1.54\times10^{-8}\times5.8\times10^{28}\times1.6\times10^{-19}} = \mu = 6.9973\times10^{-3}$ $V_d = 6.9973\times10^{-3}\times100$; $V_d = 0.69973$ m/s
24	**The Fermi temperature of a metal is 24,600 K. Calculate the Fermi velocity. (Apr.2003)** BTL4 **Given data** Fermi temperature T_F = 24,600 K We know, Mass of electron m = 9.1 X 10^{-31} Kg **Formula** $E_F = kT_F = \frac{1}{2} m V_F^2$ $V_F^2 = \frac{2kT_F}{m}$; $V_F = \sqrt{\frac{2kT_F}{m}}$ $V_F = \sqrt{\frac{2\times1.38\times10^{-23}\times24600}{9.11\times10^{-31}}} = 0.8633\times10^6$ **Answer ;** Fermi velocity $V_F = 0.8633\times10^6$ m / S
25	**Use Fermi function to obtain the value of F(E) for E – E_F = 0.01 eV at 200 K.** BTL4 **Given data** E – E_F = 0.01 eV and Temperature T = 200 K We know that eV = 1.6 X 10^{-19} J E – E_F = 0.01 X 1.6 X 10^{-19} J = 1.6 X 10^{-21} J **Formula** $F(E) = \frac{1}{1+e^{(E-E_F)/KT}}$ $F(E) = \frac{1}{1+\exp[(1.6\times10^{-21})/(1.38\times10^{-23}\times200)]}$ $F(E) = \frac{1}{1+\exp[0.5797]} = \frac{1}{1.7855} = 0.3589$ F (E) = 0.3589; ***Answer***Fermi Function F (E) = 0.3589 No unit
26.	**Comment on effective mass of electron.** BTL1 The mass acquired by a free electron when it accelerated in a periodic potential. It is also called as

	negative mass behaviour of electron.
27.	**Define energy band.** BTL1 A set of closed spaced energy levels.
28.	**Appraise the concept of hole.** BTL1 The electron with the negative effective mass is considered as a new entity having the same positive mass of that of an electron but with positive charge, this new entity is named as hole.

PART – B

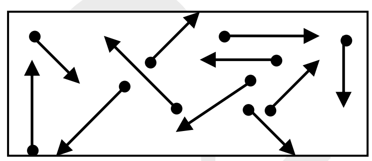
1. **(i) Give the postulates of free electron theory. Derive an expression for electrical conductivity of a metal by using classical free electron theory. (3M+7M)** BTL1

(ii) Compute the electrical conductivity, resistivity and thermal conductivity for a metal with relaxation time 10^{-14} S at 300 K. Also calculate the Lorentz number using the above result (Density of electrons is 6×10^{23} m^{-3}). (6 M) BTL4(Dec 2001, June 2011)

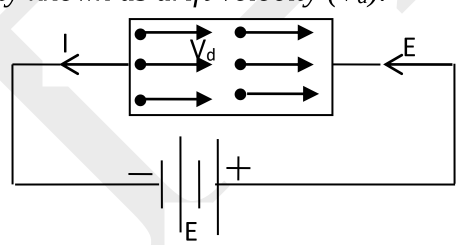
Answer: Page: 1.10 P.MANI

Postulates of CFE

- *A solid metal is composed of atoms and atoms have nucleus around which there are revolving electron.*
- *The valence electrons of an atom are free to move about the whole volume of the metal like the molecule of a perfect gas in a container.*
- *In the absence of an electric field, the free electrons move in random directions making collision with each other or with positive ion core.*



- *When an external electric filed is applied, they begin to move towards the positive potential with a constant velocity known as drift velocity (V_d).*

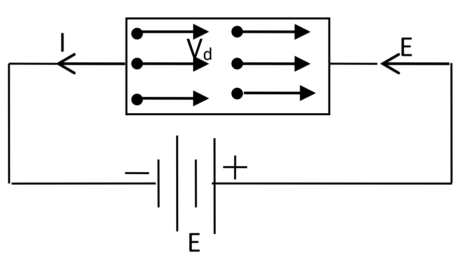


- *The movement of free electrons obeys the classical kinetic theory of gases and the electron velocities in the metal obey Maxwell – Boltzmann statistics.* (3M)

Expression for electrical conductivity (7M)

Answer page:

Electrical Conductivity: The amount charge conducted per unit time through unit cross-sectional area in unit electric field. (1 M)



(1M)

$$J = neV_d$$

$$F = eE \qquad (1M)$$

By Newton's second law,

$$F = ma \qquad a = \frac{eE}{m} \qquad (1M)$$

i.e., $a = \frac{V_d}{\tau}$; or $V_d = \tau$ a ; $V_d = \tau\left(\frac{eE}{m}\right)$; $\frac{J}{E} = \frac{ne^2\tau}{m}$ (1M)

From Ohm's law, Current density $J = \sigma E$ or $\sigma = \frac{J}{E}$ (1M)

Electrical conductivity $\sigma = \frac{ne^2\tau}{m}$ (1M)

Thus the electrical conductivity of a metal depends on 'n' and 'τ'.

(ii) Given data

Temperature T = 300 K

Electron concentration n = 6 X 10^{23} m^{-3}

Relaxation time $\tau = 10^{-14}$ S

We know, Mass of electron m = 9.1 X 10^{-31} Kg

Charge of electron e = 1.6 X 10^{-19} coulomb

Formula

i) Electrical conductivity $\sigma = \frac{ne^2\tau}{m}$ (1 M)

$$\sigma = \frac{6\times10^{28}\times(1.6\times10^{-19})^2\times10^{-14}}{9.1\times10^{-31}}$$

$$= \frac{6\times10^{28}\times2.56\times10^{-38}\times10^{-14}}{9.1\times10^{-31}} = \frac{15.36\times10^{28}\times10^{-52}}{9.1\times10^{-31}}$$

$$= 1.688\times10^{28}\times10^{-52}\times10^{+31} = 1.688\times10^{7}$$

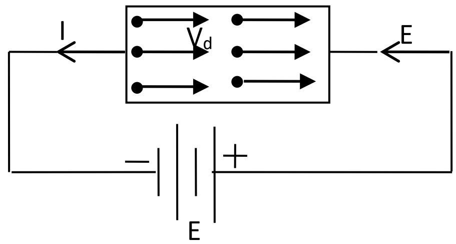
$$\sigma = 1.688\times10^{7}\ \Omega^{-1}\ m^{-1} \qquad (1 M)$$

ii) Electrical conductivity $\rho = \frac{1}{\sigma}$

$$\rho = \frac{1}{1.688\times10^{7}} = 0.5924\times10^{-7} = 5.924\times10^{-8}$$

$$\rho = 5.924\times10^{-8}\ \Omega\ m \qquad (1 M)$$

	iii) Thermal Conductivity $K = \frac{1}{2} n v^2 k \tau$ (Multiplying and dividing by m) $K \times \frac{m}{m} = \frac{1}{2} \frac{m v^2 n k \tau}{m}$ $K = \frac{3}{2} \frac{kTnk\tau}{m}$ $\frac{1}{2} m v^2 = \frac{3}{2} kT$ $K = \frac{3}{2} \frac{k^2 T n \tau}{m}$ (1 M) $K = \frac{3 \times 6 \times 10^{28} \times (1.38 \times 10^{-23})^2 \times 300 \times 10^{-14}}{2 \times 9.1 \times 10^{-31}}$ $= \frac{10283.76 \times 10^{28} \times 10^{-46} \times 10^{-14}}{18.2 \times 10^{-31}}$ $= 565.0418 \times 10 = 56.5042$ K = 56.5042 W m^{-1} K^{-1} (1 M) iv) Lorentz number $L = \frac{K}{\sigma T}$ $L = \frac{56.504}{1.688 \times 10^7 \times 300} = 0.1116 \times 10^{-7} = 1.116 \times 10^{-8}$ $L = 1.116 \times 10^{-8}$ W Ω K^{-2} (1 M) **Answers** $\sigma = 1.688 \times 10^7$ Ω^{-1} m^{-1} ; $\rho = 5.924 \times 10^{-8}$ Ω m K = 56.5042 W m^{-1} K^{-1} ; $L = 1.116 \times 10^{-8}$ W Ω K^{-2}
2.	**State and prove Wiedemann-Franz law. Why does the Lorentz number determined experimentally does not agree with the value calculated from the classical theory?(14M+2M)** BTL2(May 2011) **Answer: Page: 1.10 P.MANI** Statement of Wiedemann-Franz law *The ratio of thermal conductivity to electrical conductivity of a metal is directly proportional to the absolute temperature of the metal.* This ratio is constant for all metals at a given temperature. i.e., $\frac{K}{\sigma} \; \alpha \; T$ or $\frac{K}{\sigma} = LT$ (1M) Derivation of electrical conductivity Electrical Conductivity: The amount charge conducted per unit time through unit cross-sectional area in unit electric field.



(1M)

$$J = neV_d$$

$$F = eE \qquad \text{(1M)}$$

By Newton's second law,

$$F = ma \qquad a = \frac{eE}{m} \qquad \text{(1M)}$$

$$\text{i.e., } a = \frac{V_d}{\tau} \qquad \text{or } V_d = \tau\, a \qquad V_d = \tau\left(\frac{eE}{m}\right)$$

$$\frac{J}{E} = \frac{ne^2\tau}{m} \qquad \text{(1M)}$$

From Ohm's law, Current density $J = \sigma E$ or $\sigma = \frac{J}{E}$

Electrical conductivity $\sigma = \frac{ne^2\tau}{m}$ (1M)

Derivation of thermal conductivity

Thermal conductivity: The amount of heat flowing per unit time through the material having unit area of cross-section per unit temperature gradient.

$$\text{i.e., } Q = K\frac{dT}{dx} \quad \text{or} \quad K = \frac{Q}{\frac{dT}{dx}} \qquad \text{(1M)}$$

In a uniform metallic rod AB, let us consider two cross-sections A at high temperature T and B at low temperature (T – dT) separated by a distance of mean free path **λ.**

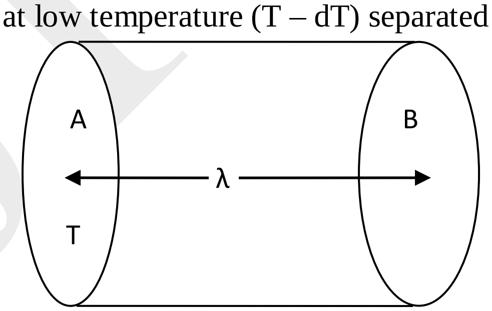


Fig. Conduction of heat in a metallic rod (1M)

Let n be the free electron density and v be the velocity of free electron.

	Average kinetic energy of the electron At A = $\frac{3}{2}kT$ Average kinetic energy of an electron At B $=\frac{3}{2}k(T-dT)$ Excess kinetic energy carried by the electron from A to B = $K.E._{\text{Excess}} = \frac{3}{2}kdT$ (1M) Number of electrons crossing unit area per unit time from A to B $=\frac{1}{6}nv$ (1M) Excess energy carried from A to B for unit area in unit time = $=\frac{1}{6}nv\times\frac{3}{2}kdT=\frac{1}{4}nvkdT$ (1M) Similarly, Deficient energy carried from B to A for unit area in unit time $=-\frac{1}{4}nvkdT$ The net amount energy transferred from A to B for unit area in unit time $Q=\frac{1}{2}nvkdT$ (1M) Thermal conductivity is the amount of heat conducted per unit area per unit time = $Q=K\frac{dT}{\lambda}$ $\frac{1}{2}nvkdT=K\frac{dT}{\lambda}$ OR $K=\frac{1}{2}nvk\lambda$ We know for metals $\tau\ v=\lambda$, Therefore $K=\frac{1}{2}nv^2k\tau$ (1M) Thus the classical expression for thermal conductivity depends on ' **v** ' , '**n**' and ' τ ' **Proof of Wiedemann-Franz law** From Classical theory, $\sigma=\frac{ne^2\tau}{m}$ and $K=\frac{1}{2}nv^2k\tau$ (1M) By dividing $\frac{K}{\sigma}=\frac{1}{2}\frac{nv^2k}{e^2}$ or $\frac{K}{\sigma}=\frac{3}{2}\left(\frac{k}{e}\right)^2T$ or $\frac{K}{\sigma}=LT$ or $\frac{K}{\sigma}\ \alpha\ T$ (1M) According to Quantum Physics, the expressions for electrical and thermal conductivity are different when compared to CFE. Therefore Lorentz number are not agree with one another. (2M)
3.	**(i) Obtain Eigen values and Eigen functions of an electron enclosed in a 3-D potential box.(10M)** BTL3 **(ii) Calculate the number of states lying in an energy interval of 0.01 eV above the Fermi level for a crystal of unit volume with Fermi energy E_F = 3.0 eV.** **(i)Answer: Page: 1.23 P.MANI** Energy of the particle (Eigen values) in 3D (5M) Wave function of the particle (Eigen values) in 3D (5M)

(ii) Solution

Given data

Fermi energy E_F = 3.0 eV ; Energy interval $\Delta E = E - E_F$ = 0.01 eV

We know, Mass of electron m = 9.1 X 10^{-31} Kg ; Planck's constant h = 6.62 X 10^{-34} J S

We know that eV = 1.6 X 10^{-19} J; Fermi energy in Joule E_F = 3.0 X 1.6 X 10^{-19} J

E_F = 4.8 X 10^{-19} J

Energy interval $\Delta E = E - E_F$ = 0.01 eV

$E = \Delta E + E_F$ = (0.01 + 3.0) eV = 3.01 X 1.6 X 10^{-19} J = 4.816 X 10^{-19} J

Formula

Number of states per unit volume lying between E_F and E is given by

$$n = \int_{E_F}^{E} \frac{4\pi}{h^3}(2m)^{3/2} E^{1/2} dE \qquad (2\text{ M})$$

$$= \frac{4\pi}{h^3}(2m)^{3/2} \int_{E_F}^{E} E^{1/2} dE = \frac{4\pi}{h^3}(2m)^{3/2}\left[\frac{E^{3/2}}{3/2}\right]_{E_F}^{E}$$

$$= \frac{4\pi}{h^3}(2m)^{3/2} \times \frac{2}{3}\left[E^{3/2} - E_F^{3/2}\right]$$

$$n = \frac{4 \times 3.14 \times \left(2 \times 9.1 \times 10^{-31}\right)^{3/2}}{\left(6.625 \times 10^{-34}\right)^3} \times \frac{2}{3}\left[\left(4.816 \times 10^{-19}\right)^{3/2} - \left(4.8 \times 10^{-19}\right)^{3/2}\right] \qquad (2\text{M})$$

= 3.74 X 10^{55} X (1.108 X 10^{-30}) ; n = 4.14 X 10^{25} m^{-3} (2M)

4. **Develop an expression for the density of states and based on that calculate the carrier concentration in metals. (10M+6M)** BTL1(Dec 2005, June 2009, June 2010)

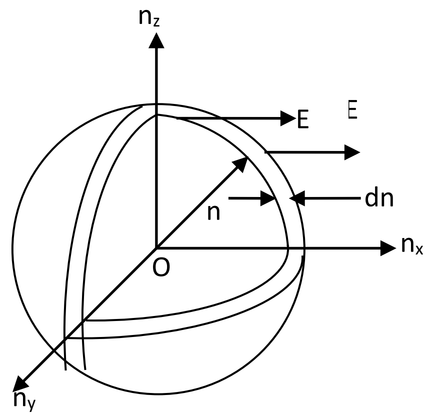
Answer: Page: 1.31 P.MANI
Density of statesderivation

Definition: Density of states is defined as the number of available electron states per unit volume in an energy interval E and E + dE.

$$Z(E)dE = \frac{\text{Number of energy states in energy interval } E \text{ and } E + dE \text{ in a metal piece N(E) dE}}{\text{Volume of the metal piece}} \quad (2\text{M})$$

Calculation of density of states in three dimensions (derivation)

Let us consider a cubical sample with side 'a' length and volume V. A sphere is constructed with radius 'n' in the space.



(1M)

In this space, unit volume represents one energy state.

$$\text{Number of energy states within a sphere of radius n} = \frac{4}{3}\pi n^3 \qquad \text{(1M)}$$

Number of available energy states within one octant of the sphere of radius n corresponding to energy E, $= \frac{1}{8}\left[\frac{4}{3}\pi\, \mathrm{n}^3\right]$ (1M)

Similarly, the number of available energy states within one octant of the sphere of radius n+dn corresponding to energy E+dE $= \frac{1}{8}\left[\frac{4}{3}\pi\, (\mathrm{n}+\mathrm{dn})^3\right]$ (1M)

As a result, the number of available energy states between the shell of radius n and n+dn or between the energy levels E and E+dE,

$$\mathrm{N(E)\ dE} = \frac{1}{8}\left[\frac{4}{3}\pi\, (\mathrm{n}+\mathrm{dn})^3\right] - \frac{1}{8}\left[\frac{4}{3}\pi\, \mathrm{n}^3\right]$$

$$N(E)dE = \frac{1}{8}\left(\frac{4}{3}\pi\right)\left[dn^3 + 3n^2 dn + 3ndn^2\right] \qquad \text{(1M)}$$

Higher powers of dn is very small, Hence dn² and dn³ can be neglected

i.e., Number of available energy states between the energy interval E and dE

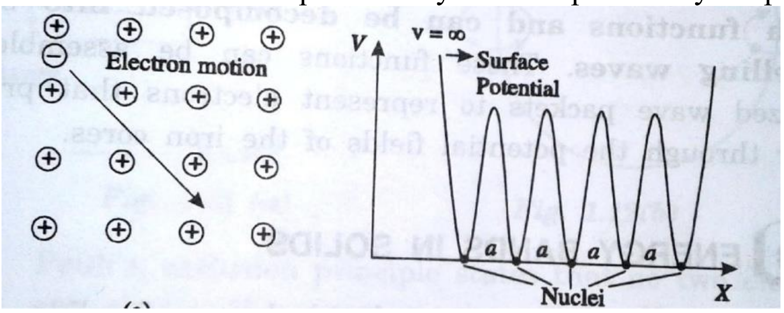
$$N(E)dE = \frac{\pi}{2}\mathrm{n}^2 dn \quad \text{or} \quad N(E)\,dE = \frac{\pi}{2} n\,(ndn) \qquad \text{(1M)}$$

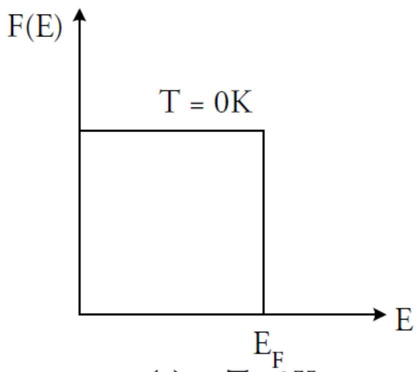
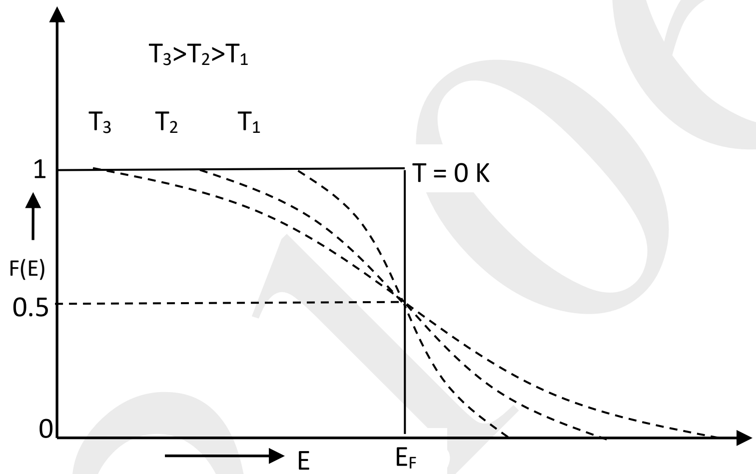
According to Particle in a box problem, the energy of an electron in a cubical metal piece of sides a is given by

$$E = \frac{n^2 h^2}{8ma^2}$$

$$\text{Or} \quad n^2 = \frac{8ma^2 E}{h^2} \quad \text{and} \quad n = \left[\frac{8ma^2 E}{h^2}\right]^{1/2} \qquad \text{(1M)}$$

	Differentiating we get , $2ndn = \frac{8ma^2 dE}{h^2}$ Or $ndn = \frac{8ma^2 dE}{2h^2}$ Substituting $N(E)dE = \frac{\pi}{4}\left[\frac{8ma^2}{h^2}\right]^{3/2} E^{1/2} dE$ (2M) Pauli's exclusion principle states that two electrons of opposite spins can occupy each state. $N(E)dE = \frac{4\pi}{h^3}(2m)^{3/2} a^3 E^{1/2} dE$; The number of energy per unit volume $Z(E)dE = \frac{4\pi}{h^3}(2m)^{3/2} E^{1/2} dE$ (1M) **Carrier concentration in metal** *Carrier concentration is the number of electrons per unit volume in a given energy interval.* i.e., $n_c = \int_{energyband} Z(E)F(E)dE$ (2M) Substituting the expressions for Z (E) and F (E) $n_c = \int_{energyband} \frac{4\pi}{h^3}(2m)^{3/2} E^{1/2} dE \times \frac{1}{1+e^{(E-E_F)/KT}} dE$ (2 M)
5.	**Starting with the density of energy states obtain the expression for the Fermi energy of an electron at 0 K and hence obtain the expression for the average energy of an electron.(12 M+4M)** BTL3 **Answer: Page: 1.37 P.MANI** Density of energy states The number of energy per unit volume $Z(E)dE = \frac{4\pi}{h^3}(2m)^{3/2} E^{1/2} dE$ (2M) Expression for Fermi energy of electron *Carrier concentration is the number of electrons per unit volume in a given energy interval.* i.e., $n_c = \int_{energyband} Z(E)F(E)dE$ (2M) Substituting the expressions for Z (E) and F (E) $n_c = \int_{energyband} \frac{4\pi}{h^3}(2m)^{3/2} E^{1/2} dE \times \frac{1}{1+e^{(E-E_F)/KT}} dE$ (2 M) For a metal at 0 K, the upper occupied level is E_F and F (E) for all the levels below E_E is 1.i.e., F (E) =1 $n_c = \int_0^{E_F} \frac{4\pi}{h^3}(2m)^{3/2} a^3 E^{1/2} dE$ (2M) i.e., $n_c = \frac{8\pi}{3h^3}(2mE_F)^{3/2}$ (2 M) Fermi energy E_F at 0 K is given by, $E_{F_0} = \left(\frac{h^2}{2m}\right)\left(\frac{3n_c}{8\pi}\right)^{2/3}$ (2M) Expression for average energy of an electron **Average energy of an electron at 0K**

	Eave = Total energy of the electrons at 0K ET / Number of energy states at 0K (N) $E_{ave} = 3/5\ E_{F0}$ (4M)
6.	**Explain the energy band theory of solids with necessary theory. (or) Describe the behaviour of electron in a periodic potential. (8 M)** BTL2 **Answer: Page: 1.40 P.MANI** **Energy band theory postulates** P.E. of electron within the crystal is periodic due to periodicity of the crystal P.E. of the solid varies periodically with the periodicity of space lattice "a" (2M)  (2 M) **Bloch Theory Postulates** The solutions of Schrodinger equations are plane waves modulated by the function $u_k(x)$ which has the same periodicity as the lattice. $$\frac{\partial^2\psi}{\partial x^2}+\left(\frac{2m}{\hbar^2}\right)[E-V(x)]\psi=0$$ $$\Psi(x) = e^{\pm ikx}u_k(x)$$ Where, $u_k(x) = u_k(x+a)$ (2M) These wave functions are called Bloch function, $$\psi(x+a) = e^{\pm ikx}u_k(x+a) = e^{\pm ikx}\psi(x)$$ Thus Bloch functions have the property that, $$\psi(x+a) = \lambda\psi(x)$$ where the constant λ is $$\lambda = e^{\pm ika}$$ (2M)
8.	**Write an expression for the Fermi energy distribution function F (E) and illustrate its behaviour with change in temperature. Plot F (E) versus E for T= 0 K, and T > 0 K. (2M+8M)(or) What is Fermi function? Describe the variation of Fermi function with respect to temperature.(8M)**BTL2 **Answer: Page: 1.26 P.MANI**

	Fermi function *Represents the probability of an electron occupying a given energy level at absolute temperature. It is also called as Fermi factor or Fermi distribution (FD) function.* It is given by $F(E) = \frac{1}{1+e^{(E-E_F)/KT}}$ (2M) Variation of Fermi energy with respect to Temperature Case (i) When $E<E_F$, at T = 0K, F(E) = 1 (2M) Case (ii) When $E>E_F$, at T = 0K, F(E) = 0 (2M) Case (iii) When $E=E_F$, at T > 0K, F(E) = 0.5 (2M) (a) at T= 0K (2M)
9.	**Explain free electron approximation and tight binding approximation with suitable diagrams. (8 M)** BTL2 **Answer Page:1.48 P. MANI** Free electron approximation (4M) Tight binding approximation (4M)
10.	(i) **Discuss the concept of holes formation.(7M)** BTL1 (ii) **Write a short note on effective mass of an electron. (or) What is effective mass? Obtain an expression for effective mass of an electron. (8 M)** BTL3 **(i) Answer: Page: 1.55 P.MANI** Definition of Hole (2M) Concept of hole formation (5M) **(ii) Answer Page: 1.51 P. MANI** Definition (2 M) Derivation (6M)

UNIT-II

Intrinsic Semiconductors – Energy band diagram – direct and indirect semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Carrier transport: Velocity-electric field relations – drift and diffusion transport - Einstein‘s relation – Hall effect and devices – Zener and avalanche breakdown in p-n junctions - Ohmic contacts – tunnel diode - Schottky diode – MOS capacitor - power transistor.

Q. No.	PART * A
1.	**What are semiconductors? Give example.** BTL1 A solid material which conducts electricity partially. Act as insulator at 0 K and conductors at high temperature Atoms are bonded with covalent band Eg: Si, Ge,
2.	**State the properties of semiconductor.** BTL2(May 2003, June 2009, May 2011) • They are crystalline in nature. • They have $E_g \approx 1eV$ • They possess negative temperature coefficient of resistance. • They have four valence electrons. • At 0 K, semiconducting materials possess filled valence band and empty conduction band. • Conductivity increases with increase in temperature and impurity.
3.	**What are the types of semiconductor?** BTL1 Semiconductor is generally classified on the basics of purity 1) Intrinsic semiconductor and 2) Extrinsic semiconductor Semiconductor may also classified on the basics of recombination process 1) Elemental / Indirect band gap semiconductors Compound / Direct band gap semiconductors
4.	**What are the types of semiconductor based on impurity?** BTL2 • N-type semiconductors • P-type semiconductors
5.	**Distinguish intrinsic and extrinsic semiconductor.**BTL4(Nov 2003, Dec2003, May 2011)

S. No	Intrinsic semiconductor	Extrinsic semiconductor
1.	Semiconductor in pure form is called as intrinsic semiconductor	Semiconductor doped with impurity is called as extrinsic semiconductor
2.	Here charge carriers are produced only due to thermal agitation	Here charge carriers are produced due to impurities and may also due to thermal agitation
3.	At 0 K, Fermi level exactly lies between conduction band and valance band	At 0K, Fermi level exactly lies closer to conduction band in n- type semiconductor and lies near valance band in the case of p- type semiconductor
4.	They have low electrical conductivity and operating temperature.	They have high electrical conductivity and operating temperature.
5.	Eg . Pure silicon and Germanium	Eg . Si and Ge doped with Al, In, P, As etc.

Q. No.	
6.	**Distinguish between direct/compound and indirect band gap/elemental semiconductors.** BTL4(April 2002, June 2009, May 2011)

S. No.	Direct band gap / Compound	Indirect band gap/ Elemental

	semiconductors	semiconductors
1.	Here electron-hole recombines directly by emitting a photon.	Here electron-hole recombines directly by emitting a phonon (Heat).
2.	Recombination time of the charge carriers are very less	Recombination time of the charge carriers are more
3.	These are mostly compound semiconductors.	These are mostly elemental semiconductors.
4.	Life time of charge carriers is less	Life time of charge carriers is large
5.	They are used in LED and laser diode fabrication.	They are used in amplification of signals as in the case of diodes and transistors
6.	Example. InP, GaAs, MgO, ZnO	Example . Ge, Si

7. **Distinguish between n – type and p – type extrinsic semiconductors.** BTL4(Nov 2003, Dec 2003, May 2011)

	n – type extrinsic semiconductors	**p – type extrinsic semiconductors**
1.	When pentavalent impurities added to the intrinsic semiconductors, n- type semiconductors are formed	When trivalent impurities added to the intrinsic semiconductors, p- type semiconductors are formed
2.	Majority charge carriers are electrons	Majority charge carriers are holes
3.	Minority charge carriers are holes	Minority charge carriers are electrons
4.	The impurity is called donor impurity	The impurity is called acceptor impurity
5.	Fermi energy decrease with increase of temperature	Fermi energy increases with increase of temperature
6.	The donor energy level is very close to the bottom of the conduction band	The acceptor energy level is very close to the top of the valance band.

8. **Define mobility and electrical conductivity of intrinsic semiconductors?** BTL1

Mobility:

The velocity of a charge carrier produced due to unit field strength $\mu = v_d / E$

Electrical conductivity:

The total electrical conductivity σ_i of the intrinsic semiconductor is the sum of electrical conductivities due to the electrons and holes. $\sigma_i = en_i(\mu_e + \mu_e)$

9. **Define the term carrier concentration in intrinsic semiconductors.** BTL1

The number of electrons in the conduction band per unit volume (n) or the number of holes in the valence band per unit volume (p) of the semiconducting material. It is also known as density of charge carriers.

10. **Define Hall Effect, Hall field, Hall voltage and Hall angle.** BTL1(Nov 2003, May 2005, June 2010)

When a conductor or semiconductor carrying a current (I) is placed in a perpendicular magnetic field (B), a potential difference is produced inside the conductor in a direction normal both the current and the magnetic field. This phenomenon is called Hall Effect and the voltage thus developed is known as Hall voltage. The field induced is known as Hall filed. The angle between applied field and Hall field is known as Hall Angle.

11. **Define hall coefficient.** BTL1

The ratio of the induced electric field to the product of the current density and the applied magnetic field.

$$R_H = \frac{E_H}{J_x B_z}; \qquad R_H = \frac{bV_H}{I_x B_z}\,; \qquad R_H = -\frac{1}{ne}(N-Type); \quad R_H = +\frac{1}{pe}(P-Type)$$

12.	**Mention four applications of Hall Effect?** BTL4(Nov 2003, May 2005, June 2010) • To identify the nature of semiconductors. • Carrier concentration, Mobility of charge carriers can be measured directly. • Electrical conductivity can be determined. • It can be used to determine whether the solid is metal, insulator or semiconductor • Magnetic field can be measured.
13.	**How can you distinguish p – type and n- type semiconductors using Hall Effect?** BTL4(June 2010, June 2012) The n- type and p-type semiconductors can be distinguished by determining the hall coefficient using Hall Effect. $$R_H = -\frac{1}{ne}(N-type): \; R_H = +\frac{1}{pe}(P-type)$$
14.	**What is hall device? List its types.** BTL4 The device which uses hall effect for its applications. • Gauss meter • Electronic meter • Electronic wattmeter
15.	Find the conductivity of intrinsic germanium at 300 K. (Given: $n_i = 2.5\times10^{19}\ m^{-3}$) **Solution:** **Given data:** $\mu_e = 0.38\ m^2V^{-1}s^{-1}$ $\mu_e = 0.18\ m^2V^{-1}s^{-1}$ $\sigma_i = en_i(\mu_e+\mu_h)$ $= 2.5\times10^{19}\times1.6\times10^{-19}(0.38+0.18)$ $= 2.24\ ohm^{-1}m^{-1}$ Answer: $\sigma_i = 2.24\ ohm^{-1}m^{-1}$
16.	Calculate the intrinsic concentration of charge carriers of germanium at 300 K. The effective masses of electrons and holes are $m_e^* = 0.12m_0$ and $m_h^* = 0.28m_0$ respectively. $E_g = 0.67$ for germanium. **Solution:** **Given data:** T = 300 K ; $m_0 = 9.11\times10^{-31}$; $m_e^* = 0.12m_0 = 1.0932\times10^{-31}$ $m_h^* = 0.28m_0 = 2.5508\times10^{-31}$; $E_g = 0.67$ eV $$n_i = 2\left(\frac{2\pi kT}{h^2}\right)^{3/2}\left(m_e^* m_h^*\right)^{3/4} e^{-E_g/2kT}$$ $$n_i = 2\left(\frac{2\times3.14\times1.38\times10^{-23}\times300}{(6.626\times10^{-34})^2}\right)^{3/2}\times\left(1.0932\times10^{-31}\times2.5508\times10^{-31}\right)^{3/4}.$$ $$e^{\left(\frac{-0.67\times1.6\times10^{-19}}{2\times1.38\times10^{-23}\times300}\right)}$$ $n_i = 4.69\times10^{18}/m^3$

	Answer: $n_i = 4.69\times10^{18}/m^3$
17.	**The donor density of a n-type silicon sample is $10^{21}/m^3$. The sample is arranged in a Hall experiment having magnetic field of 0.5 tesla and the current density 300 Ampere/m^2. Find the Hall voltage if the sample is 2 mm wide.** **Given data:** $n_e = 10^{21}/m^3$; B = 0.5 tesla ; $J_x = 300A/m^2$; t =0.3 mm $R_H = \frac{-1}{n_e e}$ $R_H = \frac{-1}{10^{21}\times1.6\times10^{-19}} = -6.25\times10^{-3}\ m^3C^{-1}$ Hall Voltage $V_H = R_H J_x Bt$; $V_H = 6.25\times10^{-3}\times300\times0.5\times2\times10^{-3}$ $V_H = 1.875\times10^{-3}$ Volts; $V_H = 1.875$ mV Answer: $V_H = 1.875$ mV
18.	**A n-type semiconductor has Hall coefficient $4\times10^{-4}m^3C^{-1}$. The conductivity is $200\Omega^{-1}m^{-1}$. Calculate its charge carrier density and electron mobility at room temperature.** **Given data:** $R_H = 4\times10^{-4}m^3C^{-1}$; $\sigma = 200\Omega^{-1}m^{-1}$ Charge density $n_e = \frac{-1}{R_H e}$ $n_e = \frac{3\pi}{8}\frac{1}{R_H e}$ (Considering the periodic potential in crystals) $n_e = \frac{3\times3.14}{8}\times\frac{1}{1.6\times10^{-19}\times4\times10^{-4}}$ $n_e = 1.8398\times10^{22}/m^3$ Electron mobility $\mu_e = \frac{\sigma_e}{n_e e}$; $\mu_e = \frac{200}{1.8398\times10^{22}\times1.6\times10^{-19}}$ $\mu_e = 0.0679m^{2^{-1}}Vs^{-1}$; Answer: $n_e = 1.8398\times10^{22}/m^3$ and $\mu_e = 0.0679m^{2^{-1}}Vs^{-1}$
PART * B	
1	**Derive an expression for density of electrons in the conduction band and density of holes in the valence band of an intrinsic semiconductor, hence deduce the expression for intrinsic carrier concentration. (16 M)** BTL2(Dec 2001) **<u>Electron concentration (n):</u>** The number of electrons in the conduction band per unit volume **Hole concentration (p)**: The number of holes in the valence band per unit volume **<u>Carrier concentration (or) Density of electron:</u>** The number of charge carries per unit volume of the material. (1M) **Calculation of Density of Holes in the Valence Band of Intrinsic Semiconductors** Let d_p be the number of holes per unit volume in the valence band between the energy E and E + d E $dp = Z(E)(1-F(E))dE$ (1M)

The probability of an unoccupied electron state, i.e., presence of a hole.

$$1-F(E)=1-\left[\frac{1}{1+e^{(E-E_F)/kT}}\right]$$

Since E is very small when compared to E_F in the valence band, $(E-E_F)$ is a negative quantity and hence $e^{(E-E_F)/\kappa}$ is very small.

i.e., $\therefore 1-F(E)=e^{(E-E_F)/kT}$ (1M)

E_v, the top level in the valence band is the potential energy of a hole at rest. Hence, (E_V-E) is the kinetic energy of the hole at level below E_V.

Density of states in the valence band, $Z(E)dE=\frac{4\pi}{h^3}(2m_h^*)^{3/2}(E_v-E)^{1/2}dE$ (1M)

$$dp=\frac{4\pi}{h^3}(2m_h^*)^{3/2}(E_v-E)e^{(E-E_F)/kT}dE$$

The number of holes in the valence band for the entire range is obtained

$$p=\int dp=\int_{-\infty}^{E_v}\frac{4\pi}{h^3}(2m_h^*)^{3/2}(E_v-E)^{1/2}e^{(E-E_F)/kT}dE \quad \text{(1M)}$$

To solve the integral in eqn (7), let us assume,

	when	when
$E_v-E=x$	$E=-\infty$	$E=E_v$
$E=-x+E_v$	$E_v+\infty=x$	$x=E_v-E_v$
$\therefore dE=-dx$	$\therefore x=\infty$	$\therefore x=0$

Substituting these values in equation,

$$p=\frac{4\pi}{h^3}(2m_h^*)^{3/2}e^{(E_V-E_F)/kT}\int_0^{\infty}x^{1/2}e^{(-x/kT)}dx \quad \text{(1M)}$$

Using the gamma function,

$$\int_0^{\infty}x^{1/2}e^{(-x/kT)}dx=\frac{(kT)^{3/2}\pi^{1/2}}{2}$$

$$p=2\left(\frac{2\pi m_h^*kT}{h^2}\right)^{3/2}e^{(E_V-E_F)/kT} \quad \text{(1M)}$$

Similarly $n_i=2\left(\frac{2\pi_e^*kT}{h^2}\right)^{3/2}e^{(E_F-E_C)/kT}$ (6M)

INTRINSIC CARRIER CONCENTRATION

In an intrinsic semiconductor, since the concentration of electrons in the conduction band is equal to the concentration of the holes in the valence band. i.e. $n=p=n_i$, $np=n_i\times n_i=n_i^2$

Substituting the corresponding expressions for n and p,

$$n_i^2 = 2\left(\frac{2\pi^*_e kT}{h^2}\right)^{3/2} e^{(E_F-E_C)/kT} \times 2\left(\frac{2\pi m_h^* kT}{h^2}\right)^{3/2} e^{(E_V-E_F)/kT} \qquad \text{(1M)}$$

where $E_C - E_v = E_g$ is the forbidden energy gap.

$$\therefore n_i = 2\left(\frac{2\pi kT}{h^2}\right)^{3/2} (m_e^* m_h^*)^{3/4} e^{-E_g/2kT} \qquad \text{(2M)}$$

2

Obtain an expression for the carrier concentration of holes in the valance band of intrinsic semiconductor. (10 M) BTL2(Dec 2001)

Hole concentration (or) Density of Holes (p): The number of holes in the valence band per unit volume. (1M)

Calculation of Density of Holes in the Valence Band of Intrinsic Semiconductors

Let d_p be the number of holes per unit volume in the valence band between the energy E and E + d E

$$dp = Z(E)(1 - F(E))dE \qquad \text{(1M)}$$

The probability of an unoccupied electron state, i.e., presence of a hole.

$$1 - F(E) = 1 - \left[\frac{1}{1 + e^{(E-E_F)/kT}}\right]$$

Since E is very small when compared to E_F in the valence band, $\left(E - E_F\right)$ is a negative quantity and hence $e^{(E-E_F)/\kappa}$ is very small.

i.e., $\therefore 1 - F(E) = e^{(E-E_F)/kT}$ (1M)

E_v, the top level in the valence band is the potential energy of a hole at rest. Hence, $\left(E_V - E\right)$ is the kinetic energy of the hole at level below E_V.

Density of states in the valence band, $Z(E)dE = \frac{4\pi}{h^3}(2m_h^*)^{3/2}(E_v - E)^{1/2} dE$ (1M)

$$dp = \frac{4\pi}{h^3}(2m_h^*)^{3/2}(E_v - E)e^{(E-E_F)/kT} dE \qquad \text{(1M)}$$

The number of holes in the valence band for the entire range is obtained

$$p = \int dp = \int_{-\infty}^{E_v} \frac{4\pi}{h^3}(2m_h^*)^{3/2}(E_v - E)^{1/2} e^{(E-E_F)/kT} dE \qquad \text{(1M)}$$

To solve the integral in eqn (7), let us assume,

	when	when
$E_v - E = x$	$E = -\infty$	$E = E_v$
$E = -x + E_v$	$E_v + \infty = x$	$x = E_v - E_v$
$\therefore dE = -dx$	$\therefore x = \infty$	$\therefore x = 0$ (1M)

Substituting these values in equation,

$$p = \frac{4\pi}{h^3}(2m_h^*)^{3/2} e^{(E_V - E_F)/kT} \int_0^\infty x^{1/2} e^{(-x/kT)} dx \qquad \text{(1M)}$$

Using the gamma function,

$$\int_0^\infty x^{1/2} e^{(-x/kT)} dx = \frac{(kT)^{3/2}\pi^{1/2}}{2} \qquad \text{(1M)}$$

$$p = 2\left(\frac{2\pi m_h^* kT}{h^2}\right)^{3/2} e^{(E_V - E_F)/kT} \qquad \text{(2M)}$$

3

Explain extrinsic semiconductors and derive the expression for carrier concentration for n-type and p-type semiconductor. (2 M + 7M+7M) BTL2(May 2003, Dec 2009, May 2011)

Answer Page: Dr. P. Mani

Extrinsic semiconductor: doped semiconductors are extrinsic semiconductors. Pentavalent doped semiconductors are n-type and trivalent doped semiconductors are p-type semiconductors. (2M)

Carrier concentration in n-type semiconductor (derivation):

Density of electrons per unit volume= $n = 2\left(\frac{2\pi m_e^* kT}{h^2}\right)^{3/2} e^{(E_F - E_C)/kT}$ (1 M)

Equating $$2\left(\frac{2\pi m_e^* kT}{h^2}\right)^{3/2} e^{(E_F - E_C)/kT} = N_d e^{(E_d - E_F)/kT} \qquad \text{(2 M)}$$

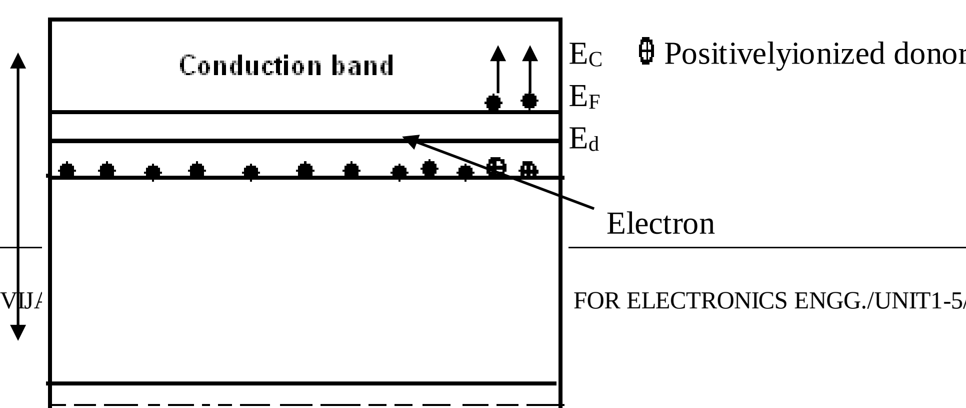
Taking log on both sides, we get

$$\log_e\left[2\left(\frac{2\pi m_e^* kT}{h^2}\right)^{3/2}\right] + \frac{E_F - E_C}{kT} = \log_e N_d + \frac{E_d - E_F}{kT}$$

$$E_F = \frac{E_d + E_C}{2} + \frac{kT}{2}\log_e\left[\frac{N_d}{2\left(\frac{2\pi m_e^* kT}{h^2}\right)^{3/2}}\right] \qquad \text{(2M)}$$

Substituting the expression of E_F $\boxed{n = (2N_d)^{1/2}\left(\frac{2\pi m_e^* kT}{h^2}\right)^{3/4} e^{-\Delta E/2kT}}$ (1M)

Where $\Delta E = E_C - E_d$ is the ionization energy of the donor



Eg

E_V

(1M)

Concentration of holes in the valence band of p-type semiconductor (derivation):

Let E_α represent the energy of the acceptor level and N_α denote the number of acceptor atoms per unit volume, Density of holes $p = 2\left(\frac{2\pi m_h^* kT}{h^2}\right)^{3/2} e^{(E_V - E_F)/kT}$ (1M)

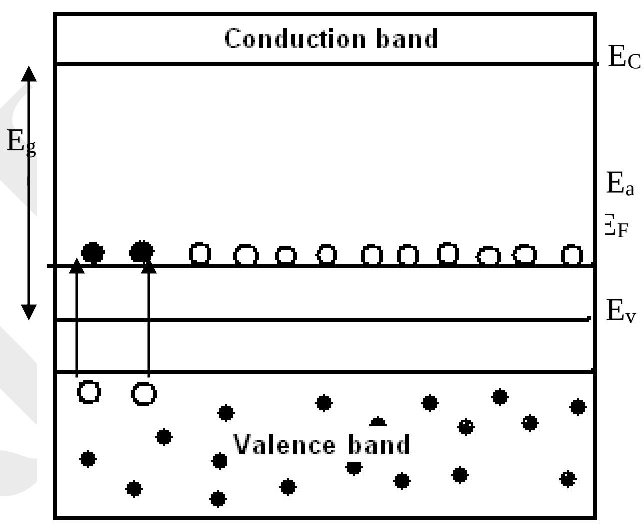
Where E_F is Fermi energy level; E_V is the energy corresponding to the top level of valence band.

Density of ionized Acceptors $N_a F(E_a) = \frac{N_a}{1 + e^{(E_d - E_F)/kT}}$

Density of ionized Acceptors $= N_a e^{(E_d - E_F)/kT}$ (1M)

At equilibrium,= Density of holes in the valence band= Density of ionized acceptors

$$2\left(\frac{2\pi m_h^* kT}{h^2}\right)^{3/2} e^{(E_V - E_F)/kT} = N_a e^{(E_d - E_F)/kT}$$ (1 M)



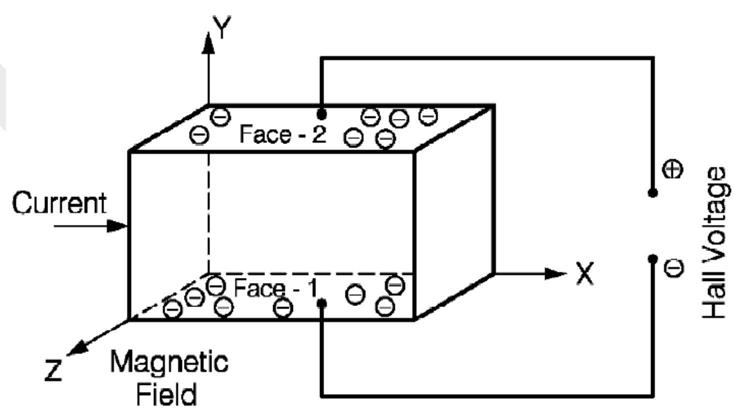
(1M)

Taking log on both sides, we have

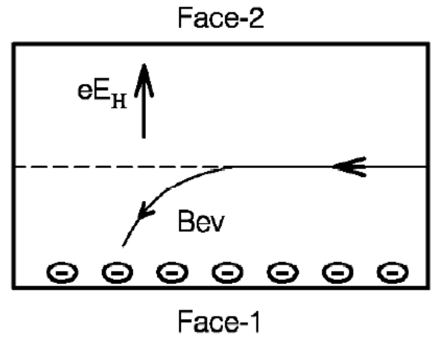
$$\log_e 2\left(\frac{2\pi m_h^* kT}{h^2}\right)^{3/2} + \frac{E_V - E_F}{kT} = \log_e N_a + \frac{E_F - E_a}{kT}$$

	Rearranging the expressions, we have $$E_F = \frac{E_a + E_V}{2} - \frac{kT}{2}\log_e\left[\frac{N_a}{2\left(\frac{2\pi m_h^* kT}{h^2}\right)^{3/2}}\right]$$ (2M) Substituting the expression of E_F , If $E_a - E_v = \Delta E$, $$\boxed{p = (2N_a)^{1/2}\left(\frac{2\pi m_h^* kT}{h^2}\right)^{3/4} e^{-\Delta E/2kT}}$$ (1M)
4	**What is carrier transport? Explain drift transportation in detail. (2M+8M)** BTL1 **Answer Page: 2.35 Dr. P. MANI** **Carrier transport:** • Any motion of free carriers in a semiconductor leads to a current. • This motion can be caused by an electric field due to an externally applied voltage, since the carriers are charged particles. • This transport mechanism is *carrier drift.* • Carriers also move from high density regions to low density region. • This carrier transport mechanism is due to the thermal energy and the associated random motion of the carries. • This transport mechanism *is carrier diffusion*. • The total current equals the sum of the drift and the diffusion current. (2M) **<u>Drift transportation</u>** **For electron** $V = -\frac{eE}{m_n}.t$ Average net velocity of electron $V_{d_n} = -\frac{eE}{m_n}.\tau_c$ We know that, Mobility $\mu_n = \frac{V_{d_n}}{E}$ $\therefore V_{d_n} = -\mu_n.E$ For Holes $V = \frac{eE}{m_n}.t$ Average net velocity of holes $V_{d_p} = \frac{eE}{m_p}.\tau_c$ We know that, Mobility $\mu_p = \frac{V_{d_p}}{E}$ $\therefore V_{d_p} = \mu_p.E$ (3 M)

	$J_{nd} = -enV_{dn}$ $\quad$ $J_{pd} = epV_{dp}$ $J_{nd} = +en\mu_n E$ $\quad$ $J_{pd} = ep\,\mu_p E$ **(2M)** $J_{drift} = e(\mu_n n + \mu_p p)E$ We know that, $J_{drift} = \sigma E$ Comparing the above two equation, we get Conductivity, $\sigma = e(\mu_n n + \mu_p p)$ Resistivity $P = \frac{1}{e(\mu_n n + \mu_p p)}$ Resistivity is commonly used to specify doping level. In n-type semiconductor $\quad$ In p-type semiconductor $P_n = \frac{1}{e N_d \mu_n}$ $\quad$ $P_p = \frac{1}{e N_a \mu_p}$ **(3M)**
5	**Write a short notes on (i) Diffusion transport (8 M) (ii) Einstein Relation (6M)** BTL2 **(i) Answer Page: 2.39 Dr. P. MANI** In semiconductors, the "flow of carriers" from one region to higher concentration to lower concentration results in a "diffusion current" or carrier diffusion. Ficks law describes diffusion as the flux 'F' is proportional to the gradient in concentration. i.e. Diffusion flux $\propto$ - concentration gradient **(2M)** For electron, $\quad$ For holes, $F_n = -D_n \frac{dn}{dx}$ $\quad$ $F_p = -D_p \frac{dp}{dx}$ $J_{n,\,dif} = e\,Dn\,\frac{dn}{dx}$ $\quad$ $J_{p,\,dif} = -e\,Dp\,\frac{dp}{dx}$ **(2M)**

	$$J_n = en\mu_n E_x + eD_n \frac{dn}{dx} \qquad J_p = ep\mu_p E_x - eD_p \frac{dp}{dx}$$ $$J = J_n + J_p \qquad = en\mu_n E_x + ep\mu_p E_x + eD_n \frac{dn}{dx} - eD_p \frac{dp}{dx}$$ **(2 M)** **(ii) Answer Page: 2.41 Dr. P. MANI** Einstein derived the relationship between the mobility (μ) and diffusion coefficient (D) using non-uniformly doped semiconductor model $$\boxed{\frac{D}{\mu} = \frac{K_B T}{e}}$$ **(3M)** In semiconductor, $$\boxed{\frac{D_n}{\mu_n} = \frac{D_p}{\mu_p} = \frac{K_B T}{e}}$$ **(3 M)**
6	**State and explain Hall effect. With necessary theory and diagram, derive the Hall coefficient. (3 M+ 13M)** BTL2(May 2007, Dec 2009) **Hall Effect:** When a conductor (metal or semiconductor) carrying a current (I) is placed in a magnetic field (B) perpendicular to this current, a potential difference (electric field) is developed inside the conductor in a direction normal to the directions of both the current and the magnetic field. This phenomenon is known as Hall effect and the voltage thus generated is called Hall voltage. (3 M) **Hall effect in n-type semiconductor** Let us consider a n-type semiconducting material in the form of rectangular slab,  (1M) **Fig. Hall effect** When a magnetic field (B) is applied in Z-direction, the electrons moving with velocity v will experience a downward force. Downward force experienced by the electrons = Bev (1 M)

This downward force deflects the electrons in downward direction and therefore, there is an accumulation of negatively charged electrons on the bottom face of the slab as shown in fig.



Hall effect in n-type semiconductor (1 M)

This electric field develops a force which is acting in the upward direction on each electron,

Upward force acting on each electron = eE_H (1 M)

At equilibrium, **the downward force Bev will balance the upward force eE_H**

$$\therefore Bev = eE_H \quad \text{or} \quad E_H = Bv \qquad (1\text{ M})$$

The current density (J_x) acting along the X-direction is related to the velocity v as

$J_x = -nev$, Where n is the concentration of current carriers (electrons).

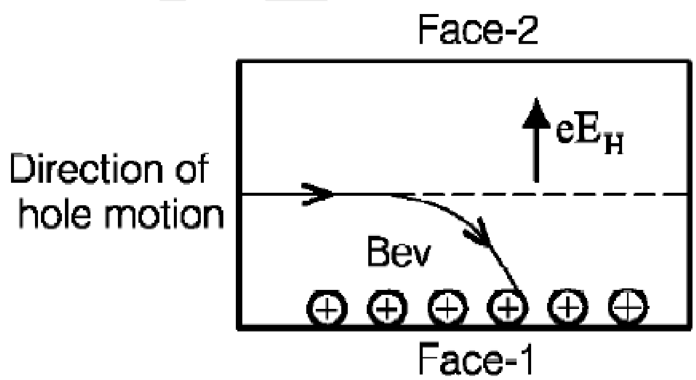
$v = \frac{-J_x}{ne}$; Substituting v, $E_H = \frac{-BJ_x}{ne}$ OR $E_H = R_H J_x B$ OR (1 M)

or $R_H = \frac{E_H}{J_x B}$, where $R_H = -\frac{1}{ne}$ (1 M)

R_H is a constant and it is known as Hall coefficient.

Hall effect in p-type semiconductor

Consider a rectangular slab of p-type semiconducting material and the current flow in this case is entirely due to the flow of positive holes from left to right as shown in fig.



(1 M)

Hall effect in p-type semiconductor

Due to applied magnetic field, the holes are accumulated in the bottom of the slab and thus produce a potential difference.Similar to n-type semiconductor, we can write $E_H = R_H J_x B$ (4 M)

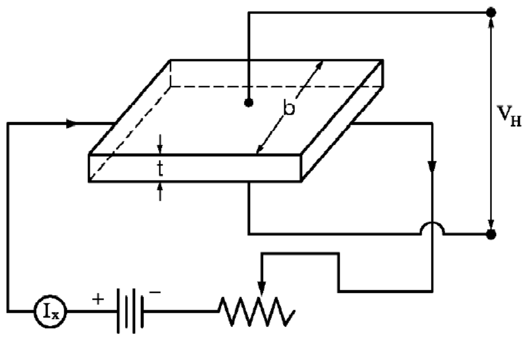
Where Hall coefficient (R_H) , $R_H = +\frac{1}{pe}$; Where p is the concentration of current carriers (holes). (1 M)

(i) Describe the experiment to determine the Hall Coefficients. List the various Hall devices and explain them. (10 M) BTL2

(ii) Find the Hall coefficient and electron mobility of germanium for a given sample of length 1 cm , breadth 5 mm and thickness 1 mm. A current of 5 mA flows from a 1.3 volt supply and develops a Hall voltage of 20 millivolt across the specimen in a magnetic field of 0.45 wb/m^2. (4 M) BTL4

(i) Answer Page : 2.48 Dr. P. MANI

Experimental set up



(2 M)

7

Explanation

$$V_H = \frac{R_H I_x B t}{bt}$$

$$V_H = \frac{R_H I_x B}{b}$$

$$\boxed{R_H = \frac{V_H b}{I_x B}}$$

(2 M)

Hall Devices

Gauss Meter (2 M)

Electronic Multiplier (2 M)

Electronic Wattmeter (2 M)

(ii) Answer

Given data: $I = 5\times10^{-3} A$; $V = 1.35$ V ; $l = 1\times10^{-2}$ m ; $b = 5\times10^{-3}$ m;

$t = 1\times10^{-3}$ m ; $V_y = 20\times10^{-3}$ V ; H = 0.45 wb/m^2

Resistance $R = \frac{V}{I} = \frac{1.35}{5\times10^{-3}}$ = 270 ohm

Resistivity $\rho = \frac{Ra}{l}$

Area $a = b\times t = 5\times10^{-3}\times1\times10^{-3} = 5\times10^{-6}$ m^2

$$\therefore \rho = \frac{270\times5\times10^{-6}}{1\times10^{-2}} = 0.135 \text{ ohm m}$$

Hall field $E_y = \frac{V_y}{thickness} = \frac{20\times10^{-3}}{1\times10^{-3}}$ = 20 V/m (2 M)

Current density $J_x = \dfrac{Current}{Area} = \dfrac{5\times10^{-3}}{5\times10^{-6}}$ = 1000 A/ m^2

$$\frac{1}{ne} = \frac{E_y}{HJ_x} = \frac{20}{0.45\times1000} = 0.044 \text{ m}^3/\text{C}$$

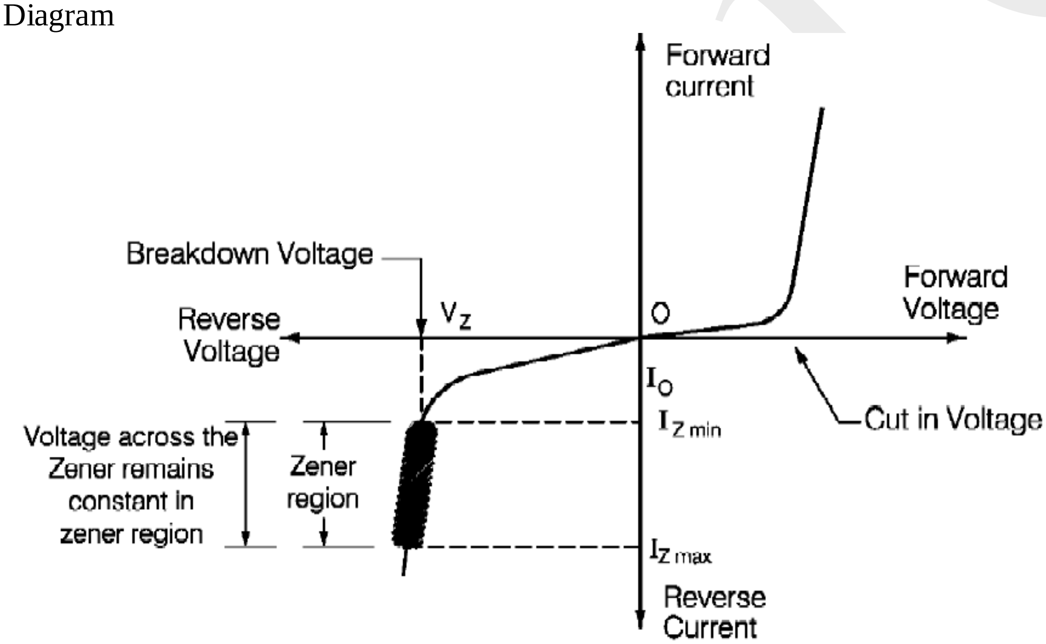
Hall coefficient $R_H = \dfrac{3\pi}{8}\times\dfrac{1}{ne} = 1.1775\times0.044 = 0.05181$ m^3/C (1 M)

Electron mobility $\mu_e = \dfrac{R_H}{\rho} = \dfrac{0.05181}{0.135} = 0.3838\ m^2V^{-1}s^{-1}$

Answer: $R_H = 0.05181\times10^{-6}m^3C^{-1}$ and $\mu_e = 0.3838m^2V^{-1}s^{-1}$ (1 M)

8. **Detail the occurrence of zener and avalanche breakdown in p-n – junction. (12 M)** BTL2

Answer Page: 2.57 D. P. MANI
Occurrence of Zener Breakdown (5 M)
Occurrence of avalanche Breakdown (5 M)
Diagram



(2 M)

9. **(i) Describe the principle, theory and V-I characteristics of Tunnel diode. (10 M)** BTL2
(ii) Give its advantages and applications of tunnel diode in engineering field. (4 M) BTL2

(i) **Answer Page : 2.67 Dr. P. Mani**
Principle : (2 M)
Theory (3 M)
V-I characteristics Diagram (2 M)
Explanation (2 M)

(ii) **Answer Page :2.70 Dr. P. Mani**
Advantages (2 M)
Applications (2 M)

10.	**With a neat sketch, describe the principle, construction and working of a Schottky diode. Compare the V-I characteristics of Schottky diode. (12M+4M)** BTL2, BTL4 **Answer Page : 2.60 Dr. P. Mani** Principle : (2 M) Theory (3 M) V-I characteristics Diagram (2 M) Explanation (2 M) Comparison of V-I characteristics (4 M)
11.	**Explain in detail the operation of MOS capacitor under various gate voltages. (8 M)** BTL2 **Answer Page : 2.71 Dr. P. Mani** Structure (2 M) Principle of operation Below the flat-band voltage (1M) Between the flat-band voltage and threshold voltage (1M) Larger than the threshold voltage (4 M)

UNIT III MAGNETIC AND DIELECTRIC PROPERTIES OF MATERIALS 9 Magnetism in materials – magnetic field and induction – magnetization - magnetic permeability and susceptibility–types of magnetic materials – microscopic classification of magnetic materials - Ferromagnetism: origin and exchange interaction- saturation magnetization and Curie temperature – Domain Theory. Dielectric materials: Polarization processes – dielectric loss – internal field – Clausius-Mosotti relation- dielectric breakdown – high-k dielectrics.	
Q.No.	**PART * A**
1.	**Give Curie-Weiss law and its importance.**BTL1(May 2003) Curie-Weiss law is given by $$\chi_m \propto \frac{1}{T} \quad i.e. \quad \chi_m = \frac{C}{T-\theta}$$ Where C- Curie constant & T-Absolute temperature & θ- Curie temperature Importance: It determines the susceptiplity of magnetic materials in terms of temperatures (i.e.) If the temperature is less than curie temperature; a paramagnetic material becomes diamagnetic and if the temperature is greater than curie temperature, a ferromagnetic material becomes paramagnetic materials.
2	**Define dia, para, ferro, antiferro and ferri magnetic materials. Give examples.** BTL1(June 2009, June 2011) **Dia Magnetic material:** In dia magnetic materials, there are equal numbers of electron spins and randomly oriented hence the net magnetic moment is zero. Susceptibility doesn't depend on temperature. Eg. Gold, antimony, bismuth, water, hydrogen, alcohol, Si, Ge. **Para Magnetic material:**In para magnetic materials, there are unequal numbers of electron spins and hence there exists a permanent magnetic dipole moment. Susceptibility depends on temperature. Eg. Platinum, chromium, aluminium, Copper Sulphate. **Ferro Magnetic material:**In ferro magnetic materials, there are large numbers of unequal electron spins and hence there exists enormous permanent magnetic dipole moment. They exhibit hysteresis. Susceptibility depends on temperature. Eg. Iron, Nickel, Cobalt, Steel. **Antiferro Magnetic material:**In antiferro magnetic materials, the adjacent magnetic dipoles are aligned antiparallel. Susceptibility depends on temperature. Eg. Iron, Nickel, Cobalt, Steel. **Ferri or Ferrite Magnetic material:**In ferrite magnetic materials, the spin alignment is antiparallel of different magnitudes. Susceptibility depends on temperature. Eg. $Mg^{2+}Fe_2^{3+}O_2^{2-}$, $Mn^{2+}Fe_2^{3+}O_2^{2-}$, $Ni^{2+}Fe_2^{3+}O_2^{2-}$, $Co^{2+}Fe_2^{3+}O_2^{2-}$
3	**What are soft and hard magnetic materials? (or) Compare soft and hardmagnetic materials on the basis of hysteresis loop. Give examples. (or) Discriminate soft and hard magnetic materials.** BTL4

S. No.	Soft Magnetic Materials	Hard Magnetic Materials
1.	They can be easily magnetized and demagnetized	They cannot be easily magnetized or demagnetized.
2.	Movement of domain wall is easy and hence even for a small applied field large magnetization occurs	Moment of domain wall is easy due to the presence impurity and hence large filed is required for magnetization
3.	The hysteresis loop is steep	The hysteresis loop is broad.
4.	Loop area is less and hysteresis loss is minimum	The loop area is maximum and hence the hysteresis loss is maximum
5.	Ex: Iron, Silicon alloys, ferrites &garnets etc	Ex: steel, Tungsten, steel chromium steel, Cu-Ni-Fe (Cunfie), Cu-Ni-Co (Cunico), Al-Ni-Co (Aalnico)
6.	Susceptibility and permeability is very high	Susceptibility and permeability is very low
7.	Retentivity and coercivity are small	Retentivity and coercivity are large
8.	They have low eddy current loss	They have high eddy current loss
9.	These materials are free from irregularities like impurities and strain	These materials are free from irregularities like impurities and strain

4. **What are Ferrites (Ferri magnetic material)?** BTL2

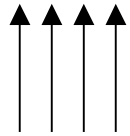
- The uncompensated ferromagnetic materials are called as Ferri magnetic material or ferrites.
- They have the magnetic moments are unequal magnitudes.
- Ferrites are compounds of iron oxides with oxides of other metals.
- Its general formula is given by $X^{2+}Fe_2^{3+} O_4^{2-}$. Where, X^{2+} is a divalent metal ion such as Mg^{2+}, Zn^{2+}, Fe^{2+}, etc.
- Susceptibility is large and positive. ($\chi = C / T \pm \theta$ for $T > T_N$)
- Above curie becomes para, below curie ferro behaviors.

5 **Define magnetic susceptiplity and magnetic permeability. (or) Comment on magnetic susceptiplity and magnetic permeability.** BTL1

Magnetic susceptiplity (χ_m): The ratio between intensity of magnetization (*I*) and magnetic field intensity (*H*) (i.e.,) $\chi_m = I / H$

Magnetic permeability (μ_m); The ratio between Magnetic flux density (B) and magnetic field intensity (H). (i.e.,) $\mu_m = B / H$.

6	**Define residual magnetism (or) Retentivity and Coercive force (or) coercivity with its unit.**BTL1. **<u>Residual magnetism or Retentivity:</u>**The amount of magnetic induction retained in the material after removing the magnetizing field. Unit: Wb m^{-2} **<u>Coercive force (or) coercivity:</u>**The amount of magnetizing field applied in the reverse direction to remove the residual magnetism completely from the material. Unit: Ampere-turn / m.
7.	**Define Curie temperature and Neel temperature.**BTL1 **<u>Curie temperature</u>:** The critical temperature at which a ferromagnetic material changes into a paramagnetic material. **<u>Neel temperature</u>:** The critical temperature at which the antiferro magnetic material changes into paramagnetic material.
8.	**What are the four types of energies involve in the growth of magnetic domains?**BTL1(June 2009) • Exchange Energy (or)Spin Exchange Interaction Energy (or) Interaction Energy • Anisotropy Energy (or) Crystal Anisotropic Energy • Magneto-static energy (or) Magnetic Potential Energy • Magnetostrictive energy (or) Magneto-Elastic energy
9	**Define Hysteresis. (or) What is hysteresis? (or) Appraise the term hysteresis.** BTL1 The lagging of induced magnetic induction (B) behinds the applied magnetizing field (H) is known as hysteresis. i.e. Lagging of B behind H.
10	**Define Bohr Magneton.**BTL1 The orbital magnetic moment and spin magnetic moment of an electron in an atom can be expressed in terms of atomic unit of magnetic moment is called Bohr Magneton. $\mu_B = e\hbar / 2m = 9.27 \times 10^{-24}$ **Am²**
11.	**What is ferromagnetism? Give examples. (or) What are ferromagnetic materials?** BTL1 These materials show spontaneous magnetization. They exhibit permanent magnetic dipole moment even in the absence of magnetic field. There is a strong internal field within the material which makes the atomic magnetic moments align with each other. This phenomenon is ferromagnetism. Examples: Fe, Co, Ni, Steel etc…
12.	**List the properties of ferromagnetic materials.** BTL1 • Relative permeability is very much greater than one. i.e, $\mu_r >> 1$ • They have positive and high value of susceptibility and it depends on temperature. It obeys Curie-Weiss law. • i.e. $\chi = \frac{C}{T-\theta}$ • Due to spin exchange interaction, it exhibits strong magnetization even in the absence of magnetic field. • They have permanent dipole moment. • Ferro magnetic materials consists of small spontaneously magnetized regions called domains. • Ferromagnetic material become paramagnetic material if the temperature is greater than curie temperature. • Magnetic moments of these materials are orderly oriented.

	• i.e.,  • They have hysteresis properties. • Examples: Fe, Co, Ni, Steel etc…
13.	**What are dielectrics? List their uses.**BTL1(Nov 2003) • Dielectric materials are the non-metallic materials in which electric dipoles can be produced permanently or temporarily by applying the electric field. • Examples: Glass, ebonite, mica, rubber, wood, and paper. Vacuum is a perfect insulator but it is not a dielectric. • These are mainly used, to store electrical energy, as insulator and coolant in transformers and as electrical insulators.
14.	**What are the properties of dielectric materials?**BTL1 • They have high resistivity (~10^6 mho cm) and high specific resistance. • In dielectric materials all the electrons are tightly bound to their parent nucleus. • They have negative temperature coefficient of resistance and high insulation resistance. • They have energy gap ~3 Ev
14.	**Define Permittivity.**BTL1 Permittivity is a quantity that represents the dielectric property of a medium. Permittivity of a material indicates how easily dielectric material is polarizable. Its unit is Fm^{-1}. $\varepsilon = \varepsilon_0 \varepsilon_r$
15	**Define dielectric constant or relative permittivity.**BTL1 The ratio of the absolute permittivity of the medium (ε) to the permittivity of free space (ε_o). It is also called as relative permittivity.i.e. $\varepsilon_r = \varepsilon / \varepsilon_o$. It has no unit. For air or vacuum $\varepsilon_r = 1$.
16	**What is Polarization? Name the four types of polarization mechanisms.**BTL1(Dec 2009, June 2010) The process of producing electric dipoles temporarily or permanently in the dielectrics by an external electric filed is called polarization in dielectrics. • Electronic polarization • Ionic polarization • Orientation or Dipolar polarization • Space-charge or Interfacial polarization
17	**Define Polarizability. Name the types of polarizabilities.** BTL2 The ratio of average dipole moment to the electric field applied. Its unit is farad m^2 or Fm^2. • Electronic polarizability • Ionic polarizability • Orientation polarizability

	• Space-Charge polarizability
18.	**What is Polarization Vector**?BTL1 The polarization vector is defined as dipole moment per unit volume of the dielectric material. i.e. $\vec{P} = N \vec{\mu}$ μ is the average dipole moment per molecule, N is the number of molecules per unit volume.
19	**What is electrical susceptibility?** BTL1 The electric susceptibility χ_e is a dimensionless proportionality constant that indicates the degree of polarization of a dielectric material in response to an applied electric field. $\vec{P} \propto \vec{E}$ $\quad \vec{P} = \varepsilon_o \chi_e \vec{E}$ Where χ_e is a scalar constant referred as electrical susceptibility and it is the characteristic of every dielectric.
20	**What is Electronic polarization?**BTL1 Electronic polarization is due to the displacement of positively charged nucleus and negatively charged electrons of an atom in the opposite directions on the application of an electric field. It is independent to temperature. Eg. Inert gases.
21	**What is Ionic polarization?**BTL2(Dec 2009, June 2010) The process of displacement of positive ions (cat-ions) and negative ions (anions) in the opposite direction in a ionic dielectric due to the application of electric field is called Ionic polarization.It is independent to temperature. Eg. Ionic crystals.
22	**What is Orientation polarization?** BTL1 When an external field is applied on the dielectric medium with polar molecules, the dipoles align themselves in the field direction and thereby increase electric dipole moment is called orientation polarization. It is inversely proportional to temperature. Eg. Alcohol, Methane, CH_3Cl.
23	**What is Space-charge polarization?**BTL1 Space-charge polarization occurs due to the accumulation of charges at the electrodes or at the interfaces of multiphase dielectric materials due to the application of electric filed. It is directly proportional to temperature. Eg. Ferrites, Semiconductors.
24	**What is Internal Field or Local Field or Lorenz field?**BTL1 The long–range coulomb field created due to dipoles inside a dielectric is called as internal field or Lorentz local field. This field is responsible for polarization of each atom or molecule in a dielectric. $E_{int}=E+P/ 3\varepsilon_o$ Where, P is the polarization, ε_o is the permittivity of free space
25	**What is dielectric loss and loss tangent?**BTL1 If a dielectric is subjected to AC voltage, electrical energy is absorbed by the dielectric and certain quantity of electrical energy is dissipated in the form of heat energy. This is called as dielectric loss. Generally dielectric loss occurs in both direct and alternating voltages. In a perfect insulator, polarization is complete during each cycle and there is no consumption

	of energy and the charging current leads to the applied voltage by 90º. But for commercial dielectric, this phase angle is less than 90º by an angle δ and is called dielectric loss angle. Tan δ is taken as measure of dielectric loss and is known as loss tangent.
26	**Define Dielectric Breakdown and Dielectric strength.**BTL1 When the strength of electric field applied to a dielectric exceeds to a critical value, the dielectric loses its insulating property and becomes a conductor. i.e., very large current flows through it. This phenomenon is called as dielectric breakdown. Dielectric strength is defined as the electric field strength at which dielectric breakdown occurs. It is the breakdown voltage per unit thickness of the material
27	**Mention the various breakdown mechanisms.**BTL4(Dec 2009) 1. Intrinsic breakdowns 2. Avalanche breakdown 3. Thermal breakdown 4. Chemical and electrochemical breakdown 5. Discharge breakdown 6. Defect breakdown
28.	**What are the remedies to avoid dielectric breakdown?**BTL4 To avoid breakdown, the dielectric material should have the following properties: • It must be in pure form. • There should not be any defect. • It should have high dielectric strength to withstand higher voltage. • It should have high resistivity to reduce leakage current. • It should be fire-proof. • It should have low dielectric loss. It should be resistant to oils, liquids, gas fumes, acids and alkalies
31.	**What are the uses of Dielectric Materials?**BTL1 • The dielectric materials has three major applications • It is used as a dielectric medium in capacitors. • It is used as insulating materials in transformers. • Synthetic oils are used as coolant and in high voltage transformers. • Mineral oils are used as transformer oils. • Petroleum oils are used in transformers and circuit breakers. • Miscellaneous oils such as vegetable oils, Vaseline etc are used in the high voltage transformers. • Ceramic materials are used in high frequency capacitors and disc capacitors. • Electrolytic solution of sodium phosphate and ammonium tetra borate are used as wet type and dry type electrolytic capacitors respectively. • Mica is used in discrete capacitors. • Papers filled with synthetic oils are used in power capacitors.

PART-B

1.

(i) State the origin of magnetic moment. (4 M) BTL2

(ii) How magnetic materials are classified based on magnetic moments? Explain their properties. Give also their characteristics and examples. (16 M) BTL3(May 2011)

(i) Answer Page: 3.1 Dr. P. MANI

- All materials are basically composed of atoms.
- The property of certain magnetic materials is associated with the magnetic property of its constituent atoms.

<u>The magnetic dipole moment of an atom depends on</u>

- The **orbital magnetic moment** due to the orbital motion of electrons around the nucleus and its magnitude is very small.
- The **spin magnetic moment** due to the spin motion of electrons about their own axes.
- The magnetic moment due to the nuclear spin.

The magnetic moment due to the electron spin only is taken into consideration neglecting the orbital and the nuclear magnetic moments because of their small magnitudes. (4M)

(ii) Answer Page: 3.23 Dr. P. MANI

Properties of Dia magnetic materials

i) Relative permeability is always less than one. i.e, $\mu_r < 1$ for these materials.

ii) They have negative value of magnetic susceptibility and it is independent to temperatrure.

iii) Since there is no permanent magnetic dipole moments, they are called as weak magnets.

iv) They are magnetised in a direction opposite to the external magnetizing field.

v) They repel the magnetic lines of forces.

vi) Induced magnetic moment is proportional to the applied magnetic field.

vii)The induced dipoles and magnetization vanishes as soon as the applied field is removed.

viii) When temperature is less than critical temperature they become normal material.

Examples; Ge, Si, Ag, Hydrogen, Bi, Niobium etc.. (4 M)

Properties of Para magnetic materials

i) Relative permeability is greater than one. i.e, $\mu_r > 1$ for these materials.

ii)They have positive value of magnetic susceptibility.

iii) Magnetic susceptibility is inversly proportional to the temperature.

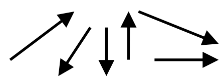
i.e., $\chi \alpha \frac{1}{T} \Rightarrow \chi = \frac{C}{T}$ **(Curie law)**

(or) $\chi = \frac{C}{T-\theta}$ **(Curie-Weiss law)**

where C-Curie constant; T-Asolute temperature; θ- Curie temperature

iv) They are magnetised along the direction of the external magnetizing field.

vi) They posses permanent magnetic dipole moments in random directions.



vii) Magnetic lines of forces can penetrate through these materials.

viii) When the temperature is than curie temperature, these materials become diamagnetic nature.

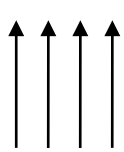
Examples: Alkali metals, Transition metals, Rare earth elements, $CuSo_4$, $MnSo_4$, Pt, Al etc. (4 M)

Properties of ferromagnetic materials

i) Relative permeability is very much greater than one. i.e, $\mu_r = 1$.
ii) They have positive and high susceptibility and it depends on temperature. It obeys **Curie-Weiss law.**

i.e., $\chi = \frac{C}{T-\theta}$

iii) Due to spin exchange interaction, it exhibits strong magnetization even in the absence of magnetic field.
iv) They have permanent dipole moment.
v) Ferro magnetic materials consists of small spontaneously magnetized regions called domains.
vi) Ferromagnetic material become paramagnetic material if the temperature is greater than curie temperature.
vii) Magnetic moments of these materials are orderly oriented.

i.e., 

viii) They have hysteresis properties. Examples: Fe, Co, Ni, etc… (4 M)

Properties of Ferrites orferri-magnetic materials

	i) Ferrites possess non-zero magnetic moment. ii) They exhibit paramagnetic property above Curie temperature and ferromagnetic character below Curie temperature. iii) The susceptibility of a ferrite is very large and positive. It is temperature dependent iv) and it is given by $\chi = \dfrac{C}{T \pm \theta}$ *for* $T > T_N$ v) They have high permeability and high resistivity **vi)** They have low eddy current losses, low hysteresis losses and low coercivity. (4 M)
2	**(i) Describe about the origin and exchange interaction in ferromagnetism. (6 M)** BTL2 **(ii) Discuss about saturation magnetisation and Curie temperature. (6 M)** BTL2(May 2012) **(i) Answer Page: 3.12 Dr.P. MANI** Origin of ferromagnetism and exchange interaction explanation with diagram (3M +3 M) **(ii) Answer Page: 3.14 Dr. P. MANI** Saturation magnetism and curie temperature definition, explanation with diagram (2M +4 M)
3	**Explain domain theory of ferromagnetism, domain magnetization and different types of energy involved in the process of domain growth in detail. (16 M)** BTL2(June 2010, May 2011) **Principle:**The total energy of a system is minimum at thermal equilibrium. The total internal energy of the domain in a ferromagnetic material is the sum of the following energies. • Magnetostatic energy or magnetic field energy or exchange energy • Crystalline energy or anisotropy energy • Domain wall energy or Bloch wall energy • Magnetostriction or magneto-strive energy. (2M) **(i) Exchange energy** • The energy which makes the adjacent dipoles align themselves in a particular direction • Arises from the interaction of electron spins • Depends upon the interatomic distance. • The energy required in assembling the atomic magnets into single domain and this work done is stored as potential energy. (2M) **(ii) Anisotropy energy** • In ferromagnetic crystals, there are two directions of magnetization namely easy direction and hard direction. • The excess energy required to magnetize a specimenin particular direction over that required to magnetize it along the easy direction (2M) **(iii) Domain wall energy or Block wall energy** • <u>**Domain wall or Bloch wall:**</u> A thin boundary line or region which separates adjacent domains magnetized in different directions • The size of the Bloch walls are about 200 to 300 lattice constant thickness.

- In going from one domain to another domain, the electron spin changes gradually as shown in fig.
- When the exchange energy is high change occurs abruptly. But, the anisotropy energy is less only when spin changes abruptly.

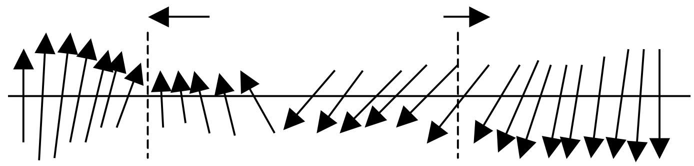
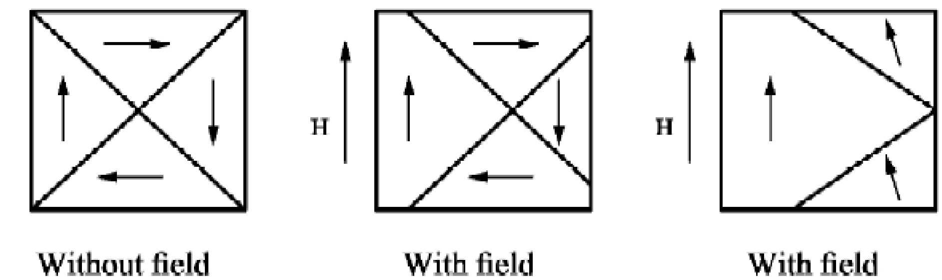


Figure. The change of electron spin in the transition region of Bloch wall (2 M)

(iv) Magnetostriction energy

- **Magnetostriction:**The change in the dimension of a ferromagnetic material when it is magnetized
- The energy involved in this change in dimension is known as magnetostriction energy
- The deformation is different along different crystal directions but it is independent of the direction of the field
- The magnetostriction energy is the energy due to the mechanical stresses generated by domain rotation (2 M)

Domain magnetization

	i. By the movement of domain walls. ii. By rotation of domains. **i. Movement of Domain Walls :** The movement of domain walls takes place in weak magnetic fields. When a small magnetic field is applied, the domains with magnetisation direction parallel to the field, grow at the expense of others.  (a) Random domain alignment(without field) (b) Domain wall movement (with weak field) (c) Domain rotation (with strong field) **ii. Rotation of Domains** If the magnetic field is increased further, domain growth becomes impossible. Rotation of magnetic moment takes place. Finally, completely grown domains and very small domains appear in a direction parallel to the applied field. (3M+3M)
4	**Define polarization. Describe the different types of polarization mechanisms involved in a dielectric material. (2M+14M) (or) Deduce Langevin-Debye equation (16 M).** BTL2(June 2009) **Answer Page:3.53 Dr. P. Mani** **Polarization***: The process of producing electric dipoles by an external electric filed (2M)* **<u>Electronic polarization</u>** *Electronic polarization is due to the displacement of positively charged nucleus and negatively charged electrons of an atom in the opposite directions on the application of an electric field*. This results the creation of dipole moment in the dielectric. Dipole moment (μ) is proportional to the electric field strength (E) $\mu \alpha$ E $\mu = \alpha_e E$

Where α_e is electronic polarisability

Electronic polarization is independent of temperature. It is proportional to the volume of atoms in the material. Electronic polarization takes place in almost all the dielectrics. Mono – atomic gases exhibit this kind of polarization.

Calculation of Electronic Polarisability (α_e)

(i) Without Electric Field

consider an atom of a dielectric material of nuclear charge Ze, where Z is the atomic number. The electrons of charge (-Ze) are distributed uniformly throughout the sphere of radius R and there is no dipole moment as shown in figure

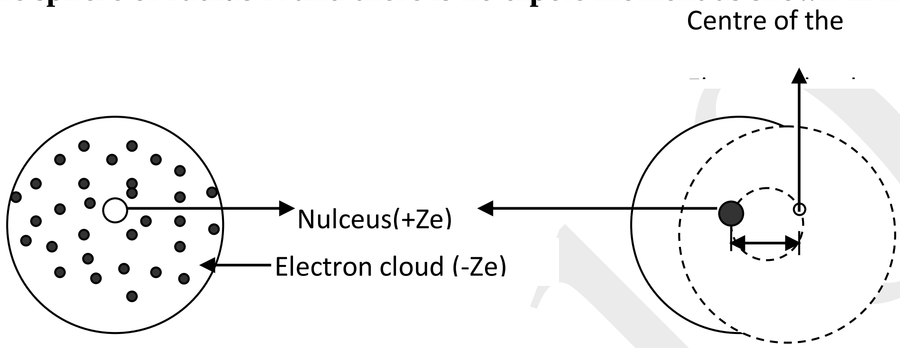


Fig. Atom without field **Fig. Atom with field**

Negative charge density on an atom of radius R is given by

$$\rho = \frac{\text{Total negative charge}}{\text{Volume of the atom}} = \frac{-Ze}{\frac{4}{3}\pi R^3}$$

$$\rho = -\frac{3}{4}\frac{Ze}{\pi R^3} \qquad \text{.....(1)}$$

ii)With Electric Field

When the atom of dielectric is placed in a DC electric field of strength E, two phenomena occur:

(a) Lorentz force due to electric field tends to separate the nucleus and electron cloud from their equilibrium positions.

(b) After separation, an attractive coulomb force arises between the nucleus and the electron cloud, which tries to maintain the original equilibrium position.

Let x be the displacement made by the electron cloud from the positive core as shown in the figure. Since the positive core is heavy, it will not move when compared to electron cloud and x << R, where R is radius of the atom.

Since these two forces are equal and opposite there will be an equilibrium between the nucleus and electron cloud of the atom.

i.e., At equilibrium $F_L = -F_C$ ……(2)

$$\text{Lorentz force} \quad F_L = \text{Charge} \times \text{Electric field}$$

$$F_L = \text{ZeE} \qquad \text{……(3)}$$

$$\text{Coulomb Force } F_C = \frac{1}{4\pi\varepsilon_0} \frac{\left.\begin{array}{c}\text{Total Negative charges enclosed} \\ \text{in the sphere of radius } x(Q_e)\end{array}\right\} \times \text{Total Positive carges } (Q_P)}{x^2} \qquad \textbf{..(4)}$$

$Q_e = \text{Charge density } (\rho) \times \text{Volume of the sphere of radius x}$

$$= -\frac{4}{3}\frac{\text{Ze}}{\pi \text{R}^3} \times \frac{4}{3}\pi x^3$$

i.e., $Q_e = -\text{Ze}\left(\frac{\text{x}^3}{R^3}\right)$ **……(5)**

Total positive charge of an atom present in the sphere of radius x,

$$Q_p = +Ze \qquad \text{……(6)}$$

Substituting equation (5) and (6) in (4), we get

$$F_C = \frac{1}{4\pi\varepsilon_0} \frac{[+\text{Ze}] \times \left[-Ze\left(\frac{\text{x}^3}{R^3}\right)\right]}{x^2}$$

$$F_C = -\frac{\text{Z}^2 e^2 x}{4\pi\varepsilon_0 R^3} \qquad \text{….(7)}$$

Substituting equation (7) and (3) in (2),

$$ZeE = -\left(-\frac{\text{Z}^2 e^2 x}{4\pi\varepsilon_0 R^3}\right)$$

$$= \left(\frac{Z^2 e^2 x}{4\pi\varepsilon_0 R^3}\right)$$

$$E = \frac{Zex}{4\pi\varepsilon_0 R^3}$$

$$x = \frac{4\pi\varepsilon_0 R^3 E}{Ze} \qquad \textbf{…..(8)}$$

Due to the application of electric field the atom gains some dipole moment. From the definition of dipole moment, induced dipole moment (μ_{ind}) is given by:

$$\mu_{ind} = \text{Magnitude of charge} \times \text{Displacement}$$

i.e., $\mu_{ind} = Zex$ **….(9)**

Substituting equation (8) in (9)

$$\mu_{ind} = Ze \times \frac{4\pi\varepsilon_0 R^3 E}{Ze}$$

$$\mu_{ind} = 4\pi\varepsilon_0 R^3 E \quad .....(10)$$

Dipole moment in terms of polarisability

$$\mu_{ind} = \alpha_e E \quad ....(11)$$

From (10) and (11)

The electronic polarizability $\alpha_e = 4\pi\varepsilon_0 R^3$ **.....(12)**

It shows that α_e is directly proportional to the volume of the atom and independent to temperature. **(5 M)**

Ionic polarization (α_i)

The process of displacement of positive ions (cations) and negative ions (anions) in the opposite direction in a ionic dielectric due to the application of electric field is called Ionic polarization. Examples: NaCl, KCl, KBr

Let us assume that there are one cation and one anion present in the unit cell of NaCl. When an electric field (E) is applied the positive ions displace in the direction of applied electric field through a distance x_1 and the negative ions displace in opposite direction through a distance x_2 as shown in the figure.

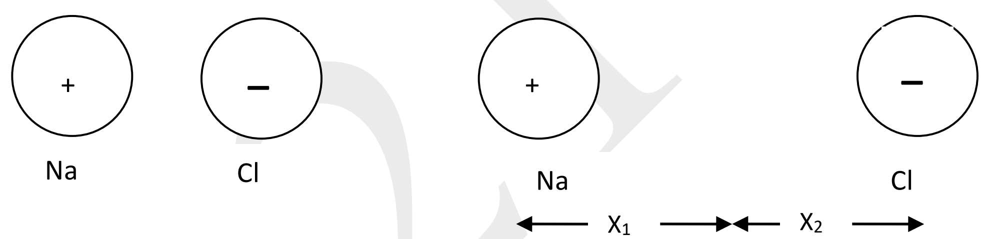


Fig. Without field E Fig. With field E

Hence, the net distance between two ions

$$x = x_1 + x_2 \quad ....(1)$$

When the field is applied, the restoring force produced is proportional to the displacement.

For cation

Restoring force, $F \alpha\, x_1$ or $F = \beta_1 x_1$ .....(2)

For anion

Restoring force, $F \alpha\, x_2$ or $F = \beta_2 x_2$ .....(3)

Where β1and ß2 are restoring force constants which depend upon the masses of ions and angular frequency of the molecule in which ions are present.

If m is the mass of cation, M is the mass of anion, and ω_0 is the angular frequency, then

$$\beta_1 = m\omega_0^2 \quad .....(4)$$

$$\beta_2 = M\omega_0^2 \quad .....(5)$$

Substituting (4) in (2), $F = m\omega_0^2 x_1$ .....(6)

We know that force $F = eE$ .....(7)

From (6) and (7),

$$eF = m\omega_0^2 x_1$$

$$x_1 = \frac{eE}{m\omega_0^2} \quad .....(8)$$

Similarly , for the anion, we can write

$$x_2 = \frac{eE}{M\omega_0^2} \quad ....(9)$$

Substituting equations (8) and (9) in (1),

$$x = x_1 + x_2 = \frac{eE}{m\omega_0^2} + \frac{eE}{M\omega_0^2}$$

$$x = \frac{eE}{\omega_0^2}\left(\frac{1}{m} + \frac{1}{M}\right) \quad ....(10)$$

The dipole moment is equal to the product of charges and the net distance between them.

i.e., $\mu = e \times x$ ....(11)

$$\mu = e \times \frac{eE}{\omega_0^2}\left(\frac{1}{m} + \frac{1}{M}\right) = \frac{e^2E}{\omega_0^2}\left(\frac{1}{m} + \frac{1}{M}\right)$$

$$\mu = \frac{e^2}{\omega_0^2}\left(\frac{1}{m} + \frac{1}{M}\right)E \quad ....(12)$$

We know that

$$\mu_i \ \alpha \ E$$

$$\mu_i = \alpha_i E \quad .....(13)$$

From equations (12) and (13)

The ionic polarzability $\alpha_i = \frac{e^2}{\omega_0^2}\left(\frac{1}{m}+\frac{1}{M}\right)$ …(14)

***Hence,* Ionic polarisability (α_i) is inversely proportional to the square of angular frequency of the ionic molecule and it is directly proportional to its reduced mass given by $\left(\frac{1}{m}+\frac{1}{M}\right)$. It is independent of temperature**. (5 M)

Orientation polarization

When the dielectric medium consists of polar molecules such as H_2O, HCl and Nitro Benzene, orientation polarization takes place. These molecules have permanent dipole moments even in the absence of an electric field as shown in figure

The orientation of polar molecules with respect to the electric field direction is called orientation polarization.

Explanation: For example CH_3Cl is a polar molecule in which +ve and –ve charges do not coincide. The Cl^- has more electronegativity than hydrogen. Therefore the chlorine atom pulls the bonding electrons strongly than hydrogen. Hence, even in the absence of field, there exists a net dipole moment.

When an electric field, +ve portion align along the filed direction and –ve portion align in the opposite direction of the filed as shown in the figure . This polarization is called orientation or dipolar polarization.

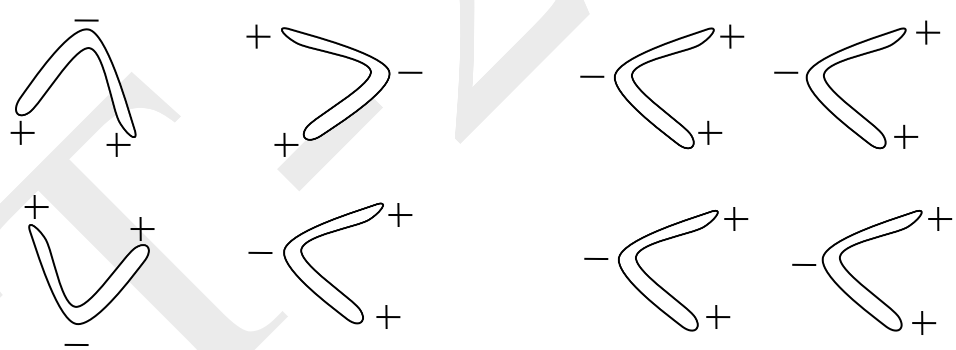


Figure Polar dielectric without field Figure Polar dielectric with field

When the temperature is increased, thermal energy tends to disturb the alignment. Thus this polarization depends on temperature.

From Langevin's theory of paramagnetism,

$$\text{Net intensity of magnetisation} = \frac{N\mu^2 B}{3kT} \quad \text{……(1)}$$

Since the same principle can be applied to the application of electric field in dielectrics, we may write

$$\text{Orientation Polarisation} = P_o = \frac{N\mu^2 E}{3kT} \qquad \text{......(2)}$$

But, orientation polarization is proportional to applied field (E)

i.e., $P_o \alpha E$

$$P_o = N\alpha_o \vec{E} \qquad \text{.....(3)}$$

Comparing (2) and (3) ,

$$\text{Orientational polarizability} \quad \alpha_o = \frac{\mu^2}{3kT} \qquad \text{.....(4)}$$

Thus the orientational polarizability is inversely proportional to absolute temperature of the material. (2M)

Space-Charge Polarisation

Space-charge polarization occurs due to the accumulation of charges at the electrodes or at the interfaces of multiphase dielectric materials.

Explanation: In the absence of field the charges are orderly arranged as shown in the Fig.. When the electric field is applied at high temperature, the charges get accumulated at the interfaces as shown in the Fig., these charges create dipoles. Thus polarization is produced. This polarization is called as space-charge polarization.

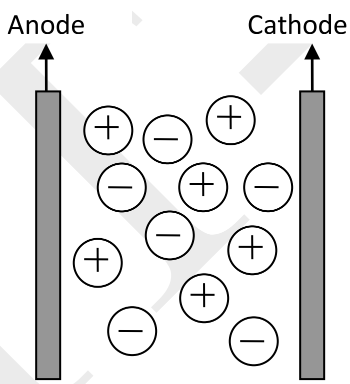


Figure Charges without filed

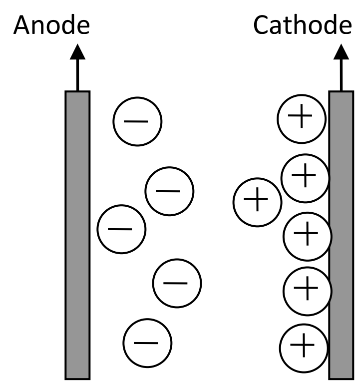


Figure Charges with field

Generally, this type of polarization occurs in ferrites and semiconductors and is very small when compared to other polarization mechanisms.

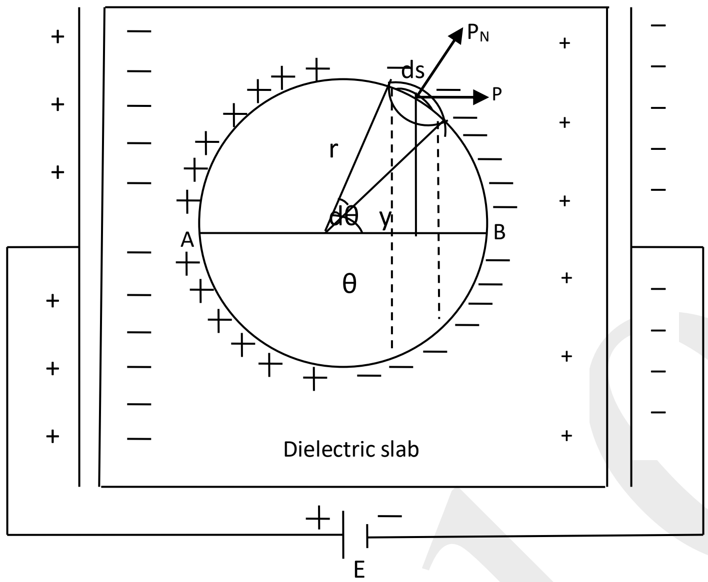
Total polarization (Langevin-Debye Equation)

The total polarization is the sum of electronic, ionic, orientaional and space–charge polarizations. Since space–charge polarization is very small it is not taken into account. Hence the total polarization is given by

	$P = P_e + P_i + P_o$ ……(1) or $P = N\,\alpha_e\,E + N\,\alpha_i\,E + N\,\alpha_o\,E$ $P = N\,(\alpha_e + \alpha_i + \alpha_o)\,E$ …….(2) Substituting the expressions for α_e , α_i , α_o in (2), Total polarization, $P = N\vec{E}\left[4\pi\varepsilon_0 R^3 + \frac{e^2}{\omega_o^2}\left(\frac{1}{m}+\frac{1}{M}\right)+\frac{\mu^2}{3kT}\right]$ ….(3) and Total polarizability $\alpha = 4\pi\varepsilon_0 R^3 + \frac{e^2}{\omega_o^2}\left(\frac{1}{m}+\frac{1}{M}\right)+\frac{\mu^2}{3kT}$ …..(4) Equation (3) is known as Langevin – Debye equation. By drawing a plot between P and 1/T, one can determine the orientational polarization and the sum of electronic and ionic polarization.(1 M)
5	**What is meant by Lorentz field in a dielectric and how it is calculated for a cubicstructure? Deduce the Clausius – Mosotti relation. (2M+10M+4M)**BTL2(June 2009, May 2011) **Answer Page: 3.64 Dr. P. Mani** **Internal Field or Local Field** When a dielectric material is subjected to an external electric field, There are two fields are exerted, (i) Macroscopic field due to external field (ii) Field due to dipole moment *The long–range coulomb field created due to dipoles inside a dielectric is called as internal field or Lorentz local field.* This field is responsible for polarization of each atom or molecule in a solid. (2 M) **<u>Lorentz method to find internal field</u>** Let us assume a dielectric material is placed in between two plates of a parallel plate capacitor as shown in figure 4.10. Consider an imaginary small spherical cavity around an atom inside the dielectric for which the internal field must be calculated at its centre. It is also assumed that the radius of the cavity is large compared to radius of atom. The internal field (E_i) at the atom site can be considered to be made up of the following four components. E_1,E_2, E_3 and E_4 i.e., $E_i = E_1 + E_2 + E_3 + E_4$ ….(1) Where E_1 is the field due to charges on the plates (externally applied) E_2 is the field due to induced charges on the plane surfaces of the dielectric

E_3 is the field due to induced charges on the surface of the spherical cavity

E_4 is the field due to permanent dipoles of atoms inside the spherical cavity



(2 M)

Figure 4.10 Calculation of Internal field

Macroscopically, we can write $E = E_1 + E_2$ ….(2)

i.e., the field externally applied (E_1) and the field induced on the plane surface of the dielectric (E_2) are considered as a single field(E).

If the dielectric is highly symmetric, then the dipoles present inside the imaginary cavity will cancel out each other.

Therefore, the electric field $E_4 = 0$ ….(3)

From equations (2) and (3), (1) becomes

$$E_i = E + E_3 \quad ….(4) \quad (1 M)$$

To Find E_3

Let us consider small area ds confined within an angle dθ at an angle θ with the direction of field E on the surface of the spherical cavity and q' is the charge on the area ds.

Polarization is also defined as the surface charges per unit area. Here polarization (P) is parallel to E and P_N is the component of polarization perpendicular to the area ds as shown in figure 4.12.

Therefore $$P_N = P\,Cos\theta = \frac{q'}{ds} \quad \text{….(5)}$$

$$\text{or } q' = P\,Cos\theta\,ds \quad \text{….(6)}$$

From Coulomb laws, the electric field intensity at C due to charge q' can be written as

$$E = \frac{q'}{4\pi\varepsilon_0\,\mathrm{r}^2} \quad \text{….(7)}$$

Substituting (6) in (7),

$$E = \frac{P\,Cos\theta\,ds}{4\pi\varepsilon_0\,\mathrm{r}^2} \quad \text{….(8)} \quad \text{(3 M)}$$

This electric field intensity is along the radius r and can be resolved into two components as shown in figure 4.11

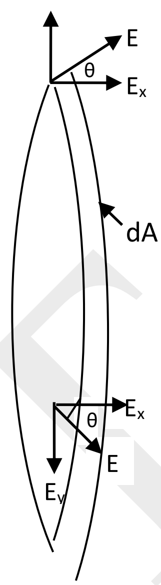


Figure 4.11 components of Intensity

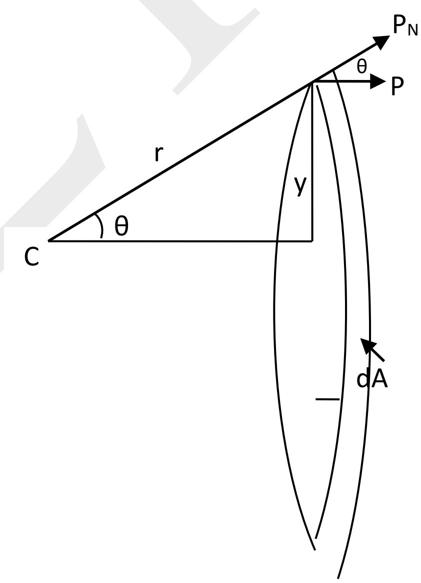


Figure 4.12 Components of polarization (1 M)

The component parallel to the field direction,

$$E_x = E\,\mathrm{Cos}\theta \quad \text{….(9)}$$

Substituting equation (8) in (9), $$\mathrm{E}_x = \frac{P\,Cos^2\theta\,ds}{4\pi\varepsilon_0\,\mathrm{r}^2} \quad \text{….(10)}$$

The component perpendicular to the field direction,

$$E_y = E\,\mathrm{Sin}\,\theta \qquad \text{....(11)}$$

Substituting equation (8) in (11), $\mathrm{E_y} = \dfrac{P\,Cos\theta\,\mathrm{Sin}\,\theta\,\mathrm{ds}}{4\pi\varepsilon_0\,\mathrm{r}^2}$ ....(12)

The perpendicular components are in opposite directions, hence they cancel out each other. For this reason, the parallel components alone are taken into consideration.

If the total surface area of the ring is considered as dA, then

$$\text{Electric field intensity due to elemental ring} = \mathrm{E} = \mathrm{E_x} = \frac{P\,Cos^2\theta\,dA}{4\pi\varepsilon_0\,\mathrm{r}^2} \qquad \text{....(13)}$$

Where, Ring Area $\mathrm{dA} = \text{Circumference} \times \text{Thickness}$

$$= 2\pi \mathrm{y} \times \mathrm{r}\,\mathrm{d}\theta$$

$$= 2\pi\,\mathrm{r}Sin\theta \times \mathrm{r}\,\mathrm{d}\theta$$

$$dA = 2\pi\,\mathrm{r}^2 Sin\theta\,\mathrm{d}\theta \qquad \text{....(14)}$$

Substituting equation (14) in equation (13) , we have

$$E = \frac{P\,Cos^2\theta}{4\pi\varepsilon_0\,\mathrm{r}^2} \times 2\pi\,\mathrm{r}^2 Sin\theta\,\mathrm{d}\theta$$

$$E = \frac{P\,Cos^2\theta\,Sin\theta\,\mathrm{d}\theta}{2\varepsilon_0} \qquad \text{....(15)} \quad \text{(1 M)}$$

The Electric field intensity (E_3) due to charge present in the whole sphere can be obtained by integrating equation (15) within the limits 0 to π.

$$\mathrm{E_3} = \int_0^\pi E = \int_0^\pi \frac{P\,Cos^2\theta\,Sin\theta\,\mathrm{d}\theta}{2\varepsilon_0}$$

$$= \frac{P}{2\varepsilon_0}\int_0^\pi Cos^2\theta\,Sin\theta\,\mathrm{d}\theta$$

$$= \frac{P}{2\varepsilon_0} \times \frac{2}{3} \qquad \left[Since \int_0^{\pi} Cos^2\theta \, Sin\theta \, d\theta = \frac{2}{3} \right]$$

$$E_3 = \frac{P}{3\varepsilon_0} \qquad \text{….(16)}$$

Substituting equation (16) in equation (4),

$$E_i = E + E_3 = E + \frac{P}{3\varepsilon_0}$$

$$i.e., E_i = E + \frac{P}{3\varepsilon_0} \qquad \text{….(17) (2 M)}$$

Equation (17) shows that the local field E_i is larger than the macroscopic intensity E. Therefore the molecules are more effectively polarized.

Clausius – Mosotti Equation

Let us consider N be the number of molecules per unit volume and α the molecular polarisability. Then

Total polarization, $P = N\alpha E_i$

$$E_i = \frac{P}{N\alpha} \qquad \text{…..(1)}$$

The displacement vector D can be written as

$$D = \varepsilon E = \varepsilon_0 \varepsilon_r E \qquad \text{…..(2)}$$

or $\varepsilon E = \varepsilon_0 (1 + \chi_e) E \quad [(\varepsilon_r = 1 + \chi_e), \chi_e$ -Electrical Susceptibility)]

$$\varepsilon E = \varepsilon_0 E + \varepsilon_0 \chi_e E$$

$$\varepsilon E = \varepsilon_0 E + P \qquad (P = \varepsilon_0 \chi_e E)$$

$$P = \varepsilon E - \varepsilon_0 E = E(\varepsilon - \varepsilon_0)$$

$$E = \frac{P}{(\varepsilon - \varepsilon_0)} \qquad \text{…..(3)}$$

We know that Lorentz local field,

$$E_i = E + \frac{P}{3\varepsilon_0} \qquad \text{…..(4)}$$

	Substituting the equation (3) in (4), $$E_i = \frac{P}{(\varepsilon-\varepsilon_0)} + \frac{P}{3\varepsilon_0} = P\left(\frac{1}{(\varepsilon-\varepsilon_0)} + \frac{1}{3\varepsilon_0}\right)$$ $$= P\left(\frac{3\varepsilon_0+\varepsilon-\varepsilon_0}{(\varepsilon-\varepsilon_0)3\varepsilon_0}\right) = \frac{P}{3\varepsilon_0}\left(\frac{2\varepsilon_0+\varepsilon}{(\varepsilon-\varepsilon_0)}\right)$$ $$E_i = \frac{P}{3\varepsilon_0}\left(\frac{2\varepsilon_0+\varepsilon}{(\varepsilon-\varepsilon_0)}\right) \quad ....(5)$$ From equations (5) and (1), $$\frac{\mathrm{P}}{\mathrm{N}\alpha} = \frac{P}{3\varepsilon_0}\left(\frac{2\varepsilon_0+\varepsilon}{(\varepsilon-\varepsilon_0)}\right)$$ $$\frac{\mathrm{N}\alpha}{3\varepsilon_0} = \left(\frac{(\varepsilon-\varepsilon_0)}{2\varepsilon_0+\varepsilon}\right) = \left(\frac{(\varepsilon_0\varepsilon_r-\varepsilon_0)}{2\varepsilon_0+\varepsilon_0\varepsilon_r}\right) = \left(\frac{\varepsilon_0(\varepsilon_r-1)}{2\varepsilon_0(2+\varepsilon_r)}\right) \text{ (Since } \varepsilon=\varepsilon_0\varepsilon\text{)}$$ $$\frac{\mathrm{N}\alpha}{3\varepsilon_0} = \frac{(\varepsilon_r-1)}{(\varepsilon_r+2)} \quad ....(6)$$ (4M) Equation (6) is Clausius – mosotti relation. It relates the macroscopic quantity (ε_r) and a microscopic quantity (α).
6	**What are the different types of dielectric break down in dielectric medium?Discuss in detail the various types of dielectric breakdown. How it can be avoided? (2M+10M+2M)**BTL2(June 2009) **Answer Page: 3.74 Dr. P. Mani** **Dielectric Breakdown** *When the strength of electric field applied to a dielectric exceeds to a critical value, the dielectric loses its insulating property and becomes a conductor. i.e., very large current flows through it. This phenomenon is called as dielectric breakdown.* **Dielectric strength** *It is defined as the electric field strength at which dielectric breakdown occurs.* It is the breakdown voltage per unit thickness of the material. $$\text{i.e., Dielectric strength} = \frac{\text{Breakdown voltage}}{\text{Thickness of the dielectric}}$$

There are different mechanisms by which dielectric breakdown takes place. Few important types of dielectric breakdown are as follows

1.Intrinsic breakdown and avalanche breakdown

2. Thermal breakdown

3. Chemical and electrochemical breakdown

4. Discharge breakdown

5. Defect breakdown *(2M)*

Intrinsic breakdown

In a dielectric the charge displacement increases with increasing electric field strength.

When a dielectric is subjected to electrical field, some of the electrons in the valence band go to the conduction band across the energy gap.

They become conduction electrons and thus produce large conduction current.

Therefore a large current flows through the dielectric and is called intrinsic breakdown or Zener breakdown. (1 M)

Avalanche breakdown

When the conduction electrons are accelerated very high velocity, they collide with valence electrons in the covalent bond.

Now the valance electrons on receiving this energy transferred to the conduction band and become conduction electron.

These secondary conduction electrons again dislodge some other valance electrons in the covalent bond and this process continues as a chain reaction. As a result very large current flows through the dielectrics and is called avalanche breakdown.

Characteristics

- They occur at about room temperature or at even low temperature.
- Both breakdowns require large electrical fields.
- They do not depend on the configuration of the electrons and dimension of the sample.
- They occur within a short span of time (microseconds).
- This kind of breakdown occurs in thin samples. (1M)

Thermal breakdown

- When a dielectric material is subjected to an electric field, heat is generated. This heat must be dissipated from the material.

- In some cases, the amount of heat produced will be very high as compared to the heat dissipated.
- Due to excess of heat, the temperature inside the dielectric increases and larger amount of current flows through the material and breakdown occurs.

This type of breakdown is known as thermal breakdown

Characteristics

- It occurs only at high temperatures.
- It requires moderate electric fields.
- It depends upon the size and shape of the dielectric sample.
- The breakdown time is of the order milliseconds. (2M)

<u>Chemical and electrochemical breakdown</u>

It is almost similar to thermal breakdown.When the temperature of a dielectric material increases, mobility of ions increases and hence the electrochemical reaction may take place. This leads to leakage current and finally dielectric breakdown occurs.

Characteristics

- It occurs only at low temperatures.
- It occurs even in the absence of electric field.
- It depends on the concentration of ions and magnitude of leakage current. (2M)

<u>Discharge Breakdown</u>

- Some dielectric material contains occluded gas bubbles as shown in the figure.
- When this type of dielectric is subjected to the electric field, the gas present in the material will easily ionize and thus produce large amount of ionization current.
- This is known as discharge breakdown.

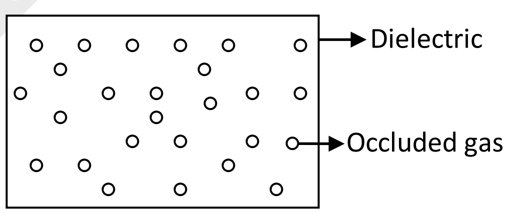


Fig. Discharge breakdown

Characteristics

- It occurs at low voltages.
- It depends upon the frequency of applied voltage.
- It occurs in the dielectric material where there are a large number of occluded gas bubbles. (2 M)

<u>Defect Breakdown</u>

Some dielectric material may have defects such as cracks, porosity and blow holes etc. as shown in the figure. These defects may have moisture or impurities which lead to a current flow. This breakdown is known as defect breakdown.

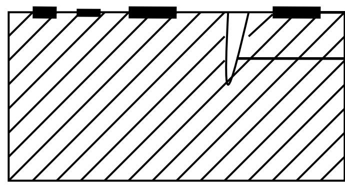


Fig. Defect breakdown (2 M)

Remedies to avoid dielectric breakdown

To avoid breakdown, the dielectric material should have the following properties:

- It must be in pure form.
- There should not be any defect.
- It should have high dielectric strength to withstand higher voltage.
- It should have resistivity to reduce leakage current.
- It should be fire-proof.
- It should have low dielectric.
- It should have sufficient mechanical strength.
- It should be resistant to acids, oils, liquids, gas fumes, and alkalies.
- It should have small thermal expansion to prevent mechanical damage. (2M)

7

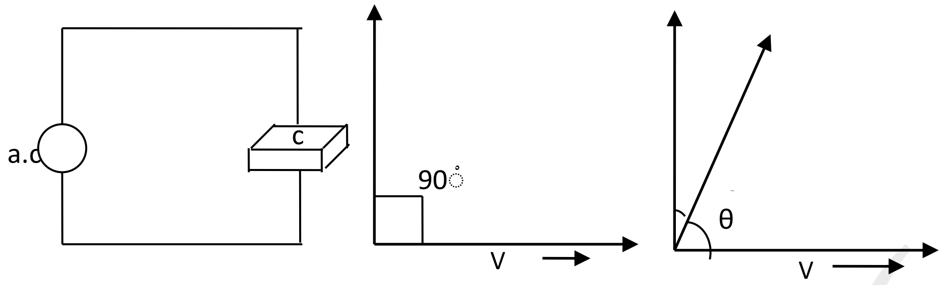
What is dielectric loss? Derive the expression for dielectric power loss. (2M+8M) BTL2

Dielectric Losses

If a dielectric is subjected to AC voltage, electrical energy is absorbed by the dielectric and certain quantity of electrical energy is dissipated in the form of heat energy. This is called as dielectric loss. Generally dielectric loss occurs in both direct and alternating voltages. It is less in direct voltage than that of alternating voltage. (2 M)

Expression for dielectric loss (Loss tangent)

If a perfect insulator like vacuum or purified gas is subjected to an AC voltage as shown in the figure. It does not absorb electrical energy and there is no loss of electrical energy.



Here, the charging current leads the applied voltage by an angle of 90 as shown in figure. polarization of the dielectric is in phase with the voltage.

We know power loss $P_L = VI \text{ Cos}\theta$ …..(1) (2M)

When $\theta = 90^0$, $P_L = VI \text{ Cos } 90^0$

$\text{P}_\text{L} = 0$ ….(2)

This means that there is no power loss in the perfect insulator.

On the other hand, in a practical dielectric the leakage current leads the voltage by an angle (90-δ). This shows that there is some loss in electrical energy and δ is a measure of the power dissipated in each cycle called as loss angle.

Power loss for this case is $P_L = VI \text{ Cos}(90 - \delta)$ ($\because \theta = 90 - \delta$)

$P_L = VI \text{ Sin}\,\delta$ ...(3)($\because$ $\text{Cos}(90 - \delta) = \text{Sin}\,\delta$) (2M)

According to Ohm's law, $V = IR$ or $I = \dfrac{V}{R}$ …..(4)

If X_c is the capacitive reactance, then current $I = \dfrac{V}{X_C}$ ……(5)

Frequency in terms of X_c, $f = \dfrac{1}{2\pi X_C C}$ ($\because R = X_C$)

$$X_C = \frac{1}{2\pi\ f\ C} \quad ….(6)$$

Substituting (6) in (5), $I = \dfrac{V}{\dfrac{1}{2\pi\ f\ C}} = V\,2\pi\ f\ C$

i.e., $I = V\,2\pi\ f\ C$ …..(7)

Substituting equation (7) in (3),

Power loss $P_L = 2\pi f C V^2 \text{ Sin}\,\delta$ …..(8)

Since the loss angle δ is very small

Dielectric power loss, $P_L = 2\pi f C V^2 \tan\delta$ …..(9) (2M)

Here, tan δ is called the power factor of the dielectric.

Generally the power loss varies with frequency. Its value is high in the electrical frequency and low in the optical frequency as shown in the figure 4.16.

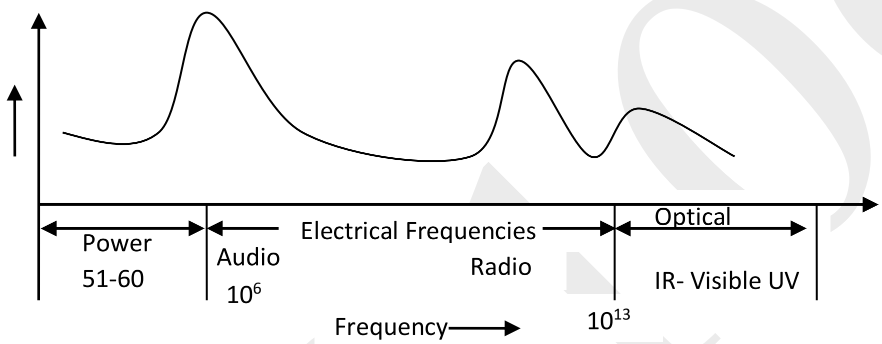


Figure Variation of power loss with frequency

Factors affecting dielectric loss

Dielectric loss may increase due to the following factors.

- High value of the applied voltage
- Frequency of applied voltage
- Temperature
- Humidity (2M)

UNIT IV OPTICAL PROPERTIES OF MATERIALS **9** Classification of optical materials – carrier generation and recombination processes - Absorption emission and scattering of light in metals, insulators and Semiconductors (concepts only) - photo current in a P- N diode – solar cell –photo detectors - LED – Organic LED – Laser diodes – excitons - quantum confined Stark effect – quantum dot laser.	
Q.No	**PART * A**
1.	**What are Opticalmaterials?**BTL2 The materials which are sensitive to light are known as Optical materials. These optical materials exhibit a variety of optical properties.
2	**What are the types of opticalmaterials?**BTL2 i) Transparent. ii) Translucent. **iii)** Opaque.
3	**Define scattering of light.**BTL2 Process by which the intensity of the waves attenuates as it travels through a medium.
4.	**Define carrier generation and recombination.**BTL2 The carrier generation is the process whereby electrons and holes are created. The recombination is the process whereby electrons and holes are annihilated.
5	**What are the types of carriergeneration?**BTL2 i) Photogeneration. ii) Phonongeneration. **iii)** Impactionization.
6	**What are the types of recombinationprocess?**BTL2 a) Radiative Recombination. b) Shockley-Read-HeadRecombination. **c)** AugerRecombination.
7.	**What is exciton? Mention its types.**BTL2 The combination of an electron in an excited stage (below conduction band) and the associated hole in valence band (electron – hole pair) is known as an exciton. a) Frenkel excitons - strongly bound excitons. **b)** Mott and wannier excitons – weakly boundexcitons.
8.	**Give the basic principle of photodiode.**BTL2 When light is incident on the depletion region of the reverse-biased pn junction, the concentration of minority carriers increases. Therefore, reverse saturation current increases.

9	**What is photodiode?**BTL2 Photo diode is a reverse biased p-n junction diode which responds to light absorption
10	**Give the importance ofexcitons.**BTL4 a) The excitons play an important role in luminescence ofsolids. b) Excitons are unstable and they will separate at hightemperature. c) The excitons can move through the semiconductor and transportenergy **d)** The excitons does not transport any charge as it is electricallyneutral.
11.	**What is solarcell?**BTL2 Solar cell is a p-n junction diode which converts solar energy (light energy) into electrical energy.
12.	**What is photodetector?**BTL2 Photo detector is a semiconductor device which is used to detect the presence of photons. This device is known as photo detector. It converts optical signals into electrical signals**.**
13.	**Specify the types of photodetector?**BTL4 a) Photoemissive. b) Photoconductive. c) Photovoltaic.
14.	**List out the types of photo-voltaic devices?** BTL2 a) PIN photodiode. b) Avalanche photo diode(APD). c) P-N junction photodetector.
15	**What is LED?**BTL2(Jan 2006) LED is a p-n junction diode which emits light when it is forward biased.
16	**What are the disadvantages ofLEDs?**BTL2 **a)** They require highpower. **b)** Their preparation cost is high when compared toLCD
17	**What are the applications used ofLEDs?**BTL2 a) They are used as indicatorlamps. b) Infrared LEDs are used in burglaralarms. c) They are used in image sensing circuits used for picturephone
	PART-B
1	**Describetheopticalabsorptioninmetals,dielectrics(insulators)and semiconductors.(or) Explain the carrier generation and recombination processes in metal, semiconductors and insulators. (16 M)** BTL2 **Answer: Page: 4.5 to 4.11 P.MANI** carrier generation and recombination processes (1 M) Absorption and emission of light in metal (or) conductors(5M)

	Absorption and emission of light in dielectrics (Insulators)(5M) Absorption and emission of light in semiconductors(5M)
2	**Describe the principle, construction and working of a photodiode. Mention its advantages, disadvantages and uses. (16 M)** BTL2 **Answer: Page: 4.18 to 4.20 P.MANI** Principle (2 M) Construction diagram (3 M) Construction description (3 M) Working (4 M) Advantages, disadvantages and uses (4 M)
3	**Discuss the principle, construction and working of solar cell. Mention its advantages, disadvantages and uses. (16 M)** BTL2 **Answer: Page: 4.20 to 4.23 P.MANI** Principle (2 M) Construction diagram (3 M) Construction description (3 M) Working (4 M) Advantages, disadvantages and uses (4 M)
4	**Describe the principle, construction and working of a photo detector. Mention its advantages, disadvantages and uses. (16 M)** BTL2 **Answer: Page: 4.24 to 4.27 P.MANI** Principle (2 M) Construction diagram (3 M) Construction description (3 M) Working (4 M) Advantages, disadvantages and uses (4 M)
5	**Describe the principle, construction and working of a GaAlAs diode laser. (or) Describe the principle, construction and working of a homo-junction diode laser (or) Describe the principle, construction and working of hetero-junction diode laser. Mention its advantages, disadvantages and uses. (16 M)** BTL2(Jan.2009, Jan.2010, Jan.2011) **Answer: Page: 4.31 to 4.35 P.MANI** Principle (2 M) Construction diagram (3 M) Construction description (3 M) Working (4 M) Advantages, disadvantages and uses (4 M)
6	**Describe the principle, construction and working of Light Emitting Diode. Mention its advantages, disadvantages and uses. (or) Explain how p-n junction diode acts as light emitting diode. (16 M)** BTL2(May 2003, Apr 2003) **Answer: Page: 4.27 to 4.31 P.MANI** Principle (2 M) Construction diagram (3 M) Construction description (3 M) Working (4 M) Advantages, disadvantages and uses (4 M)
7	**Describe the principle, construction and working of OLED. Mention its advantages,**

	disadvantages and uses. (16 M) BTL2 **Answer: Page: 4.35 to 4.38 P.MANI** Principle (2 M) Construction diagram (3 M) Construction description (2 M) Working (2 M) Types (3 M) Advantages, disadvantages and uses (4 M)
8	**What is quantum dot? Describe the principle, construction and working of quantum dot laser. Mention its advantages, disadvantages and uses. (16 M) BTL2** **Answer: Page: 4.42 to 4.45 P.MANI** Quantum dot (2 M) Principle (2 M) Construction diagram (3 M) Construction description (3 M) Working (3 M) Advantages, disadvantages and uses (3 M)
9	**Write short noteson (i) Excitons (8 M) (ii) Quantum Confined Stark Effect (QCSE).(4 M)(iii) Quantum dots (4 M)**BTL2 (i) **Answer: Page: 4.15 to 4.18 P.MANI** Definition and explanation of excitons (2 M) Types of excitons Frenkel Exciton (2 M) Motti and Wannier exciton (2 M) Importance of excitons (2 M) (ii) **Answer: Page: 4.39 to 4.40 P.MANI** Definition and explanation of QCSE (2 M) Uses of QCSE (2 M) (iii) **Answer: Page: 4.40 to 4.42 P.MANI** Definition and explanation of quantum dot (2 M) Applications of quantum dot (2 M)

UNIT V	NANOELECTRONIC DEVICES 9
	Introduction - electron density in bulk material – Size dependence of Fermi energy– quantum confinement – quantum structures - Density of states in quantum well, quantum wire and quantum dot structures – Zener-Bloch oscillations – resonant tunneling – quantum interference effects – mesoscopic structures: conductance fluctuations and coherent transport – Coulomb blockade effects - Single electron phenomena and Single electron Transistor – magnetic semiconductors– spintronics - Carbon nanotubes: Properties and applications.
Q.No.	**PART * A**
2.	**What is meant byTunneling?** BTL1 The phenomenon in which a particle, like an electron, encounters an energy barrier in an electronic structure and suddenly penetrates is known as tunnelling.
2	**What is meant by quantumconfinement?**BTL1 Quantum confinement is a process of reduction of the size of the solid such that the energylevels inside becomes discrete.
3	**Infer the term quantumstructure.**BTL2 When bulk material is reduced in its size, at least one of its dimensions, in the order of few nanometres, then the structure is known as quantum structure
4.	**Define Zener-Blochoscillation.**BTL2 Zener-Bloch oscillation denotes the oscillation of a particle confined in a periodic potential when a constant force is acting on it.
5	**What is resonant tunnelingdiode?**BTL2 Resonant tunnelling diode refers to tunnelling in which the electron transmission coefficient through a structure is sharply peaked about certain energies.
6	**Define quantuminterference.** BTL2 When two or more particles that are space and time independent have an interaction, construction or destructing their wave function is known quantum interference.
7.	**Recall the term Blochoscillations.** BTL2 A particle in a periodic potential with an additional constant force performs osciallations and these oscillations are called Bloch oscillations
8.	**What are Zener – Blochoscillations?**BTL2 The dynamics of quantum particles shows a coherent superposition of Bloch oscillations and Zener tunnelling between the sub-bands which is called as Zener-Bloch oscillation.
9	**DefineMesoscopic**. BTL2 Mesoscopic means intermediate between the macroscopic and microscopic scales.
10	**Define Coulombblockade effect.**BTL2 The resistance to electron transport caused by electrostatic coulomb forces in certain electronic structures, including quantum dots and single electron transistors is called coulomb blockade.
11.	**What is single electronphenomena?**BTL2

	A transistor made from a quantum dot that controls the current from source to drain one electron at a time is called single electron transistor.
12.	**What are magneticsemiconductors?**BTL2 Magnetic semiconductors are semiconducting materials that exhibit both ferromagnetism and semiconductor properties.
13.	**What isspintronics?**BTL2 Spintronics is nano technology which deals with spin dependent properties of on electron instead of charge dependent properties.
14.	**What are the applications ofspintronics?**BTL2 a) Solid state non-volatilememories. b) Quantum information processing and c) Quantumcomputation d) Spin basedtransistors.
PART-B	
1	**Explaintheelectrondensityinbulkmaterialandsizedependenceof Fermi energy. (8 M)**BTL2 **Answer: Page: 5.4 to 5.7 P.MANI** Electron density in bulk materials definition and equation with explanation (4 M) Fermi energy definition and size dependence of Fermi energy equation with explanation (4 M)
2	**Explain quantum confinement and quantum structures in nano materials. (OR) Discussdensityofstatesinquantumwell,quantumwireandquantumdot. (16 M)** BTL2 **Answer: Page: 5.7 to 5.11P.MANI** Definition of quantum confinement and quantum structure (4 M) Definition of quantum well and diagram with equation (4 M) Definition of quantum wire and diagram with equation(4 M) Definition of quantum dot and diagram with equation(4 M)
3	**Writenote(i)Zener–Blochoscillations(ii) Resonanttunnellingand(iii) Quantum interference effect. (5M+5M+6M)** BTL2 **(i) Answer: Page: 5.11 to 5.13P.MANI** Definition of Zener-Bloch oscillation (2 M) Derivation of Zener-Bloch oscillation equation (3 M) **(ii) Answer: Page: 51.4 to 5.16P.MANI** Definition of resonant tunnelling (2 M) Explanation of resonant tunnelling with diagram and equation (3 M) **(iii) Answer: Page: 5.29 to 5.32P.MANI** Definition of quantum interference effect (2 M) Explanation of quantum interference effect with diagram and equation (3 M) Applications of quantum interference effect (1 M)
5	**Explain mesoscopic structure of conductance fluctuations and coherent transport. (14 M)** BTL2 **Answer: Page: 5.4 to 5.7P.MANI** Definition of mesoscopic structure (2 M)

	Explanation of de-Broglie wavelength, Mean free path, diffusion length	(6 M)
	Conductance fluctuations and factors influencing conductance fluctuations	(2 M)
	Definition of coherent transport	(2 M)
	Explanation of coherent transport	(2 M)
6	**Describe Coulomb blockade effect and single electron phenomena. (6M +6 M)** BTL2 **Answer: Page:** 5.17 to 5.20**P.MANI**	
	Definition of Blockade effect	(2 M)
	Explanation of Blockade effect with diagram and equation	(4 M)
	Definition of single electron phenomenon	(2 M)
	Explanation of single electron phenomenon with diagram and equation	(4 M)
7	**Explain the phenomena of single electron which is used in single electron transistor. (or) Describe the construction and working of single electron transistor. Mention its advantages, disadvantages and uses. (16M)** BTL2 **Answer: Page: 5.20 to 5.24P.MANI**	
	Principle	(2 M)
	Construction diagram	(3 M)
	Construction description	(3 M)
	Working	(4 M)
	Advantages, disadvantages and uses	(4 M)
8	**What are magnetic semiconductors? List out the properties and applicationsof magnetic semiconductors. (2M + 4M +4M)** BTL2 **Answer: Page: 5.33 to 5.36P.MANI**	
	Definition of magnetic semiconductors	(2 M)
	Properties of magnetic semiconductors	(4 M)
	Applications of magnetic semiconductors	(4 M)
9	**Explain the concept of spintronics and its applications. (12 M) (or) Discuss on spintronics and also on spin based Field Effect Transistor (12M) (or) Write a short note on (i) GMR (6 M) (ii) Spin valve (6M)**BTL2 **Answer: Page: 5.35 to 3.38 P.MANI**	
	Concept of spintronics	(4 M)
	Applications of spintronics	(8 M)
10	**What is CNT? Describe the types, structure, properties and applications of CNTs. (15 M)** BTL2(May 2018) **Answer: Page: 5.39 to 5.47 P. MANI**	
	Definition of CNT	(2 M)
	Types of CNT	(2 M)
	Structure of CNT	(2 M)
	Properties of CNT	(5 M)
	Applications of CNT	(5 M)

BE8252 BASIC CIVIL AND MECHANICAL ENGINEERING L T P C
4 0 0 4

OBJECTIVES:

- To impart basic knowledge on Civil and Mechanical Engineering.
- To familiarize the materials and measurements used in Civil Engineering.
- To provide the exposure on the fundamental elements of civil engineering structures.
- To enable the students to distinguish the components and working principle of power plant units, IC engines, and R & AC system.

UNIT I SCOPE OF CIVIL AND MECHANICAL ENGINEERING 10

Overview of Civil Engineering - Civil Engineering contributions to the welfare of Society – Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering

Overview of Mechanical Engineering - Mechanical Engineering contributions to the welfare of Society –Specialized sub disciplines in Mechanical Engineering - Production, Automobile, Energy Engineering - Interdisciplinary concepts in Civil and Mechanical Engineering.

UNIT II SURVEYING AND CIVIL ENGINEERING MATERIALS 10

Surveying: Objects – classification – principles – measurements of distances – angles – leveling –determination of areas– contours - examples.

Civil Engineering Materials: Bricks – stones – sand – cement – concrete – steel - timber – modern materials

UNIT III BUILDING COMPONENTS AND STRUCTURES 15

Foundations: Types of foundations - Bearing capacity and settlement – Requirement of good foundations.

Civil Engineering Structures: Brickmasonry – stonemasonry – beams – columns – lintels – roofing– flooring – plastering – floor area, carpet area and floor space index - Types of Bridges and Dams –water supply - sources and quality of water - Rain water harvesting - Introduction to high way and railway.

UNIT IV INTERNAL COMBUSTION ENGINES AND POWER PLANTS 15

Classification of Power Plants - Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines – Working principle of steam, Gas, Diesel, Hydro - electric and Nuclear Power plants –- working principle of Boilers, Turbines, Reciprocating Pumps (single actingand double acting) and Centrifugal Pumps

UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM 10

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system–Layout of typical domestic refrigerator–Window and Split type room Air conditioner.

OUTCOMES:

On successful completion of this course, the student will be able to

- appreciate the Civil and Mechanical Engineering components of Projects.
- explain the usage of construction material and proper selection of construction materials.
- measure distances and area by surveying
- identify the components used in power plant cycle.
- demonstrate working principles of petrol and diesel engine.

- elaborate the components of refrigeration and Air conditioning cycle.

TOTAL: 60 PERIODS

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2. Ramamrutham S.,“Basic Civil Engineering”, Dhanpat Rai Publishing Co.(P) Ltd.1999.
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Subject Code : BE 8252 **Year/ Semester : I/II**

Subject : Basic Civil And Mechanical Engineering **Subject Handler:Mr.N.Mukilarasan**

	UNIT I SCOPE OF CIVIL AND MECHANICAL ENGINEERING
	Overview of Civil Engineering - Civil Engineering contributions to the welfare of Society –Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering **Overview of Mechanical Engineering** - Mechanical Engineering contributions to the welfare of Society –Specialized sub disciplines in Mechanical Engineering - Production, Automobile, Energy Engineering - Interdisciplinary concepts in Civil and Mechanical Engineering.
Q.No.	**Questions**

1. Define Engineering and Engineer.

Engineering is the art of converting knowledge into useful practical applications. An engineer is a person, who plays the key role in the process of conversion.

2. Define Civil Engineering.

Civil engineering is the branch of engineering which aims to provide a comfortable and safe living for the people.

3. What are roles of civil engineer?

Shelter, one of the primary needs of mankind, is provided by civil engineers. The efficient planning of water supply and irrigation systems increases the food production in a country. The engineering marvels of the world, starting from the pyramids to today's thin shell structures, are the results of the development in civil engineering. Communication lines like roads, railways, bridges, etc, without which development is impossible, are fruits of civil engineers work.

5. What is structural Engineering?

Structural engineering is the most important specialization in civil engineering. The construction of a structure needs efficient planning, design and method of construction to serve the purpose fully.

6. What are the major steps in project construction?

1. Positioning and arranging the various parts of the structure into a definite form to achieve best utilisation.
2. Finding out the magnitude, direction and nature of various forces acting on the structure.
3. Analysing the structure to know the behaviour of the various parts of the structure subjected to the above forces.
4. Designing the structure such that its stability under the action of various loads is

ensured.

5. Executing the work with selected construction materials and skilled workers.

7. What is water supply engineering?

Water supply engineering deals with the location, collection of water, its treatments methods, test for standard limits and efficient supply of water.

8. What is irrigation engineering?

Irrigation may be defines as the process of supplying water by man-made methods for the purpose of land cultivation. Irrigation engineering includes the study and design of works related to the control of river water and the drainage of waterlogged areas.

9. What are the functions of civil engineer?

1. Investigation
2. Surveying
3. Planning
4. Design
5. Execution
6. Research and development

10. What are the various field of specialization in mechanical engineering?

1. CAD/CAM/CIM
2. Manufacturing Engineering/ Production Engineering
3. Automobile Engineering
4. Machine Design
5. Industrial Engineering

11. What is mechanical Engineering?

Mechanical Engineering is a broad-based branch with umpteen numbers of applications in various types of industries world-over, including in the field of computer applications.

12. What is production engineering?

Production engineering is a combination of manufacturing technology, engineering sciences with management science. A production engineer typically has a wide knowledge of engineering practices and is aware of the management challenges related to production. The goal is to accomplish the production process in the smoothest, most-judicious and most-economic way.

13. What are the roles of production engineer?

1. Scale and integrate resources
2. Design, implement and refine products, services, processes and systems
3. Predict and analyze the demand
4. Understand the relation between production systems and the environment.
5. Manage and optimize flow

14. What is Automobile Engineering?

Automobile Engineering deals with the designing, developing, manufacturing, testing and repairing and servicing automobiles such as cars, trucks, motorcycles, scooters etc& the related sub Engineering systems.

15. What are the field in automobile engineering?

1. Automobile Engineering Technicians
2. Safety Engineering
3. Emissions Research
4. NVH (Noise, Vibration and Harshness) Engineers

5. Performance Engineer
6. Vehicle Dynamics Controller
7. Operations Research
8. Designing

16. What is Energy Engineering?

Energy engineering or energy systems engineering is a broad field of engineering dealing with energy efficiency, energy services, facility management, plant engineering, environmental compliance and alternative energy technologies.

17. What are scopes in Mechanical Engineering?

1. Aerospace industry
2. Automotive industry
3. Chemical industry
4. Defence industry
5. Marine industry
6. Materials and metals industry
7. Rail industry

18. How can a mechanical engineer contribute to society?

1. The energy solution
2. The transportation solution
3. Cost effective products.

19. What are the types of energy sources?

1. Renewable energy sources
2. Non- renewable energy sources

20. What are Renewable energy sources?

Renewable energy comes from sun's heat (solar energy), earth's heat (geothermal energy), energy in waves (tidal power) and wind (wind power). In other words, it is defined as energy source which is produced continuously in nature and in inexhaustible.

PART-B

1. Describe in details the contribution of civil engineering for the welfare of the society(13)(BTL 2)

A civil engineer has to conceive, plan, estimate, get approval, create and maintain all civil engineering activities. Civil engineer has very important role in the development of the following infrastructure: (i) Measure and map the earth's surface.
(ii) Plan new townships and extension of existing towns.
(iii) Build the suitable structures for the rural and urban areas for various utilities.
(iv) Build tanks and dams to exploit water resources.
(v) Build river navigation and flood control projects.
(vi) Build canals and distributaries to take water to agricultural fields.
(vii) Purify and supply water to the needy areas like houses, schools, offices etc.
(viii) Provide and maintain communication systems like roads, railways, harbors and airports.
(ix) Devise systems for control and efficient flow of traffic.
(x) Provide and maintain solid and waste water disposal system.
(xi) Monitor land, water and air pollution and take measures to control them. Fast growing industrialization has put heavy responsibilities on civil engineers to preserve and protect environment.

2.explain the Scope of civil engineers(13)(BTL2)

Scope of Civil Engineering Civil engineering is the oldest branch of engineering which is growing right from the stone age of civilization. American society of civil engineering fines civil engineering as the profession in which a knowledge of the mathematical and physical sciences gained by study, experience and practice is applied with judgment to develope ways to utilize economically the materials and forces of the nature for the progressive well being of man.

FIELD OF CIVIL ENGINEERING AND THEIR SCOPE Civil engineering may be divided into the following fields: (i) Building materials
(ii) Building construction
(iii) Structural engineering
(iv) Geotechnical engineering
(v) Hydraulics, water resources and irrigation engineering
(vi) Water supply and sanitary engineering
(vii) Environmental engineering
(viii) Transportation engineering
(ix) Town planning and architecture
(x) Surveying
(xi) Drawing
(xii) Estimation and specification
(xiii) Management techniques
(xiv) Computer application.

PART-C

1. Explain the Impact Of Infrastructural Development On Economy Of Country (15)(BTL 2)

Civil engineering activities in the infrastructural development are:
(i) Good planning of towns and extension areas in the cities. Each extension area should be self sufficient in accommodating offices, educational institutions, markets, hospitals, recreational facilities and residential accommodation.
(ii) Assured water supply.
(iii) A good drainage system.
(iv) Pollution free environmental conditions.
(v) A well planned and built network of roads and road crossings.
(vi) Railways connections to all important cities and towns.
(vii) Airports and harbors of national and international standards.

Infrastructure also involves electricity supply, without assured electric supply no city town can develop. Internet and telephones are also desirable features. Educational facility also forms part of infrastructure. Proximity of good primary and secondary schools to residential areas is desirable. Collegiate and professional education also form part of infrastructure of a city. Good health care facility is a necessity.Primary health centers, specialized hospitals and doctors add to the desirable infrastructure facility.

2. explain the Scope of mechanical engineers(13)(BTL2)

Mechanical Engineering is concerned with all types of machineries in industries and all aspects of their mechanisms and functioning; design, development, construction, production, installation, operation and maintenance. Mechanical Engineers not only design and create new products but also develop new materials for it. Our faculty members give individual attention to the learners and to motivate them to achieve their professional goals

Foundations in Mechanical

Mathematics
Physics
Thermodynamics
heat transfer
Materials science
Gears and systems

Fluid mechanics
Structural Analysis
Careers in Mechanical Mechanical Engineering finds application in all fields of technology. It is one of the primitive branches of Engineering which have remained always in demand and continue to be in the future.
That is why Mechanical branch is called as an Evergreen branch. Mechanical engineers have always been needed as essential staff personnel in various industries of both public and private sector.

Opportunities Mechanical engineering has a tremendous scope such as:

• Automobile Industry
• Cement Industry
• Steel Industry
• Power Sector
• Hydraulics
• Manufacturing Plants
• Drilling and Mining Industry
• Oil and Gas Industry
• Aeronautical Industry
• Biotechnology
• Nanotechnology
• Defense sector.
• Teaching

Subject Code : BE 8252 **Year/ Semester : I/II**

Subject : Basic Civil And Mechanical Engineering Subject Handler:Mr.N.Mukilarasan

UNIT - II SURVEYING AND CIVIL ENGINEERING MATERIALS

Surveying: Objects – classification – principles – measurements of distances – angles – leveling –determination of areas– contours - examples.
Civil Engineering Materials: Bricks – stones – sand – cement – concrete – steel - timber – modern materials

Part –A

1. Define surveying? [May / June 2014]

Surveying is art of determining the relative position of points of objects on the surface of the earth by taking necessary measurements of distance (both horizontal and vertical), direction and elevations.

2. List out the various types of surveying.[May / June 2009, April/May2015, April/May 2018]

Classification based on the instrument

- Chain surveying
- Compass surveying
- Plane table surveying
- Theodolite surveying
- Tacheometric surveying

- Aerial surveying
- Photographic surveying
- Classification based on the method
- Triangulation surveying

3. State the principles of surveying [Nov / Dec2009, May / June 2010]

The two basic principles which are to be observed in surveying

- To work from whole to the part
- To fix the positions of new stations by at least two independent process

4. What is meant by surveying and leveling? [Nov / Dec 2014, Nov / Dec 2010]

Surveying is art of determining the relative position of points of objects on the surface of the earth by taking necessary measurements of distance (both horizontal and vertical), direction and elevations. Leveling is defined as the art of determining the relative heights of points on the earth's surface.

5. Differentiate between WCB and RB. [Nov / Dec 2009]

Whole Circle Bearing (WCB):

The bearing of a line is measured with north in clockwise direction. The value of the bearing varies from 0 ˚ to 360˚.

Reduced Bearing (RB):

The bearing of a line measured either from north or south in clockwise direction. The value of the bearing varies from 0˚ to 90˚

6. Write the arithmetic equation used in height of collimation method rise and fall method of leveling? [April / May2011, Nov / Dec 2011, Nov / Dec 2012]

Height of collimation method:

$$\sum B.S - \sum F.S = \text{Last R.L} - \text{First R.L}$$

Rise and Fall Method:

$$\sum B.S - \sum F.S = \sum \text{Rise} - \sum \text{fall} = \text{Last R.L} - \text{First R.L}$$

7. What are the constituent materials of bricks? [April / May 2011]

The constituent materials of bricks are

- Clay (or) Alumina
- Sand (or) Silica
- Lime
- Iron Oxide
- Magnesium Oxide

8. How are bricks classified? [May / June 2010]

- Unburnt bricks
- Burnt bricks
- First class bricks
- Second class bricks
- Third class bricks
- Fourth class bricks

9. What are the raw materials used for the manufacture of cement? [Nov / Dec 2010]

The raw materials used for the manufacture of cement are

- Lime
- Silica
- Alumina
- Gypsum

- Iron Oxide
- Magnesia
- Sulphur
- Alkalies

10. List various types of cement? **[May / June 2014, April/May 2015]**

The various types of cement are

- Ordinary Portland cement
- Rapid hardening cement
- Blast furnace cement
- Acid – resistant cement
- Low – heat cement
- White cement

11. Name any two properties of good cement. **[Nov / Dec 2012]**

The properties of good cement are

- Provides strength to masonry
- Hardens early
- Possess good plasticity
- Easily workable

12. State any two types of cement and concrete? **[May / June 2014, May / June 2009]**

Types of cements

Ordinary Portland cement, Rapid hardening cement, Acid resistant cement, Low heat cement, Blast furnace slag cement, White cement, Coloured cement, Expanding cement,High – alumina cement, Hydrophobic cement, Pozzuolana cement, Quick setting cement, Sulphate resisting cement

Types of concrete

Mass concrete, Water – proof concrete, Pre – cast concrete,Reinforced cement concrete, Pre – stressed concrete, Light weight concrete, No fines concrete, High density concrete, Polymer concrete.

13. How concrete is designated by grades? **[May / June 2012]**

The concrete mix is also represented by the characteristics compressive strength of concrete or grades such as M5, M7.5, M10, M15, M20, M25, M30, M35 etc. the letter 'M' refers to 'Mix' and the number indicates the characteristics compressive strength in N/mm^2 of 150mm concrete cube tested after 28 days of curing.

14. Define bulking of sand and how it can be determined? **[Nov/Dec 2015]**

The increase in moisture of sand increases the volume of sand. The reason is that moisture causes film of water around sand particles which results in the increase of volume of sand. For a moisture content percentage of 5 to 8 there will be an increase in volume up to 20 to 40 percent depending upon sand. If the sand is more fine there will be more increase in volume. This is known as bulking of sand.

15. List the various uses of surveying. **[Nov/Dec 2015]**

- To prepare a topographical map which shows the hills, valleys, rivers, villages, towns, forests, etc. of a country.
- To prepare a cadastral map showing the boundaries of fields, houses and other properties.
- To prepare an engineering map which shows the details of engineering works such as roads, railways, reservoirs, irrigation canals, etc.
- To prepare a military map showing the road and railway communications with different parts of a country. Such a map also shows the different strategic points important for the

defence of a country.

16. What is a pedometer. **[May/June 2016]**

A pedometer is a device, usually portable and electronic or electromechanical, that counts each step a person takes by detecting the motion of the person's hands or hips.

17. Mention two advantages of reinforced concrete. **[May/June 2016]**

- High compressive strength
- Durability
- Adequate tensile strength
- Economy to model any shape
- Less deflection

18. What is back bearing? **[May / June 2012]**

The bearing taken from next station to its preceding station or line measurements in opposite direction.

19. What are different types of steel? **[Nov/Dec2014]**

There are three types of steels. They are,

1. Low carbon steel or Mild steel*: It contains Carbon between 0.10% and 0.25%*
2. Medium Carbon steel or Medium hard steel*: It contains Carbon 0.25% to 0.60%*
3. High Carbon steel or Hard steel: *It contains Carbon 0.60% and 1.5%*

20. Differentiate between Open traverse and closed traverse survey **[Nov/Dec2016]**

Open traverse survey	**Closed traverse survey**
A traverse is said to be open, if the survey lines do not close at the starting point to form a closed polygon. The traverse consists of series of lines running in the same direction.	A traverse is said to be closed. If the survey lines close at the starting point forming a closed polygon.
Open traverse is suitable for long narrow strip of works like highway roads, rivers and for laying water pipe lines etc.	Closed traverse is suitable for surveying the boundaries of large area of land such as a pond, lake, a village layout, forest, etc.

21. Define Magnetic bearing. **[Nov/Dec2016]**

Magnetic bearing is a angle which a line makes with the magnetic north always measured in the clockwise direction. The measuring angle is from 0^o to 360^o.

22. Enlist any four uses of stones as building materials. **[April/May2017]**

Granite: Used for the construction of walls, columns and bridge piers. It is also used for steps, sills and facing works.

Gravel: It is used for surfacing road. It is also used in concrete.

Basalt and trap: It is used for constructing masonry floor, ornamental or decorative works and as road metal.

Limestone: It is used for the manufacture of cement. It is also used for floors, steps, walls and as road metal.

23. What are the substitutes used for sand due to its scarcity? **[April/May 2017]**

1. Gravel 2. Cement 3. Water

24. Define mortar which is used in construction works. **[Nov/Dec2011]**

Mortar is a paste-like substance. It is prepared by adding required quantity of water to a mixture of binding material, namely, cement or lime and fine aggregate sand in certain proportion.

25. State the advantages and disadvantages of chain surveying. [Nov/Dec 2017]

Advantages:

- It is simple
- It does not require any costly equipment.
- It is adopted for preparing plans for small area.

Disadvantages:

- It cannot be used for large areas.
- It cannot be used in thick bushy areas with ups and downs.
- Chain surveying is not always accurate.

26. State the properties of cement concrete. [Nov/Dec 2017]

- It has a high compressive strength and its strength depends on the proportion in which cement, sand, stones and water are mixed.
- It is free from corrosion and there are no appreciable effects of atmospheric agents on it.
- It forms a hard surface, capable of resisting abrasion.

27. State the required properties of good quality sand. [April/May 2018]

- Sand should be clean, hard and durable and preferably dry.
- It should be free from mica, chemical salts, organic and inorganic impurities and outer foreign matters.
- The fineness modulus of sand shall be from 1.6 to 3.5mm.

28. What are the qualities of good brick? [April/May 2018]

- Brick should have perfect edges, well burnt in kilns, copper coloured, free from cracks with proper rectangular shape and of standard size.
- Bricks should give a clear ringing sound when struck with each other.
- Bricks should be homogeneous and free from voids.
- Bricks should have low thermal conductivity and should be soundproof.

Part B

1. Explain briefly how bricks are manufactured.(8)

<u>Preparation of brick earth</u>:

(i) Loose soil which contains impurities, is removed for about 20 cm depth.
(ii) Earth is then dug out from the ground, spread and weathering is done for a week time.
(iii) The clay is then mixed with suitable ingredients by tilting the clay and ingredients up and down ina kiln.
(iv) Water is added to clay to make the whole mass of clay homogeneous and plastic.

<u>Moulding of bricks:</u>

Hand moulding: It is done in a rectangular box with open at top and bottom. Box is made up of wood or steel.

Hand moulding further classified into,

(a) Table moulding (b) Ground moulding

Table moulding

(i) Done by the experienced supervisor
(ii) Bricks are moulded on the table and sent to next stage.
(iii)

Ground Moulding

(i) Small portion is cleaned and leveled.
(ii) Find sand is sprinkled over it.
(iii) Mould is dipped in water and kept on the ground and the clay is pressed by hand.

<u>Drying of bricks</u>

(i) Bricks are staked in the yard with 8 to 10 bricks in a row.
(ii) Bricks are dried for a period of 5 to 12 days.
(iii) Some times bricks are dried by hot gases from kiln.
(iv) But artificial drying produces warps on the bricks.

Burning of bricks(5)

(i) It imparts hardness and strength to bricks and makes them dense and durable.

(ii) Burning should be uniform, because unburnt bricks remain soft and hence cannot carry loads.

(iii) Overburnt bricks become brittle and break easily.
(iv) Burning of bricks done in clamp or kilns.

2. What are the various classifications of mortar? Explain.(13)

The major classifications of mortar are (i) Bricklaying mortar (ii) Finishing mortar (iii) Fire resistant mortar (iv) Light weight mortar

Brick laying mortar:

(i) It is used for brickwork and walls.

(ii) Depending upon the working conditions and the type of construction , the binding materials for the mortar is decided.

Finishing mortar :

(i) These mortars include common plastering work and ornamental effects.
(ii) Cement or lime is used as the binding material for ordinary plastering mortar.

Fire resistant mortar :

(i) It is prepared by adding aluminous cement to the finely crushed powder of fire bricks.
(ii) The usual proportion is one part aluminous cement to two parts fire brick powders.

Light weight mortar:

(i) It is prepared by adding materials such as saw dust, wood powder, etc.,

(ii) Other materials could be asbestos, fibres, coir etc., This mortar is sued for sound proof and heat proof construction.

3.What are the types of rocks? Explain briefly about (i) dressing of stones and (ii) quarrying of stones.(13)

Building stones are obtained from rocks. Rocks are classified into igneous rocks, sedimentary rocks and metamorphic rocks.

Igneous rocks are formed by cooling of the molten materials beneath the earth's surface. Stones from igneous rocks are harder. *Granite* which is widely used in construction of building is a good example.

Sedimentary rocks are formed by deposition of weathering products on existing rocks.

Deposits in layers and when the load is applied along the layers these rocks easily split.

Metamorphic rocks are formed in the change in character of the pre existing rocks.

These rocks will also be hard, if the basic rock is igneous rock.

Dressing of stones: Stones have irregular shape after quarrying. The process of cutting the stones to a regular shape and size and the required surface finish is called dressing of stones.

Quarrying of stones

It is the process of extracting stone blocks from existing rocks. In general, it is done some depth below the top surface of rock, where the effects of weathering are not found. Quarrying is done by digging, heating or wedging. **In soft rocks**, like *lime stone and marble stones* are obtained by digging, heating or wedging by hand tools. **In hard and dense rocks**, stones are obtained by blasting using explosives.

4. Explain briefly about the steels, classification and its uses in construction.(13)

Steel: It is extensively used building material. The following three varieties of steel are extensively used:
(*a*) Mild steel
(*b*) High carbon steel and
(*c*) High tensile steel.

(*a*) *Mild Steel:* It contains a maximum of 0.25% carbon, 0.055% of sulphur and 0.55% of phosphorus.
Properties of Mild Steel:
(*i*) It is malleable and ductile
(*ii*) It is more elastic
(*iii*) It can be magnetized permanently.
(*iv*) Its specific gravity is 7.8.
(*v*) Its Young's modulus is 2.1 × 105 N/mm2.
(*vi*) It can be welded easily.
(*vii*) It is equally strong in tension and in compression.
Uses of Mild Steel:
(*i*) Round bars are extensively used as reinforcement in R.C.C. works.
(*ii*) Rolled sections like I, T, L, C, plates etc. are used to build steel columns, beams,

trusses etc.
(*iii*) Tubular sections are used as poles and members of trusses.
(*iv*) Plain and corrugated mild steel are used as roofing materials.
(v) Mild steel sections are used in making parts of many types of machinery.

b) *High Carbon Steel:* The carbon contains in this steel is 0.7% to 1.5%.
Properties of Carbon Steel:
(*i*) It is more tough and elastic compared to mild steel.
(*ii*) Welding is difficult.
(*iii*) It can be magnetized permanently.
(*iv*) It is stronger in compression than in tension.

(*v*) It withstands shocks and vibrations better.
Uses of High Carbon Steel:
(*i*) It is used for making tools such as drills, files, chisels.
(*ii*) Many machine parts are made with high carbon steel since it is capable of withstanding shocks and vibrations.
(*c*) *High Tensile Steel:* It contains 0.8% carbon and 0.6% manganese. The strength of this steel is quite high. High tensile steel wires are used in prestressed concrete works.

5.Describe the different types of cement. Explain their properties and uses.(13)

Types of Cement

In addition to ordinary portland cement there are many varieties of cement. Important varieties are briefly explained below:

(*i*) White Cement: The cement when made free from colouring oxides of iron, maganese and chlorium results into white cement. In the manufacture of this cement, the oil fuel is used instead of coal for burning. White cement is used for the floor finishes, plastering, ornamental works etc. In swimming pools white cement is used to replace glazed tiles. It is used for fixing marbles and glazed tiles.

(*ii*) Coloured Cement: The cements of desired colours are produced by intimately mixing pigments with ordinary cement. The chlorium oxide gives green colour. Cobalt produce blue colour. Iron oxide with different proportion produce brown, red or yellow colour. Addition of manganese dioxide gives black or brown coloured cement. These cements are used for giving finishing touches to floors, walls, window sills, roofs etc.

(*iii*) Quick Setting Cement: Quick setting cement is produced by reducing the percentage of gypsum and adding a small amount of aluminium sulphate during the manufacture of cement. Finer grinding also adds to quick setting property. This cement starts setting within 5 minutes after adding water and becomes hard mass within 30 minutes. This cement is used to lay concrete under static or slowly running water.

(*iv*) Rapid Hardening Cement: This cement can be produced by increasing lime content and burning at high temperature while manufacturing cement. Grinding to very fine is also necessary. Though the initial and final setting time of this cement is the same as that of portland cement, it gains strength in early days. This property helps in earlier removal of form works and speed in construction activity.

(*v*) Low Heat Cement: In mass concrete works like construction of dams, heat produced due to hydration of cement will not get dispersed easily. This may give rise to cracks. Hence in such constructions it is preferable to use low heat cement. This cement contains low percentage (5%) of tricalcium aluminate (C3A) and higher percentage (46%) of dicalcium silicate (C2S).

(*vi*) Pozzulana Cement: Pozzulana is a volcanic power found in Italy. It can be processed from shales and certain types of clay also. In this cement pozzulana material is 10 to 30 per cent. It can resist action of sulphate. It releases less heat during setting. It imparts higher degree of water tightness. Its tensile strength is high but compressive strength is low. It is used for mass concrete works. It is also used in sewage line works.

(*vii*) Expanding Cement: This cement expands as it sets. This property is achieved by adding expanding medium like sulpho aluminate and a stabilizing agent to ordinary cement. This is used for filling the cracks in concrete structures.

(*viii*) High Alumina Cement: It is manufactured by calcining a mixture of lime and bauxite. It is more resistant to sulphate and acid attack. It develops almost full strength within 24 hours of adding water. It is used for under water works.

(*ix*) Blast Furnace Cement: In the manufacture of pig iron, slag comes out as a waste product. By grinding clinkers of cement with about 60 to 65 per cent of slag, this cement is produced. The properties of this cement are more or less same as ordinary cement, but it is cheap, since it utilise waste product.

This cement is durable but it gains the strength slowly and hence needs longer period of curing.

(*x*) Acid Resistant Cement: This cement is produced by adding acid resistant aggregated such as quartz, quartzite, sodium silicate or soluble glass. This cement has good

resistance to action of acid and water. It is commonly used in the construction of chemical factories.
(*xi*) Sulphate Resistant Cement: By keeping the percentage of tricalcium aluminate C3A below five per cent in ordinary cement this cement is produced. It is used in the construction of structures which are likely to be damaged by alkaline conditions. Examples of such structures are canals, culverts etc.
(*xii*) Fly Ash Blended Cement: Fly ash is a byproduct in thermal stations. The particles of fly ash are very minute and they fly in the air, creating air pollution problems. Thermal power stations have to spend lot of money to arrest fly ash and dispose safely.
It is found that one of the best way to dispose fly ash is to mix it with cement in controlled condition and derive some of the beneficiary effects on cement. Now-a-days cement factories produce the fly ash in their own thermal stations or borrow it from other thermal stations and further process it to make it suitable to blend with cement. 20 to 30% fly ash is used for blending.
Fly ash blended cements have superior quality of resistance to weathering action. The ultimate strength gained is the same as that with ordinary portland cement. However strength gained in the initial stage is slow. Birla plus, Birla star, A.C.C. Suraksha are some of the brand make of blended cement.

Properties of Ordinary Portland Cement
(*i*) Chemical properties: Portland cement consists of the following chemical compounds:
(*a*) Tricalcium silicate 3 CaO.SiO2 (C3S) 40%
(*b*) Dicalcium silicate 2CaO.SiO2 (C2S) 30
(*c*) Tricalcium aluminate 3CaO.Al2O3 (C3A) 1%1
(*d*) Tetracalcium aluminate 4CaO.Al2O3.Fe2O3 %
(C3AF)
11
There may be small quantities of impurifies present such as calc%ium oxide (CaO) and magnesiumoxide (MgO).
When water is added to cement, C3A is the first to react and cause initial set. It generates great amount of heat. C3S hydrates early and develops strength in the first 28 days. It also generates heat. C2S is the next to hydrate. It hydrates slowly and is responsible for increase in ultimate strength. C4AF is comparatively inactive compound.
(*ii*) Physical properties: The following physical properties should be checked before selecting a portland cement for the civil engineering works. IS 269–1967 specifies the method of testing and prescribes the limits:

(*a*) Fineness (*b*) Setting time
(*c*) Soundness (*d*) Crushing strength.
(a) ***Fineness****:* It is measured in terms of percentage of weight retained after sieving the cement through 90 micron sieve or by surface area of cement in square centimeters per gramme of cement. According to IS code specification weight retained on the sieve should not be more than 10 per cent. In terms of specific surface should not be less than 2250 cm2/gm.
b) ***Setting time****:* A period of 30 minutes as minimum setting time for initial setting and a maximum period of 600 minutes as maximum setting time is specified by IS code, provided the tests are conducted as per the procedure prescribed by IS 269-1967.
(c) ***Soundness:*** Once the concrete has hardened it is necessary to ensure that no volumetric changes takes place.
The cement is said to be unsound, if it exhibits volumetric instability after hardening. IS

code recommends test with Le Chatelier mould for testing this property. At the end of the test, the indicator of Le Chatelier mould should not expand by more than 10 mm.
(*d*) ***Crushing strength**:* For this mortar cubes are made with standard sand and tested in compression testing machine as per the specification of IS code. The minimum strength specified is 16 N/mm2 after 3 days and 22 N/mm2 after 7 days of curing.

PART-C

1. Describe the tests conducted on building bricks.(15) (BTL 1)

Tests on Bricks
The following *laboratory tests* may be conducted on the bricks to find their suitability:
(*i*) Crushing strength
(*ii*) Absorption
(*iii*) Shape and size and
(*iv*) Efflorescence.
(***i*) Crushing Strength**: The brick specimen are immersed in water for 24 hours. The frog of the brick is filled flush with 1:3 cement mortar and the specimen is stored in damp jute bag for 24 hours and then immersed in clean water for 24 hours. The specimen is placed in compression testing machine with 6 mm plywood on top and bottom of it to get uniform load on the specimen. Then load is applied axially at a uniform rate of 14 N/mm2 . The crushing load is noted. Then the crushing strength is the ratio of crushing load to the area of brick loaded. Average of five specimen is taken as the crushing strength.
(*ii*) Absorption Test: Brick specimen are weighed dry. Then they are immersed in water for a period of 24 hours. The specimen are taken out and wiped with cloth.
The weight of each specimen in wet condition is determined. The difference in weight indicate the water absorbed. Then the percentage absorption is the ratio of water absorbed to dry weight multiplied by 100. The average of five specimen is taken. This value should not exceed 20 per cent.
***iii*) Shape and Size:** Bricks should be of standard size and edges should be truely rectangular with sharp edges. To check it, 20 bricks are selected at random and they are stacked along the length, along the width and then along the height. For the standard bricks of size 190 mm × 90 mm × 90 mm. IS code permits the following limits:
Lengthwise: 3680 to 3920mm
Widthwise: 1740 to 1860mm
Heightwise: 1740 to 1860mm
The following *field tests* help in acertaining the good quality bricks:
(*i*) uniformity in size
(*ii*) uniformity in colour
(*iii*) structure
(*iv*) hardness test
(*v*) sound test
(*vi*) strength test.
(*i*) *Uniformity in Size:* A good brick should have rectangular plane surface and uniform in size. This check is made in the field by observation.
(*ii*) *Uniformity in Colour:* A good brick will be having uniform colour throughout. This observation may be made before purchasing the brick.

(***iii***) ***Structure:*** A few bricks may be broken in the field and their cross-section observed. The section should be homogeneous, compact and free from defects such as holes and lumps.
(***iv***) ***Sound Test:*** If two bricks are struck with each other they should produce clear ringing sound. The sound should not be dull.
(***v***) ***Hardness Test:*** For this a simple field test is scratch the brick with nail. If no impression is marked on the surface, the brick is sufficiently hard
(***vi***) ***Efflorescense****:* The presence of alkalies in brick is not desirable because they form patches of gray powder by absorbing moisture. Hence to determine the presence of alkalies this test is performed as explained below:
Place the brick specimen in a glass dish containing water to a depth of 25 mm in a well ventilated room. After all the water is absorbed or evaporated again add water for a depth of 25 mm. After second evaporation observe the bricks for white/grey patches. The observation is reported as 'nil', 'slight 'moderate', 'heavy' or serious to mean

(*a*) Nil: No patches
(*b*) Slight: 10% of area covered with deposits
(*c*) Moderate: 10 to 50% area covered with deposit but unaccompanied by flaking of the surface. (*d*) Heavy: More than 50 per cent area covered with deposits but unaccompanied by flaking the surface.
(*e*) Serious: Heavy deposits of salt accompanied by flaking of the surface..

2. Summaries the principles of surveying.(15) (BTL 2)

Surveying is the art of determining the relative position of points on above or beneath the surface of the earth by means of direct or indirect measurements of distances, direction and elevation.

object of surveying

The primary object of a survey is the preparation of a plan map. the results of surveys when plotted and drawn on paper, constitute a plan. Therefore a plan is a representation of the ground and the objects upon it some scale as projected on a horizontal plane. If the scale is large, then it is called a plan. if the scale is small, then it is called a map. Example: a plan of a building, a map of India.

Purposes of survey

Following are some of the purposes of survey:

- To prepare archeological maps, geological maps, military maps etc.
- To establish boundary points of properties with reference to the available records and demarcate ownership.
- To measure quantities in cutting or in embankments using contour maps.
- To lay out th alignment of engineering structures such as roads, railways etc.
- To plot profile of a structure(eg. irrigation canal) for ascertaining the carrying capacity of canal, capacity of reservoir etc
- To determine the relative position of desired points with reference to a known bench mark (eg. position of hill stations with reference to mean sea level).
- To measure distance between various points (eg. distance between two cities).

Primary divisions of surveying

Survey may be primarily divided into following two divisions.

- Plane surveying: in plane surveying, the mean surface of the earth is considered as a plane and the spheroid shape is neglected as the surveys extend over small areas.
- Geodetic surveying: in geodetic surveying, the curvature of earth is taken into

account and all lying in the surface are curved lines and the triangles are spherical triangles, since large distances and areas are covered.

Principle of surveying

All surveys are based on two fundamental principles they are:

Working from whole to part: in order to prevent accumulation of errors and to localize the minor errors, a set of primary central points are established first with higher precision in and around the area to be surveyed. Later on, in between those primary control points, inner control points are established with less precision method. The details are surveyed with the help of these inner control points, adopting any one method of surveying. This principles is known as working from whole to part.

Fixing a point with reference to two fixed points: suppose points 'A'and'B'are known on the distance between them is measured

. Let it be required to locate or mark a point 'C'. The relative position of the point C is located with reference to the two fixed points A and B by one of the following methods.

a) Liner measurement
b) Angular measurement
c) Both liner and angular measurements

Classification of surveying:

According to the instruments used, the surveying is classifieds follows:

- chain surveying
- compass surveying
- theodolite surveying
- plane table surveying
- tachometric surveying etc.

3. The following perpendicular offsets were taken at 10 meter intervals from a survey line to an irregular boundary line.
3.15m, 4.3m, 8.2m, 5.6m, 6.85m, 7.6m, 4.2m, 5.6m, 4.3m
Calculate the area enclosed between the survey line, the irregular boundary line, and first and last offsets, by the application of
a) Average ordinate rule
b) Trapezoidal rule
c) Simpson's rule(15) (BTL 6)

Average
d = the interval between the offset = 10 m
n = number of divisions = 8
n+1 = number of ordinates = 8+1 =9
L= Length of the base line = 8 x 10 = 80m

a) Average ordinate rule

Area = ((O1+O2+……On)/(n+1))L
O1, O2….= Ordinates at the end of each division
Area = ((3.15 + 4.3 + 8.2+ 5.6 + 6.85 + 7.6 + 4.2 + 5.6 + 4.3)/(8+1)) x 80
=442.66m2

b) Trapezoidal rule

Area= (((O0+On)/2)+(O0+O2+……On-1))d
Area = (3.725 + 42.35) x10 =460.75m2

c) Simpson's rule

Area= 10/3(7.45 +92.4 +38.5) = 461.167m2

UNIT - III BUILDING COMPONENTS AND STRUCTURES

Foundations: Types of foundations - Bearing capacity and settlement – Requirement of good foundations.
Civil Engineering Structures: Brickmasonry – stonemasonry – beams – columns – lintels – roofing– flooring – plastering – floor area, carpet area and floor space index - Types of Bridges and Dams –water supply - sources and quality of water - Rain water harvesting - Introduction to high way and railway.

1. What is a foundation (for building)? [Nov / Dec 2011, Nov / Dec 2012]

The foundation is a structural component of the building which is in direct contact with the ground and transmits the entire load of the building to the ground.

2. List any two objectives of foundation? [Apr / May 2011]

The objectives of foundation are

- To distribute the load of the superstructure on the subsoil uniformly
- To provide a leveled firm base for the construction of the buildings
- To support the structures
- To prepare a leveled hard surface for concreting and masonry work
- To give stability to the structures against earthquake, wind, rain, etc.

3. Define bearing capacity of soil and safe bearing capacity of soil?
[May / June 2009, Nov/ Dec 2009, May/June2010, April/May2015]

The maximum load at which the soil can bear per unit area without any yielding or failure is called as bearing capacity of the soil. The ratio between the bearing capacities of the soil to factor of safety (FOS) is known as safe bearing capacity of soil.

Safe bearing capacity of soil = Bearing Capacity of the Soil / FOS

4. What are the requirements of a good foundation? [Apr / May 2017]

The requirements of a good foundation are

- The foundation should evenly distribute the entire load transmitted through the structure.
- The foundation should be strong enough to safe guard the building from any possible failure.
- The foundation should not deflect.
- It should protect the building against scouring or undermining flood water or burrowing animals.

5. List different types of foundation used for buildings? [Nov / Dec 2010]

- Shallow foundations
- Spread footings
- Combined footings
- Strap footings
- Mat foundation
- Deep foundations
- Pile foundation
- Pier foundation
- Well foundation

6. Write any two types of pile foundation based on function? [May/June2012]

The types of pile foundation are

- End bearing piles
- Friction piles
- Partly bearing & partly friction pile
- Compaction pile
- Pre – cast pile
- Cast – in – situ piles
- Under reamed piles
- Batter piles
- Sheet piles

7. What are 'beams' in a building? [Apr / May 2011]

Beam is a structural member which is supported along the length and subjected to external forces or loads acting transversely. Beam is sufficiently long when compared to the lateral dimensions.

8. What is a 'column' in a building? [May / June 2012]

A column is a vertical member which carries loads from the slab and the beam to the foundation. It is used to bear the compressive load or compressive load and bending moment.

9. Define plastering. List the types of plasters [Nov / Dec 2010, Nov / Dec 2011]

The process of covering the surface of brick masonry work and the uneven surface with a layer of suitable plaster to make it decorative and weather resisting is called as plastering. The various types of the plaster used for plastering are

- Cement plaster
- Lime plaster
- Lime – cement plaster
- Mud plaster
- Water – proof plaster

10. Define stress and strain and show the notation used.[May / June 2010, April/May 2015]

The internal resisting force per unit area is called as stress and is denoted by f.

The ratio of change in length to original length is called strain and is denoted by e.

11. Define Poisson's ratio? [Nov/ Dec 2009]

When a body is stressed within its elastic limit, the ratio of lateral strain to the longitudinal strain is constant for the given material

$$\mu=\frac{Lateral\ strain}{Logitudinal\ strain}$$

12. State the basic components of the bridge? [May/ June 2009]

The basic components of the bridge are

- Piers
- Abutments
- Wing walls
- Decking
- Bearings
- Parapet

13. Write any purposes of a dam. [May/June2014, April/May 2018, Nov/Dec 2017]

The purposes of a dam are

- To store and control of water for irrigation
- Generation of Hydro – electric power
- To store and supply water for domestic and industrial uses
- For navigation purpose

14. List the types of dams. [Nov/ Dec 2009]

- Gravity dam
- Arch dam
- Buttress dam
- Timber dam

15. Define modulus of rigidity. [May/ June 2016]

Modulus of Rigidity is the coefficient of elasticity for a shearing force. It is defined as "the ratio of shear stress to the displacement per unit sample length.

16. Mention two unique features of a Flemish bond. [May/ June 2016]

In Flemish bond, each course consists of alternate headers and stretchers. The alternate headers of each course are centered over the stretchers in the course below. Every alternate course starts with a header at the corner. For the breaking of vertical joints in the successive courses, closers are inserted in alternate courses next to the quoin header. In walls having their thickness equal to odd number of half bricks.

17. List the different types of bonds in brick masonry. [May/June 2014]

Stretcher bond, Harder bond, English bond, Flemish bond, Raking bond, Zigzag Bong and Garden wall bond are the various types of bond in brick masonry.

18. Define Elasticity. [Nov/Dec 2014]

Elasticity is the property of a material to regain its original shape and size completely on the removal of external load acting on it. *Example: Mild steel.*

19. List the different types of bonds in brick masonry. [Nov/Dec 2014]

1. Header bond, 2. Stretcher bond, 3.English bond, 4. Flemish bond
5. Raking bond

20. State the advantages and disadvantages of the flat roofs. [Nov/Dec 2015]

Advantage:

Construction and maintenance are easy
It is capable of withstanding concentrated loads.
It does not require false ceiling

Disadvantage:

Cracks may developed due to large temperature variations
It is not suitable for hill regions or heavy snow-fall regions.

21. Enlist the type of flooring. [Nov/Dec 2015]

1. Mud Flooring
2. Brick Flooring
3. Stone Flooring
4. Cement Concrete Flooring
5. Terrazzo Flooring
6. Granolithic Flooring
7. Mosaic Flooring

22. Why steel is a good reinforcing agent in RCC? Give two reasons. [Nov/Dec 2015]

Steel has high tensile strength and high modulus of elasticity
Steels forms a monolithic structure on reinforcement with concrete
Steel is available as round or flat bars

23. What is the use of an abutment? [Nov/Dec 2015]

Abutments are the end supports to the superstructure of the bridge. They are constructed of either masonry or R.C.C. the purpose of abutments are:

1. It transfer the superstructure load(Vertical load) to the foundation

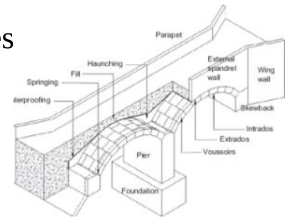
2. It laterally support and retain the earthwork of the embankment of the approaches.

24. What is a mud plaster? [May/June 2013]

In mud plastering the paste is prepared by mixing suitable clay, soil with water. Mud plaster is generally applied in two coats, the first coat being 18mm thick while the thickness of the second coat is kept 6mm.

25. Write the various types of bridges and draw any one. [April/May 2017]

1. Masonry bridges
2. R.C.C. bridges
3. Pre-stressed Concrete bridges
4. Steel bridges
5. Timber bridges
6. Composite bridges



26. What is deep foundation? [May/June 2013]

A foundation is said to be a Deep Foundation, when its depth is more than the width of the foundation. Deep Foundation transmits the load of a super structure through weak soils to strong soil beds or rock beds available at great depth.

27. What are the types of flooring used in residential building? [Nov/Dec 2012]

1. Terrazzo Flooring
2. Mosaic Flooring
3. Marble Flooring
4. Tiled Flooring
5. Granite Flooring

28. Mention the objectives of plastering. [April / May 2018]

- To protect the surface from the effects of atmospheric agencies.
- To conceal the defective workmanship.
- To provide an even, smooth, regular, clean and durable finished surface and hence to improve the appearance.

29. List the failures of foundation. [Nov/Dec 2017]

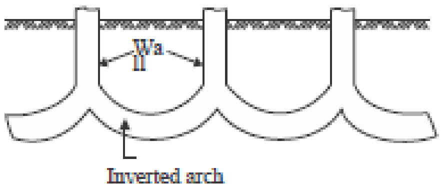
- Unequal settlement of subsoil
- Unequal settlement of masonry
- Withdrawal of moisture from the sub-soil
- Lateral pressure on the superstructure
- Horizontal movement of earth

PART-B

1. Describe with neat sketches (a) Arch foundation (b) Pile foundation.(13)

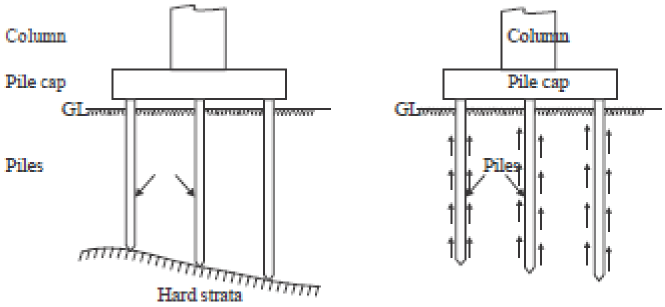
Arch foundation

Inverted arch foundations are provided in the places where the SBC of the soil is very poor and the load of the structure is through walls. In such cases inverted arches are constructed between the walls. End walls should be sufficiently thick and strong to withstand the outward horizontal thrust due to arch action. The outer walls may be provided with buttress walls to strengthen them. Figure 2.2.3.1 shows a typical inverted arch footing.



Pile foundations

These foundations are known as deep foundations. A pile is a slender column made of wood, concrete or steel. A pile is either driven into the soil or formed in situ by excavating a hole and then filling it with concrete. A group of piles are driven to the required depth and are capped with R.C.C. slab, over which super structure is built. The pile transfer the load to soil by friction or by direct bearing, in the latter case, piles being taken up to hard strata. This type of foundations is used when top soil is not capable of taking the load of the structure even at 3–4 m depth.



(a) Bearing pile (b) Friction pile

2.Describe with neat sketches any two types of bridges.(13)

BRIDGES

INTRODUCTION

A bridge is a structure providing passage over an obstacle without closing the way beneath.

The required passage may be for a road, a railway pedestrian or a canal of a pipeline. The obstacle to be crossed may be river, a road, a railway or a valley.

CLASSIFICATION OF BRIDGES

Bridges can be classified into various types depending upon the following factors:

Materials used for construction : Under this category bridges may be classified as:

a) Timber bridges b) Masonry bridges

c) Steel bridges d) Reinforced cement concrete bridges

e) Pre-stressed concrete bridges f) Composite bridges

Alignment : Under this category, the bridge can be classified as

a) Straight or square bridges and b) Skew bridges

Straight or square are the bridges which are at right angles to the axis of the river.

Skew bridges are not at right angles to the axis of the river.

The Relative position of bridge floor: Under this category, the bridge and classified as

a) Deck bridge b) Semi through bridge and c) Through bridge

Deck bridges are the bridges whose floorings are supported at the top of the super structure. Through bridges are the bridges whose floorings are supported at the bottom of the super structure. Semi-through bridges are the bridges whose floorings are supported at some intermediate level of the super structure.

Function of Purpose : Under this, the bridge can be classified as

a) Highway bridge b) Railway bridge c) Foot bridge
d) Viaduct and e) Aqueduct etc.

Position of High floor level : Under this, the bridges may be classified as

a) Submersible bridge and b) Non-submersible bridge

Submersible Bridges are the bridges whose floor levels are below the high flood level. During flood seasons, it allows the water to pass over the bridge submerging the communication route. In economic point of view, these bridges are constructed.

Non-submergible bridges are the bridges whose floor levels are above the high flood level.

Life : Under this, the bridges may be classified as

a) Permanent bridges b) Temporary bridges

Type of Superstructure : Under this, the bridges may be classified as

a) Arch bridges b) Truss bridges
c) Portal frame bridges d) Balanced cantilever bridges
e) Suspension bridges etc.,

Span length : Under this category, the bridges can be classified as

a) Culverts (span less than 6m)
b) Minor bridges (span between 6 to 30m)
c) Major bridges (span above 30m
d) Long span bridges (span above 120m)

Loading : Road bridges and culverts have been classified by Indian raod congress into

a) Class AA bridges b) Class A bridges
c) Class B bridges according to the loadings they are designed to carry.

COMPONENT PARTS OF A BRIDGE

Broadly, a Bridge can be divided into two major parts.

1. Sub structure 2. Super structure

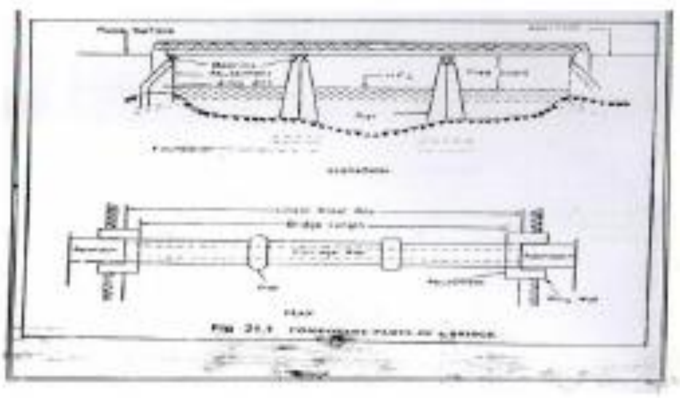
1. SUB STRUCTURE

The function of the sub structure is similar to that of foundations, columns and walls of a buildings, because it supports the super structure of the bridges and transmits the load safely to the ground.

The substructure consists of the following:

a. Abutments b. Piers c. Wing walls d. Approaches
e. Foundations for the piers and abutments

a. Abutments: The end of superstructure of a bridge is called abutments.



Its main functions are

1. To laterally support the earth work of the embankment of the approaches.
2. To transmit the load from the bridge superstructure.
3. To give final formation level to the bridge.

Bridge abutments can be made of brick masonry, stone masonry, plain concrete or reinforced concrete

b. Piers : Piers are the intermediate supports for the superstructure. Piers transmit the loads from the superstructure of the bridge to the foundations. A pier essentially consists of a column or shat and a foundation. They may have different configurations as shown in figure. These piers may be constructed with stone masonry or concrete.

c. Wing walls : These are the walls provided at both ends of the abutments to retain the earth filling of the approach road. They are constructed of the same material as those of the main abutment.

d. Approaches: The portion of the road constructed to reach the bridge from their general route or height is known as approach of the bridge. The alignment and the level of the approaches mainly depend on the design and layout of the bridge.

e. Foundations for the Piers and Abutments : The foundation of a bridge structure distributes the load from the piers and abutments over the larger area of sub soil. It prevents the tilting and over-turning of the piers and abutments and also unequal settlement of the sub soil.

The different types of functions adopted for bridges are:

i. Spread foundation ii. Raft foundation iii. Pile foundation
iv. Caisson foundation v. Well foundation

2. Super structure : The super structure is that part of the bridge over which the traffic moves with safely.

It consists of:

a. Decking b. Parapet or hand rails, guard stones etc. c. Bearing

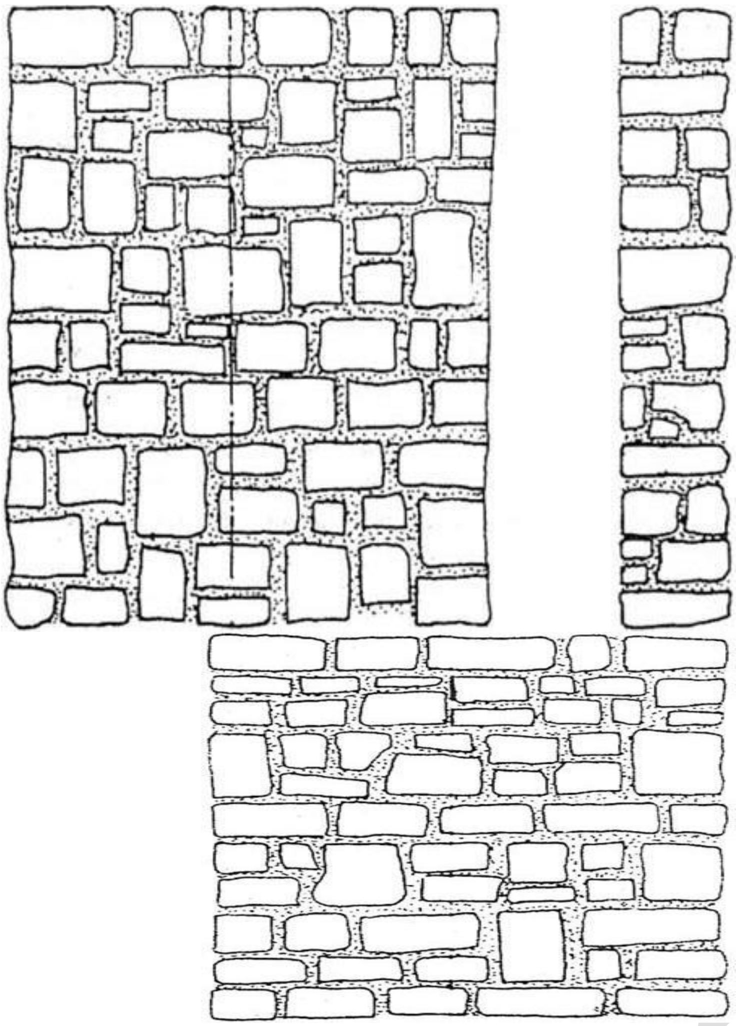
a. Decking : It is provided to allow the road surface to be built in over it. It may consist of a slab, trusses, arches etc.

b. Parapet or Hand rails, guard stones: These are the protective works provided on both sides of the deck along the roadway in order to safe guard the moving vehicles and the passengers on a bridge. Foot paths are also provided for pedestrians to walk along the bridge. In order to prevent a vehicle from striking the parapet wall of the hand rails, guard stones painted white are provided at the ends of the road surfaces.

c. Bearing: It is part of the bearing structure provided to distribute the load coming from the superstructure and also to allow for longitudinal and angular movements.

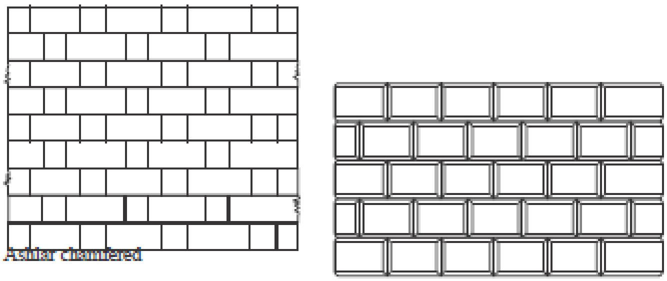
4.Discuss the different type of masonry.(13)

Rubble Masonry: In this type of constructions stones of irregular sizes and shapes are used. To remove sharp shapes they may be hammered. The rubble masonry may be coursed or uncoursed . In uncoursed rubble masonry the wall is brought to level at every 300 mm to 500 mm. The mortar consumed in these construction
is more. Course rubble masonry is used for the construction of public and residential buildings. Uncoursed rubble masonry is used for the construction of foundations, compound walls, garages, labour quarters etc. A skilled mason may arrange the facing stones in polygonal shapes to improve the aesthetic of the wall.



2. Ashlar Masonry: In this type of masonry stones are dressed to get suitable shapes and sizes. The height of the stones varies from 250 mm to 300 mm. The length should not exceed three times the height. The dressing of the stone need not be very accurate on all sides. Usually good dressing is made on facing side. In such construction mortar consumption is less compared to rubble masonry.

There are different types of ashlar masonry depending upon the type of dressing such as Ashlar fine dressed, Ashlar rough dressed, Ashlar rock or quarry faced, Ashlar facing, Ashlar chamfered etc. Figure 8.3 show some of such masonry



(b) Ashlar chamfered

(a)Fig.2.2.2.5.3 Fine finished ashlar Fig.2.2.2.5.4Ashlar masonry

Supervision of Stone Masonry Construction

The following points should be kept in mind in supervising stone masonry work:

1. Hard and durable stones, free from defects like flaws, cavities veins etc. should be used.
2. Dressing of the stones should be as per the requirement.
3. Stones should be properly wetted before they are used so as to avoid sucking of water from mortar.
4. Stones should be laid on their natural bed.
5. Facing and backing faces should be laid neatly and levelled and checked with

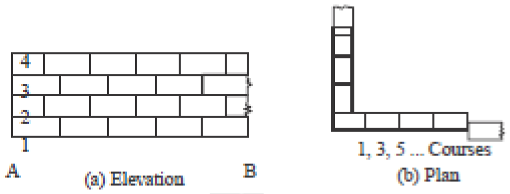
wooden template.
6. The heart of masonry should be filled with stone chips and mortars. To thick mortar joints should be avoided.
7. Verticality of the wall should be frequently checked with plumb-bob.
8. Mortars with correct proportion of sand and cement should be used.
9. Continuous vertical joints should be avoided.
10. Through stones should be used within 1.5 m distances.
11. The height of masonry should be raised uniformly.
12. Under the beams, trusses, sills etc large flat stones should be used.
13. Before continuing work, the masonry built on previous day should be well cleaned and freed from loose particles.
14.Curing should be done properly for 2 to 3 weeks.

Brickmasonry

Brick masonry is built with bricks bonded together with mortar. For temporary sheds mud mortar may be used but for all permanent buildings lime or cement mortars are used.

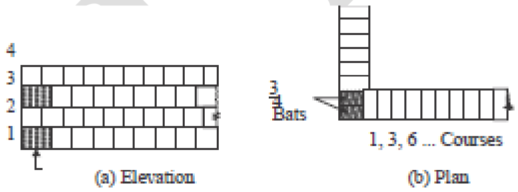
The various types of bonds generally used in brick masonry are
1. Stretcher bond
2. Header bond
3. English bond and
4. Flemish bond.

1. Stretcher Bond: A stretcher is the longer face of the brick as seen in the elevation. In the brick of size 190 mm × 90 mm × 90 mm, 190 mm × 90 mm face is the stretcher. In stretcher bond masonry all the bricks are arranged in stretcher courses as shown in Fig .However care should be taken to break vertical joints. This type of construction is useful for the construction half brick thick partition wall.

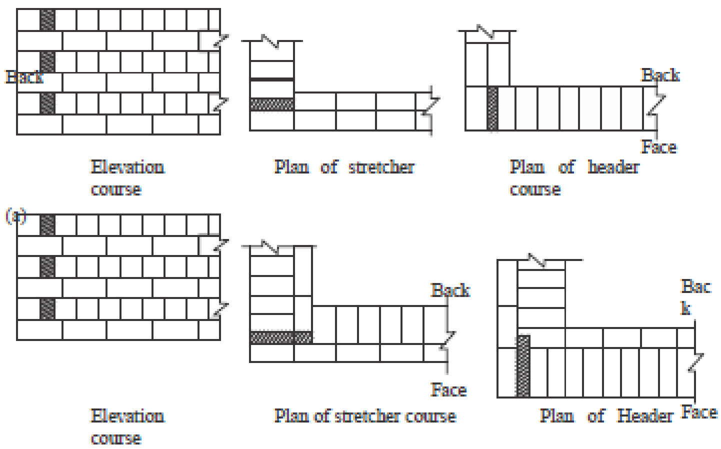


bond

2. Header Bond: A header is the shorter face of the brick as seen in the elevation. In a standard brick it is 90 mm × 90 mm face. In header bond brick masonry all the bricks are arranged in the header courses as shown in Fig.. This type of bond is useful for the construction of one brick thick wall



3. English Bond: In this alternate courses consist of headers and stretchers. This is considered to be the strongest bond. Hence it is commonly used bond for the walls of all thicknesses. To break continuity of vertical joints a brick is cut lengthwise into two halves and used in the beginning and end of a wall after first header. This is called queen closer. Figure . shows typical one brick and one and half brick thick wall with English bond.



4. Flemish Bond: In this type of bond each course comprises of alternate header and stretcher fig 2.6.4 Alternate courses start with stretcher and header. To break the vertical joints queen closers are required, if a course starts with header. Every header is centrally supported on the stretcher below it.

Flemish bonds may be further classified as

(*a*) Double Flemish Bond

(*b*) Single Flemish Bond.

In case of *double flemish bond*, both faces of the wall have flemish look, *i.e.* each course consist of alternate header and stretcher, whereas *single flemish bond* outer faces of walls have flemish look whereas inner faces have look of English bond

Construction of flemish bond needs greater skill. It gives more pleasing appearance. But it is not as strong as English bond. If only pointing is to be used for finished wall, flemish bond may be used to get good aesthetic view. If plastering is going to be used, it is better to use English bond.

PART-C

1.What are all the factors influencing the selection of dams?(15)

INTRODUCTION

A dam is an impervious barrier construction across a river to store water. The side on which water gets collected is called the upstream side, and the other side of the barrier is called the downstream side. The lake of water which is collected in the upstream side is called as reservoir. This water is then utilized as and when it is needed.

PURPOSE OF A DAM

1. To store and control the water for irrigation
2. To store and divert the water for domestic uses
3. To supply water for Industrial uses
4. To develop hydroelectric power plant to produce electricity
5. To increase water depths for navigation
6. To create storage space for flood control
7. To preserve and cultivate the useful aquatic life
8. For recreational purposes.

Multipurpose Reservoirs

A reservoir planned and constructed to serve not only one purpose but various purposes together is called a multipurpose reservoir.

Reservoir, designed for one purpose, incidentally serving other purposes, shall not be called a multipurpose reservoir.

Hence a reservoir designed to protect the down stream areas from floods and also to conserve water for water supply, irrigation, industrial needs, hydroelectric purposes etc. shall be called as MULTIPURPOSE RESERVOIR.

FACTORS GOVERNING SELECTION OF SITE FOR DAM

1. Suitable foundations should be available at the site selected for a particular type a

dam. For gravity dams, sound rock is essential. For earth dams, any type of foundations is suitable with proper treatment.

2. The river cross-section at the dam site should preferably have a narrow gorge to reduce the length of the dam. However, the gorge should open out u/s to provide large basin for a reservoir.

3. The general bed level at dam site should preferably be higher than that of the river basin. This will reduce the height of the dam and will facilitate the drainage.

4. A suitable site for the spillway should be available in the near vicinity. If the spillway is to be combined with the dam, the width of the George should be such as to accommodate both.

5. Materials required for the construction should be easily available, either locally or in the near vicinity, so that the cost of transporting them is as low as possible.

6. The reservoir basin should be reasonably water tight. The stored water should not escape out through its side walls and bed.

7. The value of land and property submerged by the proposed site should be as low as possible.

8. The dam site should be easily accessible so that it can be economically connected to important towns and cities by rails, roads, etc.

9. To establish site for labour colonies, a healthy environment should be available in the near vicinity.

2.Explain with neat diagram of any one type of dam(15)

CLASSIFICATION OF DAMS

Dams may be classified into different categories, depending upon the basis of the classification.

(a) Classification according to use : Based on use, dams are classified as follows

i. Storage dam ii. Diversion dam iii. Detention dam

i. Storage Dam : Storage dam is constructed to store water to its upstream side during the periods of excess supply in the river (i.e. during rainy season) and is used in periods of deficient supply.

ii. Diversion Dam : Diversion dam supply raises the water level slightly in the river and thus provides head for carrying or diverting water into ditches, canals or other conveyance systems to the place of use.

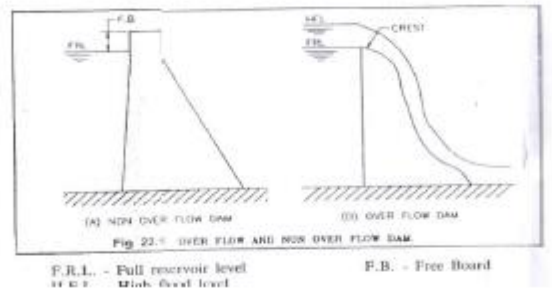
iii. Detension Dam : A detention dam is constructed to store water during floods and release it gradually at a safe rate when the flood reduces.

(b) Classification According to Hydraulic Design : According to hydraulic design, dams may be classified as follows :

i. Non – Overflow dam ii. Overflow dam

i. Non-Overflow Dam :

A non-overflow dam is the one in which the top of the dam is kept at a higher elevation than the maximum expected high flood level.



ii. Over Flow Dam :

An overflow dam is the one which is designed to carry surplus discharge (including floods) over its crest.

Usually, in a river valley project, the two types of dams are combined. The main dam is kept as a non – overflow dam and some portion of dam is kipt as overflow dam (spill way)at some suitable location along the main dam.

c) Classification according to material : According to this classification, dam may be classification, dam may be classified as follows : i. Rigid dam ii. Non-rigid dam

i. Rigid Dams : Rigid dams are those which are constructed of rigid materials such as masonry, concrete, steel or timber. Rigid dams may be further classified as follows:

1. Solid Masonry gravity dam
2. Solid concrete gravity dam
3. Arched masonry dam
4. Arched concrete dam
5. Concrete buttress dam
6. Steel dam

7. Timber dam

ii. Non-Rigid Dams : Non-rigid dams are those which are constructed of non-rigid materials such as earth and or rockfill. The most common types of non-rigid dams are :
1. Earth dam 2. Rockfill dam

Gravity dams : A gravity dam is the one in which the external forces (such as water pressure, wave pressure, silt pressure, uplift pressure etc.) are resisted by the weight of the dam itself. A gravity dam may be constructed either of masonry or of concrete. Masonry gravity dams are now-a-days constructed of only small heights. All major and important gravity dams are now constructed of concrete only. A gravity dam may be either straight or curved in plan.

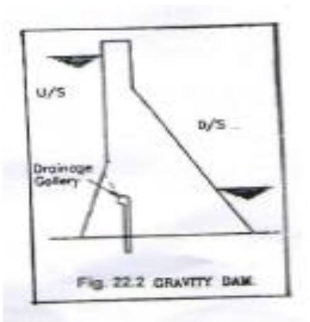


Fig. 22.2 GRAVITY DAM

Arch dams : An arch dam is a dam curved in plan and carries a major part of its waterload horizontally to the abutments by arch action. The thrust developed by the water load carried by arch action essentially require strong side walls of the canyon to resist the arch forces. The weight of arch dams is not counted on to assist materially in the resistance of external loads.

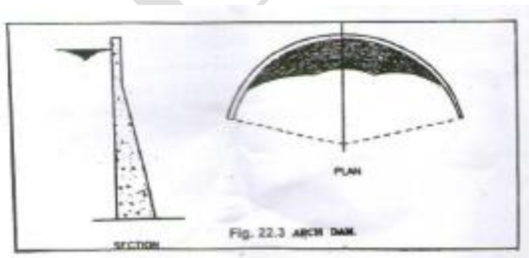


Fig. 22.3 ARCH DAM

Butter Dams :

A buttress dam consists of a number of buttresses of piers. These piers divide the space (i.e. the space to be dammed) into number of spans. Between these piers, panels are constructed of horizontal arches or flat slabs. When the panels consist or arches, it is known as **Multiple arches type buttress dam.** If the panels consist of flat slab, it is known as **Deck type buttress dam.**

Subject Code : BE 8252 **Year/ Semester : I/II**

Subject : Basic Civil And Mechanical Engineering **Subject Handler:Mr.N.Mukilarasan**

UNIT IV INTERNAL COMBUSTION ENGINES AND POWER PLANTS 15
Classification of Power Plants - Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines – Working principle of steam, Gas, Diesel, Hydro - electric and Nuclear Power plants –- working principle of Boilers, Turbines, Reciprocating Pumps (single actingand double acting) and Centrifugal Pumps

1. Mention any four types of power plants? [May/June 2014, April/May 2015]

- Steam power plant
- Hydroelectric power plant
- Nuclear power plant
- Gas turbine power plant
- Diesel power plant
- Solar power plant
- Wind power plant
- Tidal power plant
- Geo thermal power plant

2. Differentiate between thermal and hydroelectric power. [May/June 2016]

Thermal Power:

(i) It is generated from petroleum (oil) or coal.
(ii) Its sources (coal and oil) are exhaustible.
(iii) On burning coal and oil they cause a lot of pollution.
(iv) It is expensive in the long run.

Hydroelectric Power:

(i) It generated from water falling on turbines.
(ii) Its source is perennial, i.e., in-exhaustible.
(iii)It causes no pollution.
(iv)It is cheaper in the long run.

3. What is meant by greenhouse effect? [May/June 2016]

The greenhouse effect is a natural process that warms the Earth's surface. When the Sun's energy reaches the Earth's atmosphere, some of it is reflected back to space and the rest is absorbed and re-radiated by greenhouse gases.

4. Classify hydraulic turbines based on operating head and direction of water flow. [May/June 2014, April/May 2017]

According to the type of energy at inlet of the turbine:
(a) Impulse turbine (b) Reaction turbine
According to the direction of flow of water:
(a) Tangential flow turbine (b) Radial flow turbine (c) Axial flow turbine
According to the head at the inlet of the turbine:
(a) High head turbine (b) Medium head turbine (c) Low head turbine

5. Mention any three parts of steam power plants. [May/June 2014, Nov/Dec 2014]

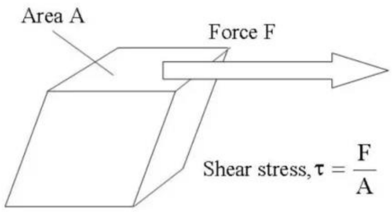
High pressure boiler, prime movers, condenser & cooling towers, coal handling system, air pre-heater, economizer, ash handling system.

6. Write the working principle of centrifugal pump. [Nov/Dec 2009, April/May 2015]

A centrifugal pump works on the principle of conversion of the mechanical energy into pressure energy of the fluid. The impeller converts mechanical (rotation) energy into kinetic energy that provides the centrifugal acceleration to the fluid. The casing converts the kinetic energy into pressure.

7. Name the common fuel gas [Nov/Dec 2015]

1. Natural gas
2. Blast furnace Gas
3. Producer Gas



8. What is meant by pumped storage system? [Nov/Dec 2015]

Pumped hydroelectric energy storage (PHES), is a type of hydroelectric energy storage used by electric power systems for load balancing. The method stores energy in the form of gravitational potential energy of water, pumped from a lower elevation reservoir to a higher elevation.

9. Mention two disadvantages of Gas turbines [Nov/Dec 2016]

1. The overall efficiency of the turbine is low
2. Temperature produced during the combustion is very high even at moderate pressure.

10. What is the use of blow off valve in a boiler? [Nov/Dec 2016]

Blow off valve is located at the bottom of the boiler. When the blow-off valve is opened during the running of the boiler, the steam pressure acting on the water pushes (drains) out the impurities like mud, etc., in the water collected at the bottom.

11. Distinguish boiler mountings and accessories. [April/May 2017, April/May 2018]

Boiler mountings are fitted in the boiler for safe operation and controlled steam generation whereas boiler accessories increases the efficiency of the boiler.

12. What is the advantage of buttress dam compared to solid gravity dam? [May/June 2013]

1. Thin section with one-third to one-half economy in concrete compared to gravity dam of similar size.
2. No problem of uplift or foundation drainage
3. Can be constructed weak foundation
4. Vertical component of water resting against upstream sloping deck add to the stability of the dam.

13. What are the main components of gas turbine power plant? [May/June 2013]

Low pressure compressor, High pressure compressor, Intercooler, Regenerator, combustion chamber, Low pressure turbine, high pressure turbine.

14. Sketch a pictorial view of a rectangular block subjected to a shear force and indicates shear area. Hence, state what is a shear stress? [May/June 2013]

Shear stress, force tending to cause deformation of a material by slippage along a plane or planes parallel to the imposed stress.

15. Mention two disadvantages of single jet carburettor? [May/June 2016]

The drawbacks of a single jet carburettor are;

- It cannot provide the richer mixture required for starting.
- It cannot provide the richer mixture required for sudden acceleration.

16. What is the use of a flywheel in an I.C engine? [Nov/Dec 2016]

The main function of the flywheel is to store the excess energy during the power stroke of the engine and supply the energy for the movement of the piston during the remaining stroke and to maintain uniform rotation of the crankshaft.

17. Write down the two prime requirements of the boiler? [April/May 2015]

- All chimney and vents shall be installed in accordance with Boiler Manufacturer recommendations.
- When boilers of a seal combustion design are installed, the boiler room is required to either meet the requirements listed above or have a Carbon Monoxide Detector installed.

18. What are the types of heat engine and define any one type? [April/May 2015]

A heat engine is a device which converts heat energy into a thermal energy.

Types of heat engines

- External combustion engines
- Internal combustion engines - An internal combustion engine (ICE) is a heat engine where the combustion of a fuel occurs with an oxidizer (usually air) in acombustion chamber that is an integral part of the working fluid flow circuit. In an internal combustion engine the expansion of the high-temperature and high-pressure gases produced by combustion apply direct force to some component of the engine. The force is applied typically to pistons, turbine blades, or a nozzle.

19. Define engine capacity and compression ratio. [Nov/Dec 2015, May/June 2016]

Compression ratio is the ratio of cylinder volume to the clearance volume.

Compression ratio = Maximum cylinder volume / Clearance volume

20. State any five differences between two stroke and four stroke engines. [May/June 2014]

Two stroke engines	Four stroke engines
The cycle is completed in two strokes of the piston or in one revolution of the crank.	The cycle is completed in four strokes of the piston or in every two revolutions of the crank.
One power stroke is obtained in every revolution of the crank.	One power stroke is obtained in every two revolution of the crank.
Thermal efficiency is high	Thermal efficiency is more
Construction is simple and light weight	Construction is rigid and bulk
Initial coast is less	Initial cost is high

21. List the importance parts of diesel engine power plant. [May/June 2014]

Fuel supply system, air in-take and exhaust system, cooling and lubricating system

22. Define boiler. [Nov/Dec 2014]

Boiler is a closed vessel in which steam is generated from water by the application of heat and the pressure being higher than the atmosphere.

23. Name the cooling systems used for I.C engine. [Nov/Dec 2014]

1. Air cooling
2. Water cooling

24. Mention two advantages of a Tidal power plant. [Nov/Dec

2016]

1. Tidal energy is environment friendly energy and doesn't produce greenhouse gases.
2. Efficiency of tidal power is far greater as compared to coal, solar or wind energy. Its efficiency is around 80%.

25. Draw the ideal and actual indicator diagrams of two stroke petrol engines. [April/May

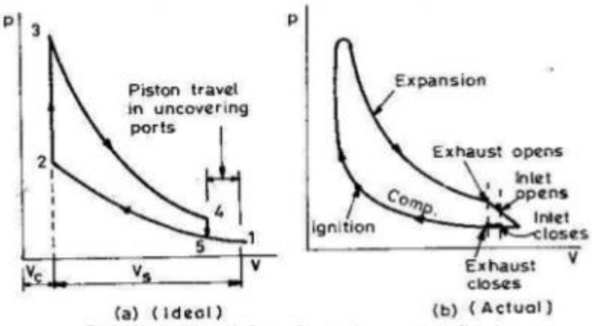


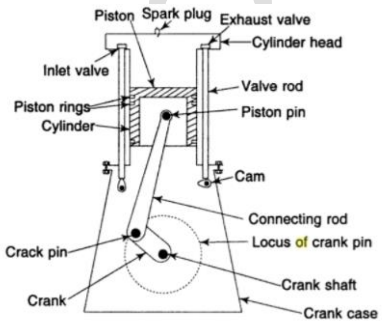
Fig. 2.8 Ideal and actual indicator diagrams for a two stroke SI engine

2017]

Indicator diagrams

26. Draw the sectional elevation of a four stroke engine and mark the parts. [April/May 2017]

Four stroke engine



27. What is the use of surge tank in hydropower plants? [April / May 2018]

Surge tank is introduced in between the power house and dam to avoid sudden rise in the penstock. As the load on the turbine is suddenly reduced then there will be a backflow of water inside the penstock. The back flow of water causes a pressure rise in the penstock.

28. Mention two merits and two demerits of a nuclear power plant. [Nov/Dec 2017]

Merits:

- Very large amount of heat is liberated by a small quantity of fuel
- It is suitable for large power generation
- Cost of fuel transportation and storage is less

Demerits:

- Installation cost is very high
- Large amount of trained and qualified personnel are required.
- Maintance cost is higher

29. State the principle of centrifugal pump under rotodynamic pumps. [Nov/Dec 2017]

A rotodynamic pump is a kinetic machine in which energy is continuously imparted to the pumped fluid by means of a rotating impeller, propeller, or rotor, in contrast to a positive displacement pump in which a fluid is moved by trapping a fixed amount of fluid and forcing the trapped volume into the pump's discharge.

30. Differentiate with any two points between Spark Ignition (SI) and Compression Ignition (CI) engines. [Nov/Dec 2017]

Spark Ignition (SI)engine	Compression Ignition (CI)engine
During the suction stroke Air fuel mixture enters in to the cylinder bore.	During the suction stroke only Air enters into the cylinder bore.
Compression ratio is less (6 to 8)	Compression ratio is high (16 to 18)
Fuel consumption is more.	Fuel consumption is Less.

31. List the various boiler accessories [Nov/Dec 2017]

- Economizer
- Air Preheater
- Super heater
- Steam Separator

PART-B

1. Describe the working principle of thermal power plant.(13)

The layout of steam power plant has the following circuits:

1. Fuel (Coal) and ash circuit
2. Air and flue gas circuit
3. Feed water and steam flow circuit
4. Cooling water flow circuit.

Coal and Ash Circuit:

• Coal from mines is delivered by ships, rails or trucks to the power station.
• Coal received at coal yard.
Coal is sized by crushers, breakers etc.,
• The sized coal is stored in coal storage.
• From stock yard, the coal is transferred to the boiler furnace by means of conveyors, elevators etc.,
• The coal is burnt in the boiler and ash is formed.
• Ash coming out of the furnace will be too hot, dusty and accompanied by poisonous gases.
• The ash is transferred to the ash storage.
• Generally the ash will be quenched to reduce the temperature and the dust content.

AIR AND FLUE GAS CIRCUIT:

• Air is taken from the atmosphere by the action of FD fan.
• It is passed through an air pre heater
• The air is preheated by the flue gases in the pre heater.
• This preheated air is supplied to the furnace to aid the combustion of fuel.
• Due to the combustion of fuel the flue gases are formed.
• The flue gases from the furnace pass over the boiler tubes and super heater tubes.
• Then the flue gases pass through economiser to heat the feed water.
• After that it passes through a dust collector.
It is then exhausted to atmosphere through chimney

Water and Steam Circuit:

• The water is preheated by the flue gases in the economiser.
• This preheated water is then supplied to the boiler drum.

- Heat is transferred to the water by the burning of the coal.
- Due to this, water is converted into the steam.
- The steam raised in boiler is passed through a super heater.
- It is superheated by the flue gases.
- The turbine drives generator to produce electric power.
- The expanded steam is then passed through the condenser.
- In the condenser, steam is condensed into water there circulated**.**

COOLING WATER CIRCUIT:

- The exhaust steam from the turbine is condensed in the condenser.
- In the condenser, the cold water is circulated to condense the steam into water.
- The steam is condensed by losing its latent heat to the circulating the cold water.
- Hence the cold water gets heated.
- This hot water is then taken to a cooling tower.
- In cooling tower the water is sprayed in the form of droplets through nozzles.
- The atmospheric air enters.This cold water is again circulated through the pump, condenser and the cooling

- Some amount of water may be lost during circulation.
- Hence make up water is added to the pond by means of a pump

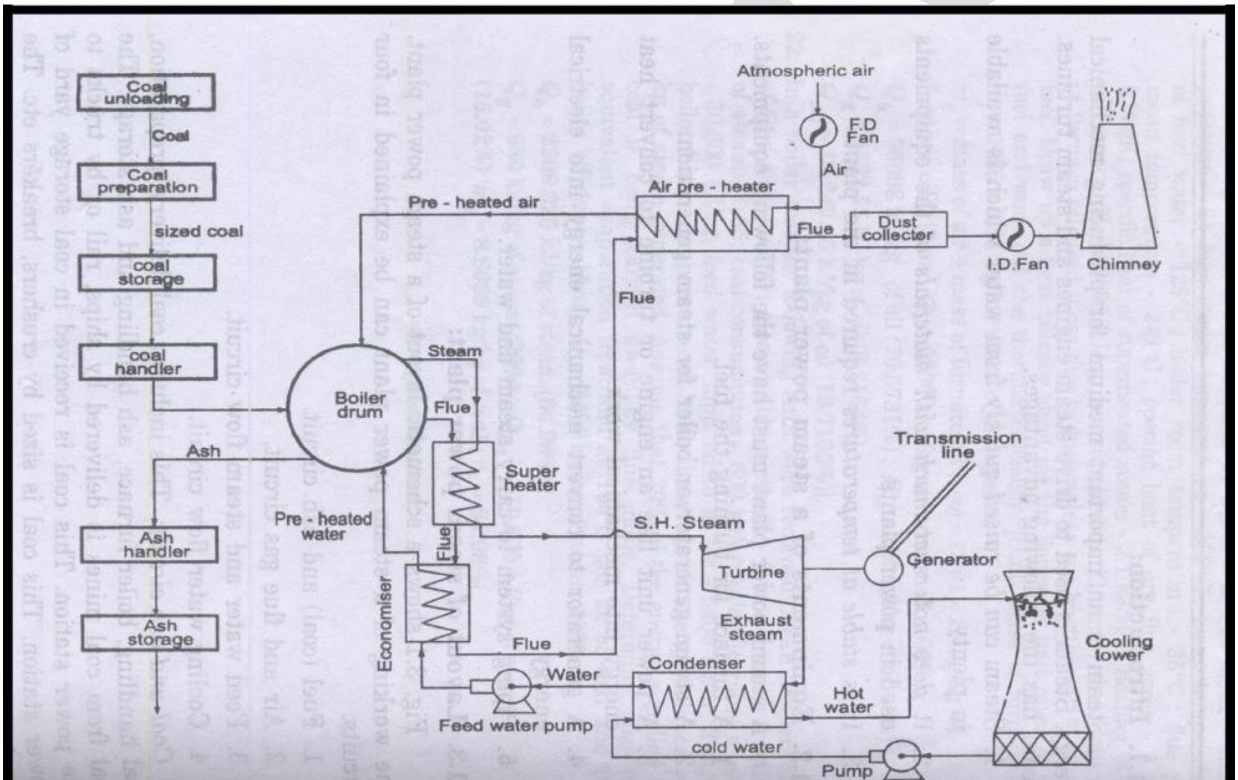
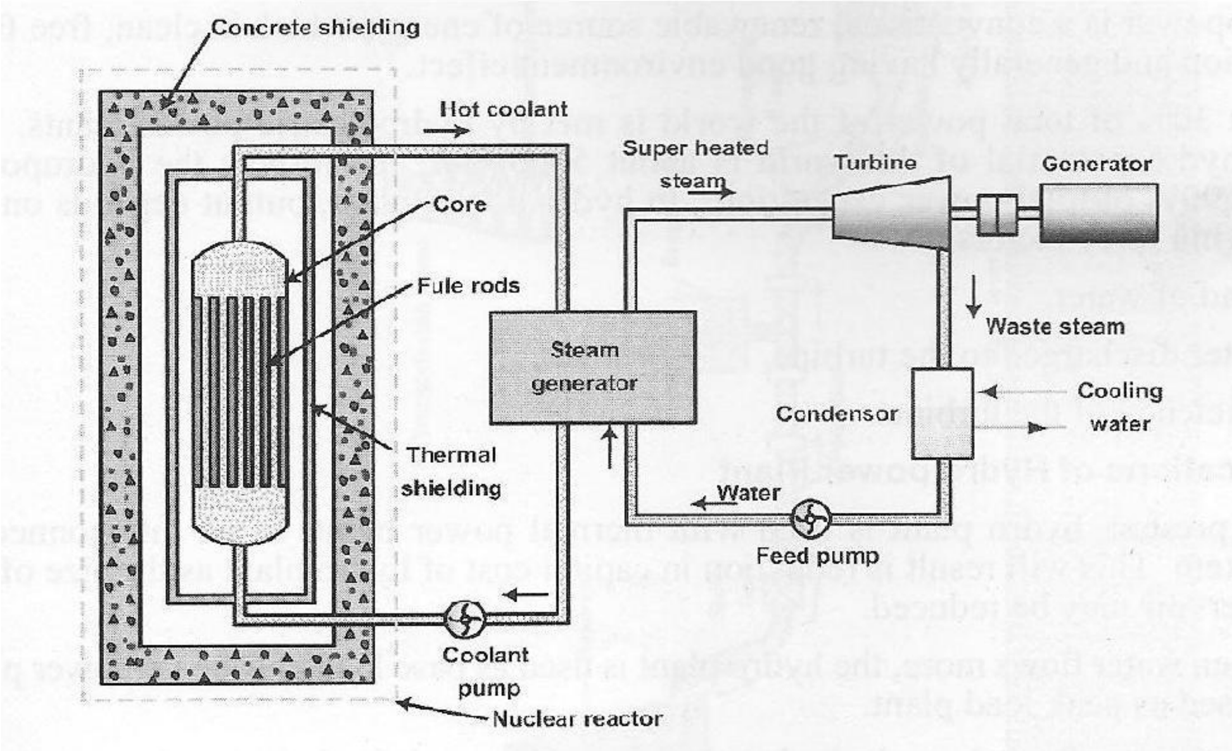
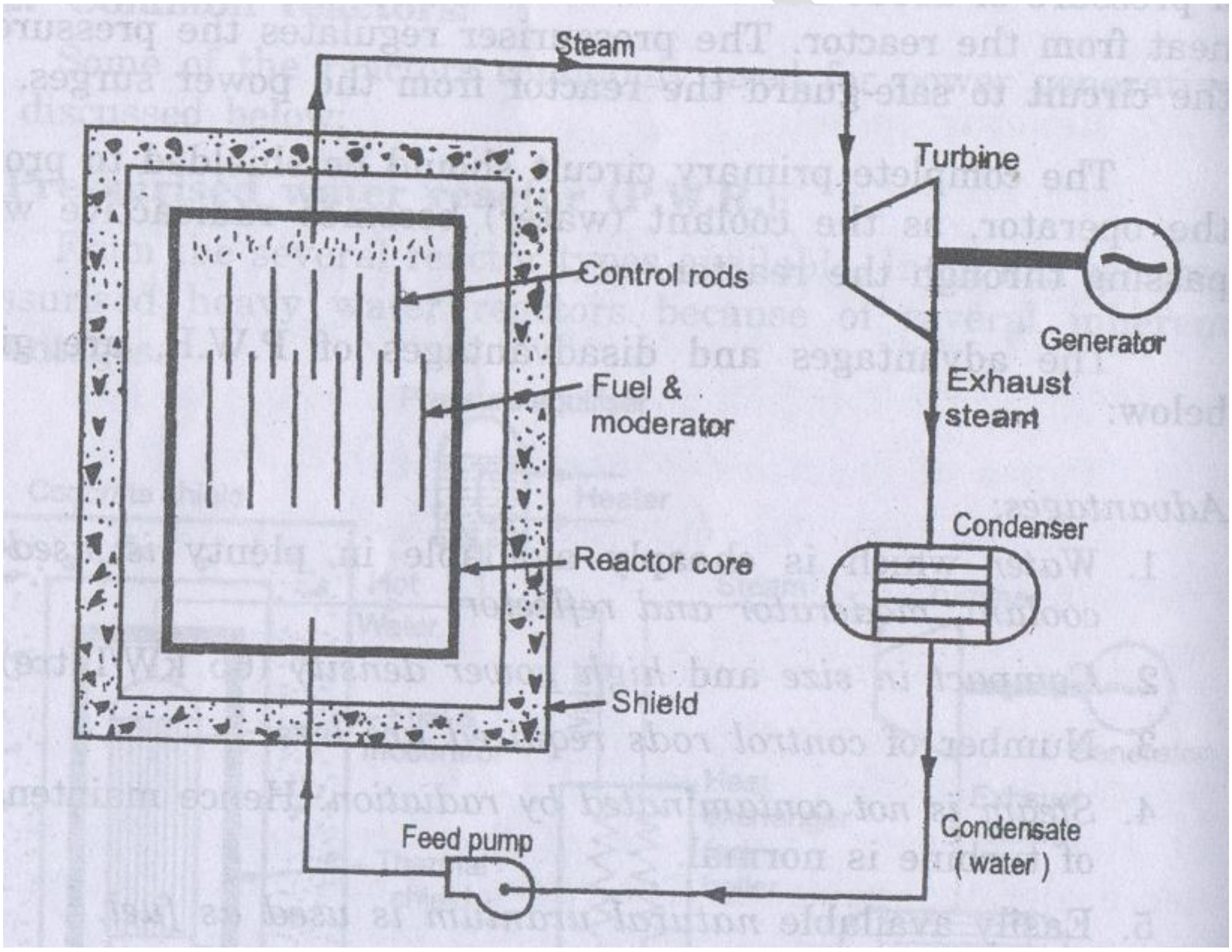


Fig 3.1. Layout of a steam power plant.

2. Demonstrate the layout of nuclear power plant and explain the nuclear fission its merits and demerits.(13)





• Nuclear power plant uses nuclear energy from radioactive element for generating electrical energy.
• More than 15% of the world's electricity i
• It is generally located far away from populated areas.
• In future generation of electricity will be depending on Nuclear Power Plant, as it is economical.

• 1 kg of uranium U -235 can produce electrical power electrical that can be produced by using 3000 -4500 tonnes of high grade coal or 2000 tonnes of oil.

COMPONENTS OF NUCLEAR POWER PLANT:

Nuclear Fuel :

Normally used nuclear fuel is uranium (U235)

Fuel Rods:

The fuel rods hold nuclear fuel in a nuclear power plant.

Neutron Source: A source of neutron is required to initiate the fission for the first time. A mixture of beryllium with plutonium is commonly used as a source of neutron.

Reactor:

• Nuclear fission takes place in the reactor only.
• Nuclear fission produces large quantity of heat.
• The heat generated in the reactor is carried by coolant circulated through the reactor.

Control Rods:

• They are used to control the chain reaction.
• They are absorbers of neutrons.
• The commonly used control rods are made up of cadmium or boron.

Moderator:

• Moderators are used to slow down the fast neutrons.
• It reduces 2 MeV to an average velocity of 0.025 eV.
• Ordinary or heavy water are used as moderators.

Fuel Rods:

• The fuel rods hold nuclear fuel in a nuclear power plant.

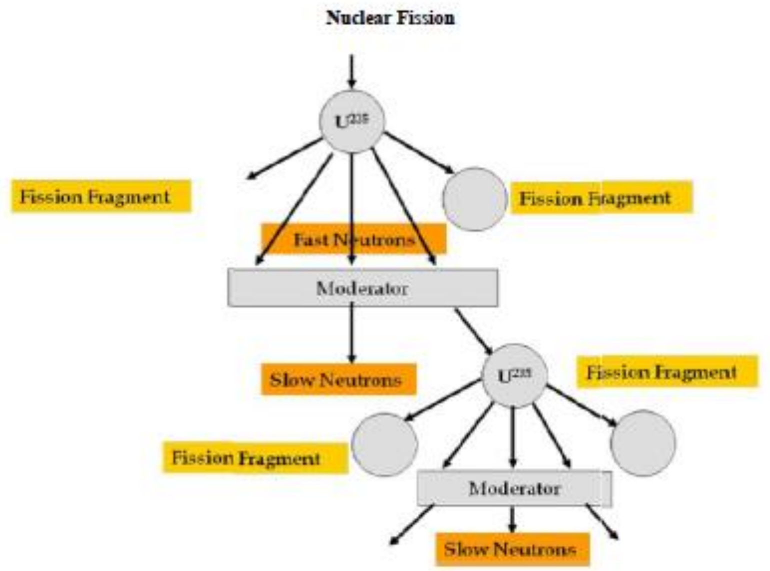
Neutron Reflectors:

• To prevent the leakage of neutrons to large extent.
• In PHWR, the moderator itself acts as reflectors.

Shielding:

• To protect from harmful radiations the reactor is surrounded b a concrete wall of thickness about 2 to 2.5 m.

• It is a process of splitting up of nucleus of fissionable material like uranium into two or more fragments with release of enormous amount of energy.
• The nucleus of U235 is bombarded with high energy neutrons
U235+0n1 Ba 141+Kr92+2.50n1+200 MeV energy.
• The neutrons produced are very fast and can be made to fission other nuclei of U235, thus setting up a chain reaction.
• Out of 2.5 neutrons released one neutron is used to sustain the chain reaction.
1 eV = 1.6X10-19 joule.
1 MeV = 106 Ev



WORKING PRINCIPLE:

• The heat generated in the reactor due to the fission of the fuel is taken up by the coolant.
• The hot coolant then leaves the reactor and flows through the steam generator.
• In the steam generator the hot coolant transfers its heat to the feed water which gets converted into steam.
• The steam produced is passed through the turbine, which is coupled with generator.

• Hence the power is produced during the running of turbine.
• The exhaust steam from the turbine is condensed in the condenser.
• The condensate then flows to the steam generator through the feed pump.
• The cycle is thus repeated.

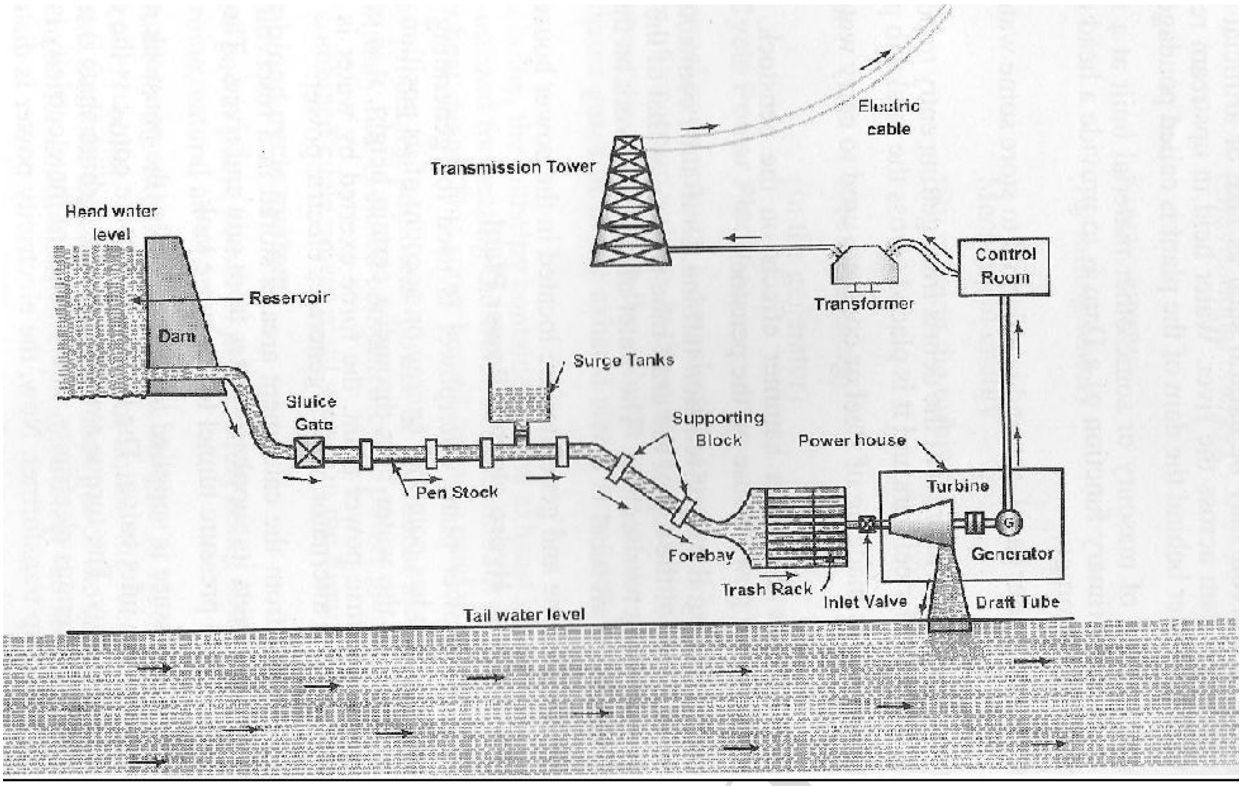
Advantages of Nuclear Power Plant:

• Requires less space compared to steam power plant.
• Fuel required is negligible compared to coal requirement.
• Fuel transport cost is less.
• Reliable in operation.
• Cost of erection is less.
• Water required is very less.

Disadvantages of Nuclear Power Plant:

• Initial Cost is higher.
• Not suitable for varying load condition.
• Radioactive wastes are hazardous. Hence these are to be handled with much care.
• Maintenance cost is higher.
• Trained workers are required to operate the plant.

3. **Explain the working principle of hydroelectric power plant with neat sketch and state the merits and demerits.(13)**



COMPONENTS OF HYDRO ELECTRIC POWER PLANT:

Reservoir :

• Water is collected during rainy season

• It is stored in the reservoir.
• A dam is built across the river adequate water head.

Penstock :

• It is a passage through which water flows from reservoir to turbine.

Surge Tank :

• It is installed along the penstock (between turbine and reservoir)
• To control or regulate the sudden water over flow and to protect the penstock from bursting.
• It reduces the pressure and avoids damage to the penstock due to the **water hammer** effect.
• When the load on the turbine is decreased there will be a back flow, which causes increase or decrease in pressure. It is known as water hammer.
• Power House :
• It is building that houses that water turbine, generator, transformer and control room.
• Water Turbine:
• Water turbines such as Pelton, Kaplan and Francis are used to convert pressure and kinetic energy of flowing water into mechanical energy.
• Draft Tube:
• It is connected to the outlet of the turbine.
• Tailrace:
• It refers to the downstream level of water discharged from turbine.
• Generator :
• It is a machine used to convert mechanical energy into electrical energy.
• Step up transformer:
• It converts the Alternating Current (AC) into high voltage current suitable for transmission.

WORKING PRINCIPLE OF HYDRO ELECTRIC POWER PLANT:

• It uses the potential energy of water of water stored in a reservoir.

• The water from the reservoir through a penstock and then forced through nozzle or nozzles before reaching the turbine.
• The hydraulic turbine converts the kinetic energy of water under pressure into mechanical energy.
• The shaft of the turbine is coupled to a generator that generates electricity
• The electricity generated is fed to the step-up transformer to increase its voltage.
• Power is fed to the transmission lines for distribution.
• The output power of Hydel power plant depends on the head of water stored in the reservoir and the quantity of water discharged

4. **Explain the working principle of Open and closed cycle gas turbine power plant with neat sketch and state the merits and demerits.(13)**

GAS POWER PLANT
• A gas power plant uses gas turbine as the prime mover for generating electricity.
• It uses natural gas or kerosene or benzene as fuel.
• Gas plant can produce only limited amount of the electricity.
• Efficiency of the plant is only 35%
• Generally a gas plant is expensive to operate.

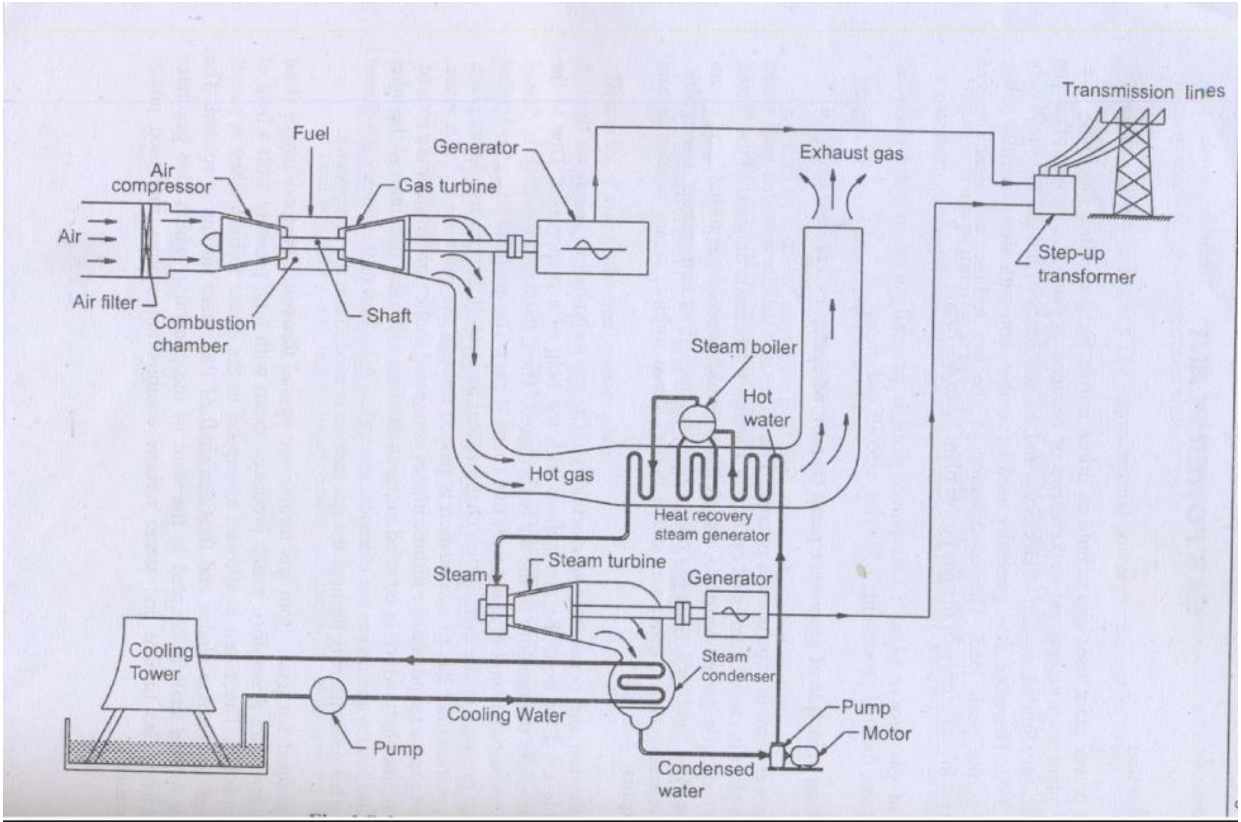
• Hence it is usually installed with steam power plant in closed combined cycle.
• It is generally used in combination with steam/thermal power plant during peak load
• When the gas power plant is combined with thermal/steam power plant efficiency of the plant is up to 60% - 70%

Combustion and generation of electricity:
• Gas turbine draws clean air into through air filter from atmosphere, with the help of a compressor.
• During the compression pressure of the air is increased.
• Compressed air is passed through to a combustion chamber along with fuel (Natural gas).
• The air fuel mixture is ignited at high pressure in the combustion chamber.

• Combustion takes place.
• The generated hot gas of compression is passed through the gas turbine.
• Hot gases expand, and the turbine blades are connected to the turbine shaft are rotated.
• The turbine shaft which is coupled to the shaft of the electrical generator at the other end also rotates and drives the electrical generator.
• A portion of the energy developed by the hot gases through the gas turbine is used to run the compressor.
• The residual hot gases from gas turbine are passed through a heat exchanger (heat recovery steam generator)
• The heat exchanger produces steam with high pressure with the help of a steam boiler.
• The steam is allowed to expand in the steam turbine.
• when it passes through the turbine blades, the turbine shaft is rotated. The shaft is coupled to the generator, which generates electricity.
• Gas turbine and steam turbine combination enables increased power generation.
Transmission and distribution :
• The generated electricity from both gas and steam turbines is fed to the step up transformer where its voltage is increased.
• Then the electricity is conveyed through transmission lines for distribution.
Merits:
Natural gas is readily available.
• Setting up cost can be reduced if the plant is installed near the source of natural gas.
• Less gas storage cost
• Less space occupation.

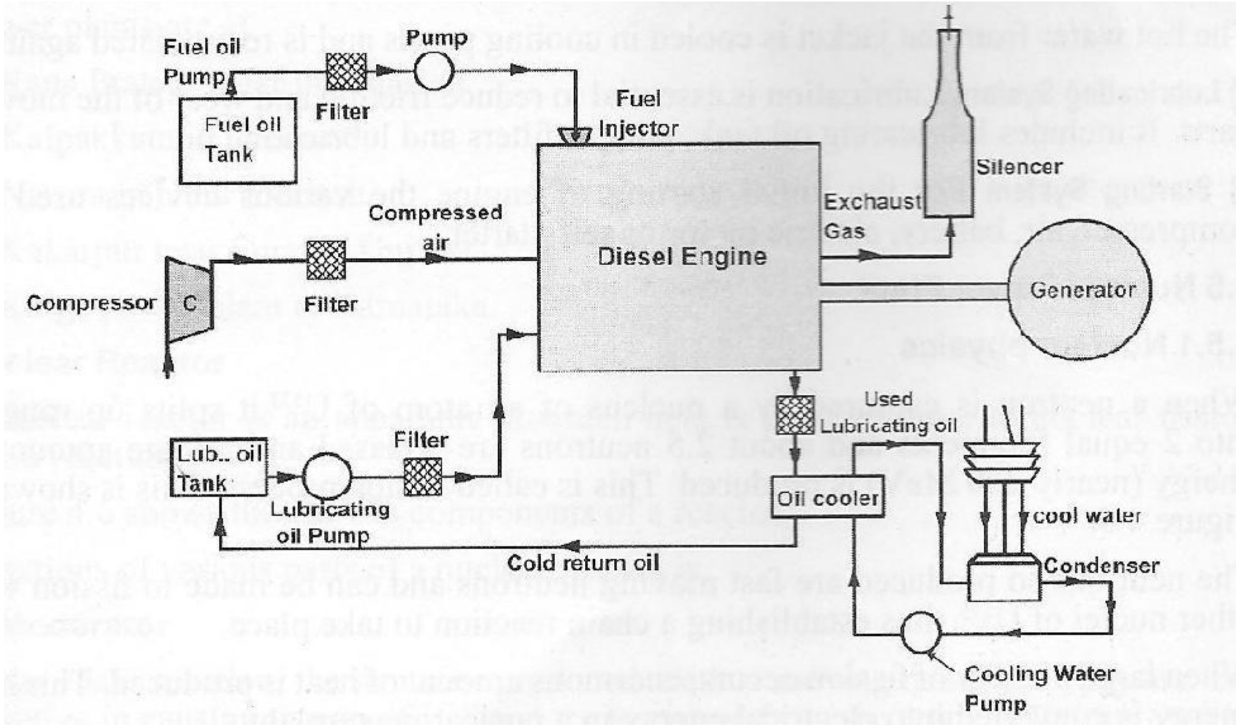
• Compared to steam power plant, smaller in size.
• Low operating cost.
• Low maintenance cost.
• No standby losses.
• Cheaper fuels like natural gas.

Demerits:
• Gas turbine has low thermal efficiency.
• Has starting problem.
• Efficient only in combined cycle configuration.
• Temperature of combustion chamber is too high, which results in shorter life time.



PART-C

1. Explain the working principle of Diesel power plant with neat sketch and state the merits and demerits.(15)



WORKING OF DIESEL POWER PLANT:

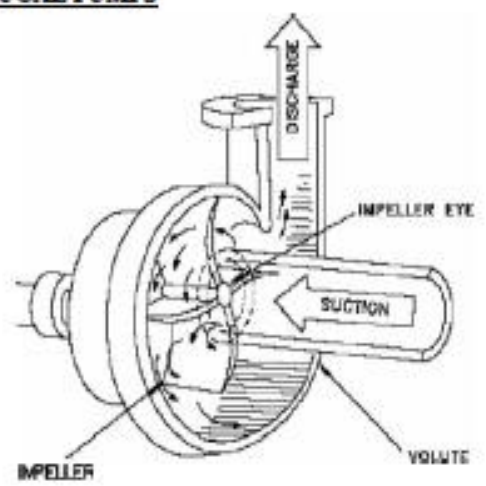
• Air from atmosphere is drawn into the compressor and is compressed.
• The compressed air is sent to diesel engine through filter.
• In the filter, dust, dirt from air are filtered and only clean air is sent to diesel engine.
• Fuel oil from tank is passed through filter where it gets filtered and clean oil is injected into the diesel engine through fuel pump and fuel injector
• Mixture of compressed air and spray of fuel oil are ignited into the engine and combustion takes place.
• The heat energy is utilized for driving the generator, which produces power.

MAIN COMPONENTS OF A DIESEL POWER PLANT:

1. **Fuel Supply system**
It consists of fuel tank, fuel filter and fuel pump and injector.
2. **Air Intake and Exhaust system**
It consists of compressor, filter and pipes for the supply of air and pipes for exhaust gases. In the exhaust system silencer is provided to reduce the noise.
3. Cooling system
Circulates water around the Diesel engines to keep the temp at reasonably low level.
4. Lubricating system
It includes lubricating oil tank, pump, filters and lubricating oil.
5. Starting system
For initial starting the devices used are compressed air, battery, electric motor or self-starter.

2. **Explain the working principle of centrifugal pump with neat sketch.(15)**

CENTRIFUGAL PUMPS



COMPONENTS OF CENTRIFUGAL PUMP:

- A rotating component comprising of an impeller and a shaft.
- A stationery component comprising a volute (casing), suction and delivery pipe.

WORKING PRINCIPLE OF CENTRIFUGAL PUMP:

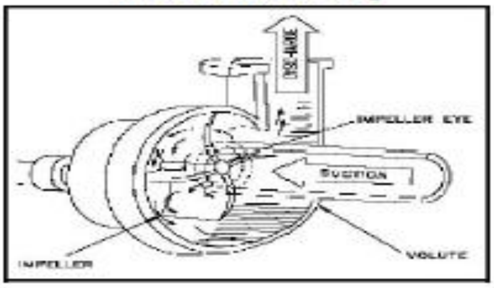
Principle:

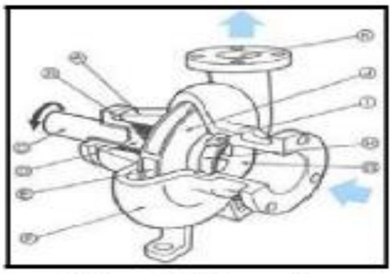
When a certain mass of fluid is rotated by an external source, it is thrown away from the central axis of rotation and a centrifugal head is impressed which enables it to rise to a higher level.

Working:

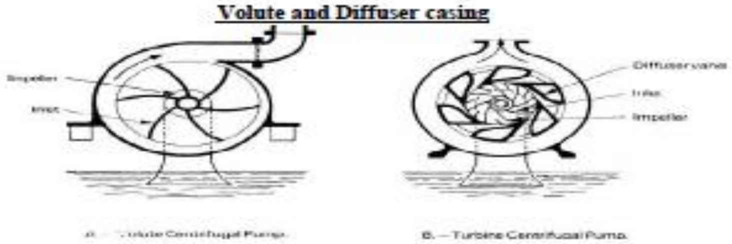
- The delivery valve is closed and the pump is primed, so that no air pocket is left.
- Keeping the delivery valve still closed the electric motor is started to rotate the impeller.
- The rotation of the impeller is gradually increased till the impeller rotates at its normal speed.
- After the impeller attains the normal speed the delivery valve is opened when the liquid is sucked continuously upto the suction pipe.
- It passes through the eye of the casing and enters the impeller at its centre.
- The liquid is impelled out by the rotating vanes and it comes out at the outlet tips of the vanes into the casing.
- Due to the impeller action the pressure head as well as the velocity heads are increased.
- From the casing the liquid passes into the pipe and lifted to the required height.
- When pump is to be stopped the delivery valve is to be first closed, otherwise there may be some backflow of water into the reservoir.

Types of casing
Volute and Vortex Casing





Volute and Diffuser casing



Volute Casing: In this type of casing the area of flow gradually increases from the impeller outlet to the delivery pipe.

Vortex Casing:

If a circular chamber is provided between the impeller and volute chamber the casing is known as Vortex Chamber.

Diffuser C :

- The impeller is surrounded by a diffuser.
- The guide vanes are designed in such a way that the water from the impeller enters the guide vanes without shock.
- It reduces the vibration of the pump.
- Diffuser casing, the diffuser and the outer casing are stationery parts.

Priming of a centrifugal Pump:

- The operation of filling the suction pipe, casing and a portion of delivery pipe with the liquid to be raised, before starting the pump is known as Priming
- It is done to remove any air, gas or vapour from these parts of pump.
- If a Centrifugal pump is not primed before starting air pockets inside impeller may give rise to vortices and causes discontinuity of flow

Losses in Centrifugal pump:

Hydraulic Losses:

- Shock or eddy losses at the entrance to and exit from the impeller
- Losses due to friction in the impeller
- Friction and eddy losses in the guide vanes/diffuser and casing

Mechanical Losses:

- Losses due to disc friction between the impeller and the liquid which fills the clearance spaces between the impeller and casing
- Losses pertaining to friction of the main bearing and glands.

Specific speed of Centrifugal Pump:

• It is the speed in revolutions per minute at which a geometrically similar impeller would deliver one cubic meter of liquid per second against a delivery head of one meter.

3. Differentiate between the Impulse and Reaction turbine.

IMPULSE TURBINE:

• The steam coming out at a very high velocity through the nozzle impinges on the blades fixed on the periphery of rotor.
• The blades change the direction of steam flow without change in pressure.
• The resulting force causes the rotation of the turbine.
E.g Pelton wheel.

REACTION TURBINE:

• The high pressure steam from the boiler is passed through the nozzles.
• When the steam comes out through these nozzles, the velocity of steam increases relative to the rotating disc.

S.No.	Impulse Turbine	Reaction Turbine
1	It consists of nozzles and moving blades	It consists of fixed blades which act as nozzles and moving blades
2	Steam is expanded completely in the nozzle. All the pressure energy is converted into kinetic energy	Steam is partially expanded in the fixed blades. Some amount of pressure energy is converted into kinetic energy
3	Pressure of steam is constant over the moving blades.	Pressure drop takes place in the moving blades.
4.	Because of high pressure drop in the nozzles, blade speed and steam speed are high.	Because of small pressure drop, blade speed and steam speed are less.
5.	Low Efficiency	High Efficiency
6.	Occupies less space per unit power	Occupies more space per unit power.

5. Explain the components of internal combustion engine with neat sketch.(15)

MAIN COMPONENTS OF IC ENGINES:

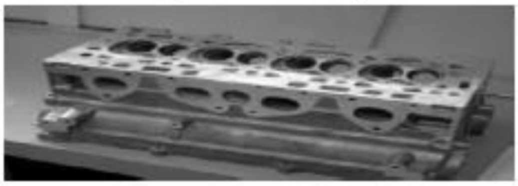
Cylinder Block:

• It is the main block of the engine.
• It contains cylinders accurately finished to accommodate pistons
• The cylinder block houses crank, camshaft, piston and other engine parts.

• In water cooled engines, the cylinder block is provided with water jackets for the circulating cooling water.
• The materials used for cylinder are grey cast iron, aluminium alloys etc.,
• It is usually made of a single casting


Cylinder block of motor cycle


Cylinder block of car



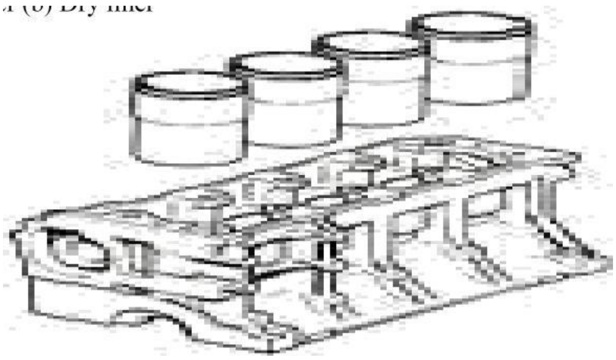
Cylinder Head:

• The cylinder head is bolted to the cylinder Block by means of studs.
• The water jackets are provided for cooling water circulation.

• The materials used for cylinder head are cast iron, aluminium alloy etc.,
• This is also generally made of single cast iron.

Cylinder Liners:
• The liner is a sleeve which is fitted into the cylinder bore.
• It provides wear resisting surface for the cylinder bores.

Liners are classified into:
• (a) Wet liner (b) Dry liner



Wet Liner : These liners are surrounded or wetted by cooling water. It provides wear resisting surface for the piston to reciprocate. Also it acts as a seal for the water jacket
Dry Liner : Dry liners have metal to metal contact with the cylinder block. They are not directly in touch with the cooling water.

Liner Materials:
• Liner material should withstand abrasive wear and corrosive.Chromium plated mild teel
• tubes are used as liners.

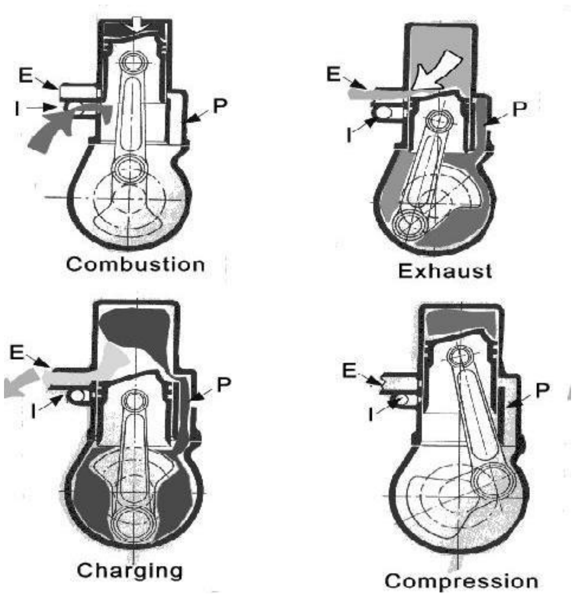
Crankcase : It may be cast integral with the cylinder block.Some times, it is cast separately and then attached to the block. These materials are used for crank case are cast iron, aluminium alloys or alloy steels.

Oil pan or oil sump:
Oil sump is the bottom part of the engine.It contains lubricating oil.A drain plug is provided the oil sump to drain out the oil.It is made of the pressed sheet.

Piston :
The piston serves the following purposes
• It acts as a movable gas tight seal to keep the gases inside the cylinder
• It transmits the force of explosionin the cylinder to the crankshaft through the connecting rod.
• Some of the materials used for piston are cast iron, aluminium alloy, chrome nickel alloy, nickel iron alloy and cast steel.

Piston rings :
Piston rings are inserted in the grooves provided in the piston. Two types of piston rings are used in the piston.
1. Compression rings, 2. Oil rings or oil control rings

6.**Describe the principal, parts and functions of a Two Stroke Petrol engine with neat sketch.(15)**

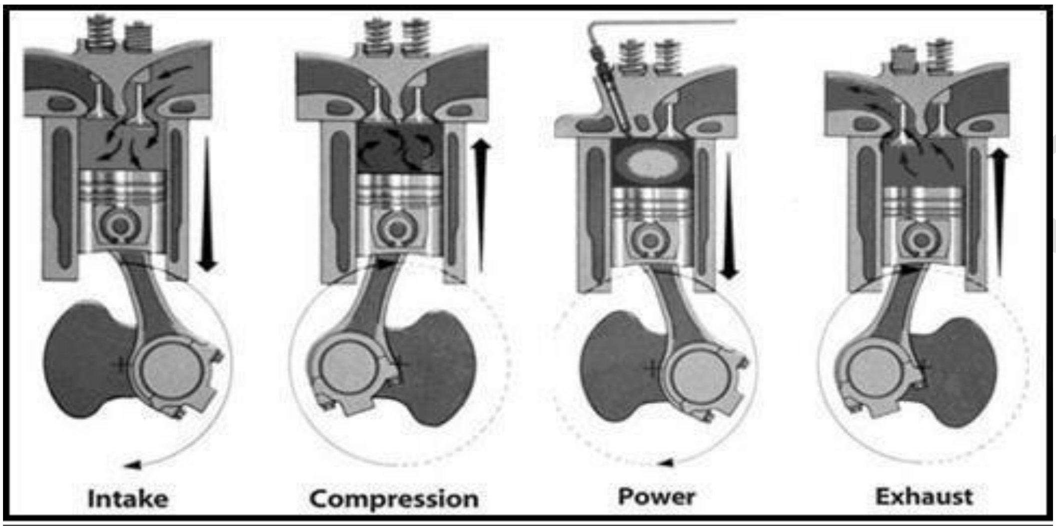


Two Stroke Cycle Petrol Engine - Construction
Construction :
• A piston reciprocates inside the cylinder
• It is connected to the crankshaft by means of connecting rod and crank
• There are no valves in two stroke engines, instead of valves ports are cut on the cylinder walls.
• There are three ports, namely inlet, exhaust and transfer ports.
• The closing and opening of the ports are obtained by the movement of piston. The crown of piston is made in to a shape to perform this.
• A spark plug is also provided.
First Stroke : (Compression, ignition and inductance) (Upward stroke of piston)
(a) **compression:**
• The piston moves up from Bottom Dead Centre (BDC) to Top Dead Centre (TDC)
• Both transfer and exhaust ports are covered by the piston.
• Air fuel mixture which is transferred already into the engine cylinder is compressed by moving piston.
• The pressure and temperature increases at the end of compression.

First Stroke : (Compression, ignition and inductance) (Upward stroke of piston)
(b) Ignition and Inductance:
• Piston almost reaches the top dead centre
• The air fuel mixture inside the cylinder is ignited by means of an electric spark
• produced by a spark plug
• At the same time, the inlet port is uncovered by the plane.
• Fresh air fuel mixture enters the crankcase through the inlet port.
Second Stroke: (Downward Stroke of the engine) :
(c)Expansion and Crankcase compression
• The burning gases expand in the cylinder
• The burning gases force the piston to move down. Thus useful work is obtained.
• When the piston moves down, the air fuel mixture in the crankcase is partially compressed. This compression is known as **Crank case compression.**
Second Stroke: (Downward Stroke of the engine) :
(d) Exhaust and transfer:

• At the end of expansion, exhaust port is uncovered.
• Burnt gases escape to the atmosphere.
• Transfer port is also opened. The partially compressed air fuel mixture enters the cylinder through the transfer port.
• The crown of the piston is made of a deflected shape. So the fresh charge entering the cylinder is deflected upwards in the cylinder.
• Thus the escape of fresh charge along with the exhaust gases is reduced.

7. Describe the principal, parts and functions of a Four stroke diesel engine With neat sketch.(15)



Construction:
• A piston reciprocates inside the cylinder
• The piston is connected to the crankshaft by means of a connecting rod and crank.
• The inlet and exhaust valves are mounted on the cylinder head.
• A fuel injector is provided on the cylinder head
• The fuel used is diesel.
(a) Suction Stroke (First Stroke of the piston)
• Piston moves from TDC to BDC
• Inlet valve is opened and the exhaust valve is closed.
• The pressure inside the cylinder is reduced below the atmospheric pressure.
• Fresh air from the atmosphere is sucked into the engine cylinder through air cleaner and inlet valve.
(b) Compression stroke (Second stroke of the piston)
• Piston moves from BDC to TDC
• Both inlet and exhaust valves are closed.
• The air is drawn during suction stroke is compressed to a high pressure and temperature
(c) Working or power or expansion stroke (Third stroke of the piston)
• The burning gases (products of combustion) expand rapidly.
• The burning gases push the piston move downward from TDC to BDC
• This movement of piston is converted into rotary motion of the crank shaft through connecting rod.
• Both inlet and exhaust valves are closed.

d) Exhaust Stroke (Fourth stroke of the piston)
• Piston moves from BDC to TDC
• Exhaust valve is opened the inlet valve is closed.
• The burnt gases are forced out to the atmosphere through the exhaust valve. (some of the burnt gases stay in the clearance volume of the cylinder)
• The exhaust valve closes shortly after TDC

• **UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM 10**
Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system–Layout of typical domestic refrigerator–Window and Split type room Air conditioner.

1. Define the term refrigeration effect? [Nov/Dec 2009, April/May 2018]

Refrigeration is the process of removing heat from the body, to reduce its temperature lower than that of its surroundings.

2. What is refrigeration? Name any two common refrigerants used in refrigerators? [Nov/Dec 2011]

Refrigeration is the process of removing heat from the body, to reduce its temperature lower than that of its surroundings. Some commonly used refrigerants are

- Ammonia (NH3)
- Carbon di oxide (CO_2)
- Freon – 12 (CCl_2F_2)
- Freon – 22 ($CHClF_2$)
- Sulphur di oxide (SO_2)

3. Name any four refrigerants? [Nov/Dec 2010]

Some commonly used refrigerants are

- Ammonia (NH3)
- Carbon di oxide (CO2)
- Freon – 12 (CCl2F2)
- Freon – 22 (CHClF2)
- Sulphur di oxide (SO2)

4. Define the unit of refrigeration?

Refrigeration is expressed in terms of tons. One ton of refrigeration is defined as the quantity of heat remove (amount of refrigeration required to freeze one ton of water at 0˚C into ice at 0˚C in 24 hours)

1 ton of refrigeration = 3.5 KJ/sec

5. DefineTonne of refrigeration? [June/July 2010, May/June 2013, May/June 2014, Nov/Dec 2015, April/May 2017, Nov/Dec 2017]

One ton of refrigeration is defined as the quantity of heat remove (amount of refrigeration required to freeze one ton of water at 0˚C into ice at 0˚C in 24 hours)

1 ton of refrigeration = 3.5 KJ/sec

6. What is the capacity of refrigeration? [May/June 2009, April/May 2015]

The capacity of a refrigeration system is expressed by its cooling capacity. It is expressed in terms of tons of refrigeration.

One ton of refrigeration is defined as the quantity of heat remove (amount of refrigeration required to freeze one ton of water at 0˚C into ice at 0˚C in 24 hours)

1 ton of refrigeration = 3.5 KJ/sec

7. Mention the applications of refrigeration? [Nov/Dec 2009]

Refrigeration process is used

- In manufacturing of ice
- For preserving food materials
- For cooling water
- For preserving medicines

8. Define wet bulb temperature?

The temperature of the air which is measured when the bulb of an ordinary thermometer is covered with a wet cloth dipped in a small basin of water.

9. State the role of condenser in vapor compression refrigeration cycles? [Nov/Dec 2012]

Condenser is used to condense the refrigerant which is in form of vapor and make them into liquid. The condenser is a coil of tubes, which is made of copper.

10. Differentiate vapor compression and vapor absorption system? [Nov/Dec 2016]

Vapour Compression System	Vapour Absorption System
• It works on vapor compression cycle • Freon – 12 is most commonly used refrigerant • COP is much higher (4 to 10)	• It works on vapor absorption cycle • Ammonia is most commonly used refrigerant • COP is less than 2

11. Define the term 'Air conditioning'? [April/May 2011, April/May 2015]

Air conditioning is the process of controlling and maintaining the properties of air like temperature, humidity, purity, direction of flow etc., in a closed space.

12. Define relative humidity?
[May/June 2016]

It is defined as the ratio of mass of water vapor in a given volume of air at the given temperature to the mass of water vapor present in the same volume and temperature on the air when fully saturated.

13. What are the needs for comfort air conditioning? [May/June 2014, Nov/Dec 2014, April/May 2017]

- Humidity of air
- Temperature of air
- Purity of air
- Movement of air
- Percentage of oxygen and carbon – di – oxide

14. Name any two commonly used refrigerants in air conditioners? [May/June 2012, Nov/Dec 2016]

Some commonly used refrigerants are

- Freon – 12 (CCl_2F_2)
- Freon – 22 ($CHClF_2$)
- Sulphur di oxide (SO_2)
- Methylenechloride(CH_2Cl_2)

15. Write the advantages and disadvantages of a window room-air-conditioner? [May/June 2009]

Advantages:

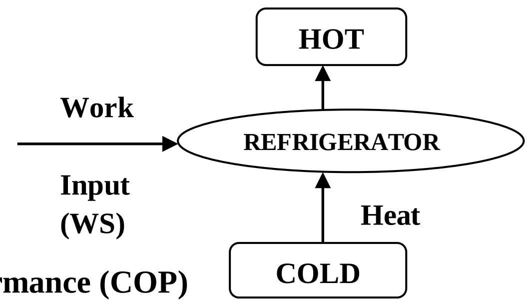
- Ducts are not required for air distribution
- Installation is simple and plumbing is not required

Disadvantages:

- Not suitable for large halls
- Installation must be made only on an external wall of the room

16. State the second law of thermodynamics in refrigeration?

It states that heat does not flow from a low temperature body to a high temperature body without the help of an external work.



17. Define Coefficient of performance (COP) [Nov/Dec2014, April/May 2016]

- It is defined as the ratio of heat extracted in a given time (refrigerating effect) to the work input.
- Co efficient of performance= Refrigerating Effect/Work Inpu

18. Mention the two differences between unitary and centralized air conditioning system? [April/May 2016]

Unitary system as name indicates used for unit or single area normally comes in small capacities and cooling can be done by either way. Central air conditioning is a method of structural cooling in which a centralized unit cools and dehumidifies air before circulating it throughout a building. This is in direct contrast with systems that rely on individual units in rooms or suites of rooms

19. Why evaporator is placed in the top portion of the refrigerator? [Nov/Dec 2015]

Because if you cool the air at top, it'll become denser (because of contracting), thus heavy and travel downward. This air will replace the hot air at the bottom portion, causing hot air to move up and get cooled.

So, it is for natural convection to set up that we keep evaporator at the top. Additionally, refrigerators have a deep freezer at the top, around which the evaporator is placed to maintain a even more cooler space.

20. What is the purpose of a fusible plug in a boiler? [May/June 2012]

The initial use of the fusible plug was as a safety precaution against low water levels in steam engine boilers, but later applications extended its use to other closed vessels, such as air conditioning systems and tanks for transporting corrosive or liquefied petroleum gasses.

21. What is scavenging? [April/May 2011]

In the two-stroke petrol engine, the exhaust gases are removed from the cylinder with the help of fresh compressed charge. This process of removing exhaust gases is called Scavenging.

22. Mention the types of air conditioning.

1. Comfort air conditioning
2. Industrial air conditioning

23. State the function of compressor.

Compressor is used to compress the lower pressure vapour refrigerant.

24. What is the function of thermostat? [April / May 2018]

The refrigerator thermostat, which is generally located inside the appliance, is the controlling device that allows users to adjust the temperature inside the fridge. This device controls the cooling system, which includes the condenser, the compressor, the evaporator, and the metering device.

25. What are the various properties of refrigerants? [Nov/Dec 2017]

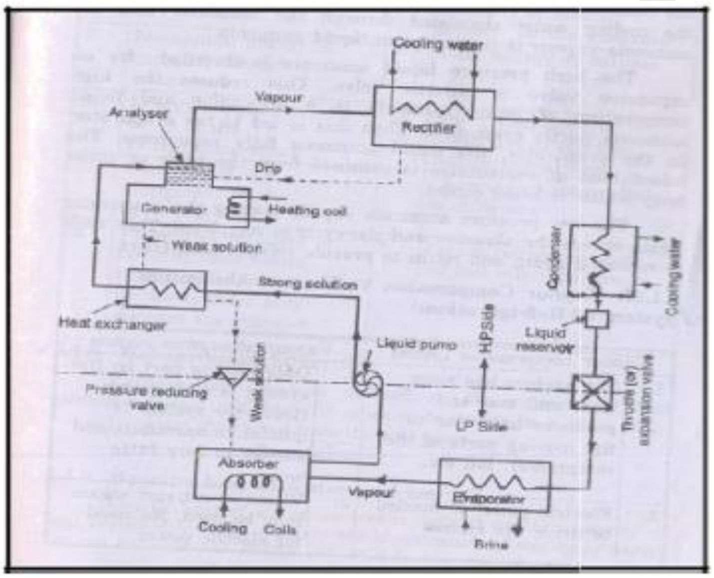
- It has low freezing point and boiling point
- It should be easily liquefied
- It should have high COP
- It should absorb high latent heat

PART-B

1. **Describe with neat sketch of vapour absorption refrigeration system.(13)**
   Construction:
    The vapour absorption system consists of a condenser, an expansion valve and an evaporator.
    They perform the same as they do in vapour compression method.
    In addition to these, this system has an absorber, a heat exchanger, an analyser and rectifier.

Working:

• Dry ammonia vapour at low pressure passes in to the absorber from the evaporator.
• In the absorber the dry ammonia vapour is dissolved in cold water and strong solution of ammonia is formed.
• Heat evolved during the absorption of ammonia is removed by circulating cold water through the coils kept in the absorber.
• The highly concentrated ammonia (known as Aqua Ammonia) is then pumped by a pump to generator through a heat exchanger.



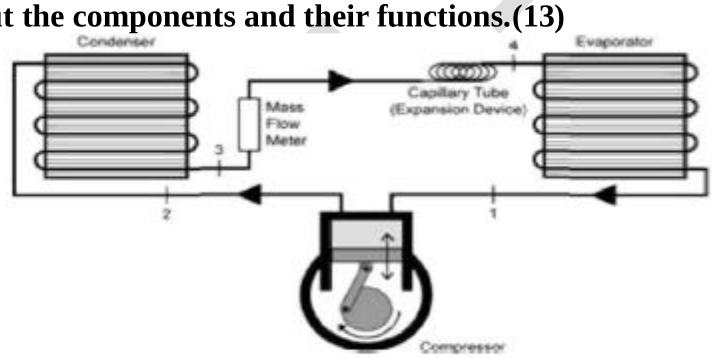
• In the heat exchanger the strong ammonia solution is heated by the hot weak solution returning from the generator to the absorber.
• In the generator the warm solution is further heated by steam coils, gas or electricity and the ammonia vapour is driven out of solution.
• The boiling point of ammonia is less than that of water.
• Hence the vapours leaving the generator are mainly of ammonia.
• The weak ammonia solution is left in the generator is called weak aqua.
• This weak solution is returned to the absorber through the heat exchanger.
• Ammonia vapours leaving the generator may contain some water vapour.
• If this water vapour is allowed to the condenser and expansion valve, it may freeze resulting in chocked flow.
• Analyser and rectifiers are incorporated in the system before condenser.
• The ammonia vapour from the generator passes through a series of trays in the analyser and ammonia is separated from water vapour.
• The separated water vapour returned to generator.

• Then the ammonia vapour passes through a rectifier.
• The rectifier resembles a condenser and water vapour still present in ammonia vapour condenses and the condensate is returned to analyser.
• The virtually pure ammonia vapour then passes through the condenser.
• The latent heat of ammonia vapour is rejected to the cooling water circulated through the condenser and the ammonia vapour is condensed to liquid ammonia.
• The high pressure liquid ammonia is throttled by an expansion valve or throttle valve.
• This reduces the high temperature of the liquid ammonia to a low value and liquid ammonia partly evaporates.
• Then this is led to the evaporator.
• In the evaporator the liquid fully vaporizes.
• The latent heat of evaporation is obtained from the brine or other body which is being cooled.
• The low pressure ammonia vapour leaving the evaporator again enters the absorber and the cycle is completed.
• This cycle is repeated again to provide the refrigerating effect.

Applications of refrigeration system:

- Preservation of food items like vegetables, milk and eggs.
- Preservation of medicines.
- Preservation of blood, tissues, etc.,
- Preservation and cooling of cool drinks.
- Preservation of chemicals (Chemical industries)
- Cooling of water.
- Industrial and comfort airconditioning.
- Processing of dairy products.

2. **Describe with neat sketch of vapour compression refrigeration system. List out the components and their functions.(13)**



Construction:

- This system consists of a compressor, condenser, a receiver tank, an expansion valve and an evaporator.
- **Compressor :** Reciprocating compressors generally used. For very big plants centrifugal compressors directly coupled with high speed rotating engines (gas turbine) are used.
- For very big plantsCentrifugal compressors directly coupled with high speed rotating engines (gas turbine) are used
- **Condenser :** It is a coil of tubes made of copper.
- **Receiver tank:** It is the reservoir of liquid refrigerant.
- **Expansion Valve:** This is a throttle valve. High pressure refrigerant is made to flow at

a controlled rate through this valve.

 Evaporator : It is the actual cooler and kept in the space to be cooled. The evaporator is a coil of tubes made of copper

3. **Compare the vapour absorption refrigeration system and vapour compression refrigeration system. Give either reason or brief exSplanation for each point of comparison.(13)**

S.No.	Vapour Compression System	Vapour Absorption System
1.	This system has more wear and tear and produces more noise due to the moving parts of the compressor.	Only moving part in this system is an aqua pump. Hence the quieter in operation and less wear and tear
2.	Electric power is needed to drive the system	Waste of exhaust steam may be used. No need of electric power
3.	Capacity of the system drops rapidly with lowered evaporator pressure	Capacity of the system decreases with the lowered evaporative pressure, by increasing the steam pressure in generator.
4.	At partial loads performance is poor.	At partial loads performance is not affected.
5.	Mechanical energy is supplied through compressor	Heat energy is utilized
6.	Energy supplied is ¼ to ½ of the refrigerating effect	Energy supplied is about one and half times the refrigerating effect
7.	Charging of the refrigerating to the system is easy	Charging of refrigerant is difficult
8.	Preventive measure is needed, since liquid refrigerant accumulated in the cylinder may damage to the cylinder	Liquid refrigerant has no bad effect on the system.

4. How is the air conditioning system classified?(13)

CLASSIFICATION OF AIR CONDITIONING:

Air conditioning systems are classified as

1) According to the purpose

Comfort Air conditioning.

Industrial Air conditioning.

2**) According to Season of the year**

Summer Air conditioning.

Winter Air conditioning.

Year round Air conditioning.

Types of Air conditioners

Room Air conditioners

Winter Air conditioners

Central Air conditioners

Functions of Air conditioners

Cleaning air.

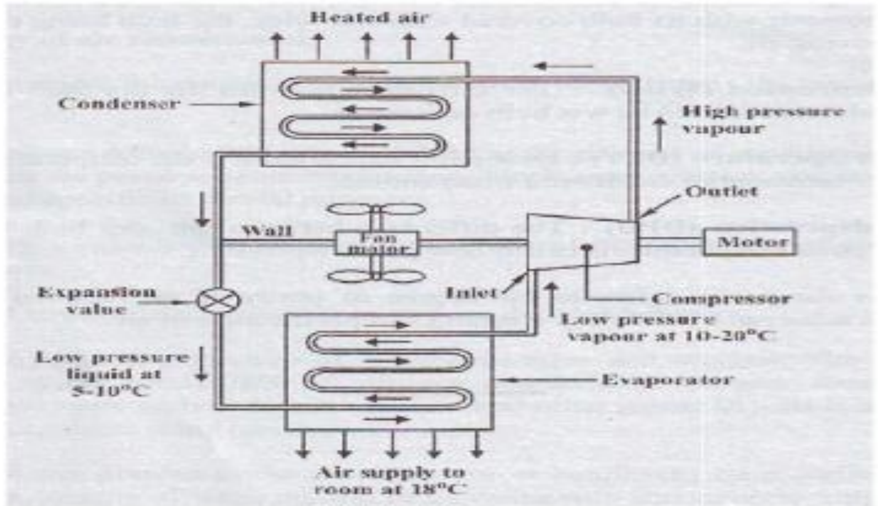
Controlling the temp of air.

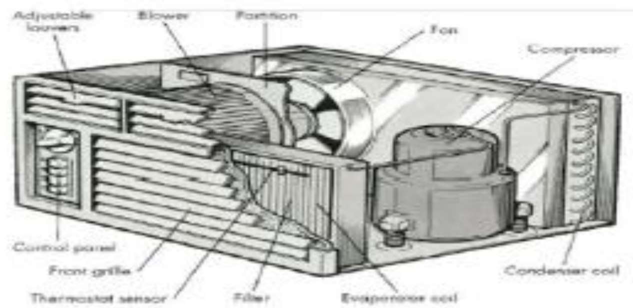
Controlling the moisture content.

Circulating the air.

PART-C

1. **Illustrate with neat sketch the working principle of a window type room air conditioner.(15)**





Construction:

This is also called room air conditioner.

This unit consists of the following.

- A cooling system to cool and dehumidify the air involves a condenser, a compressor and a refrigerant coil.
- A filter to any impurities in the air. The filter is made of mesh, glass wool or fibre.
- A fan and adjustable grills to circulate the air.
- Controls to regulate the equipment operation.
- The low pressure refrigerant vapour is drawn from the evaporator to the hermetic compressor through suction pipe.
- It is compressed from low pressure to the high pressure and supplied to the condenser.
- It is condensed in the condenser by passing the outdoor air over the condenser coil by a fan.
- The liquid refrigerant is passed through the capillary into the evaporator.
- . In the evaporator the liquid refrigerant picks up the heat from the refrigerator surface and gets vaporized.
- A motor driven fan draws air from the room through the air filter and this air is cooled by losing its heat to the low temperature refrigerant and cold air is circulated back into the room.
- The vapour refrigerant from the evaporator goes to the compressor from evaporator and the cycle is repeated.
- Thus the room is air conditioned
- The quantity of air circulated can be controlled by the dampers.

The moisture in the air passing over the evaporator coil is dehumidified and drips into the trays.

This water evaporator to certain extent and thus helps in cooling the compressor and condenser.

The unit automatically stops when the required temperature is reached in the room. This is accomplished by the thermostat and control panel.

Merits and Demerits of Window type air conditioner:

Merits :

- A separate temperature control is provided in each room.
- Ducts are not required for distribution.
- Cost is less.
- Skilled technician is required for installation.

Demerits:

- It makes noise.
- Large hole is made in the external wall or a large opening to be created in the window panel. This leads to insecurity to inmates**.**

2. Explain the following terminologies 1.Refrigeration effect 2. Ton of Refrigeration 3. Coefficient of performance 4.Specific Heat.(15)

Terminologies of Refrigeration:

Refrigerating Effect (N):

It is defined as the quantity of heat extracted from a cold body or space to be cooled in a given time.

N= Heat extracted from the cold
space Time taken

Specific Heat of water and ice :

It is the quantity of heat required to raise or lower the temperature of one kg of water (or ice), through one kelvin or (10 c) in one second.

Specific heat of water, Cpw = 4.19 kJ/kg K

Specific heat of ice, Cpice = 2.1 kJ/kg K.

Capacity of a Refrigeration Unit :

Capacity of a refrigerating machines are expressed by their cooling capacity. The standard unit used for expressing the capacity of refrigerating machine is ton of refrigeration.

One ton of refrigeration is defined as, “the quantity of heat effect) to freeze one ton of water Heat extracted from at oo c = latent heat of ice into one ton of ice in a duration of 24 hours at 0o C”.

Latent heat of ice= 336 kJ/kg i.e., 336 kJ of heat should be extracted one kg of water at 0o C to convert it into ice.

One ton of refrigeration = 336x1000 kJ/24 hrs.

= 336x1000 kJ/min
24x60

One ton of refrigeration = 233.333 kJ/min

= 3.8889 kJ/sec

Co efficient of Performance

It is defined as the ratio of heat extracted in a given time (refrigerating effect) to the work input.

Co efficient of performance = Heat extracted in evaporator
Work Input

Co efficient of performance = Refrigerating Effect
Work Input
Co efficient of performance = NW
The COP is always greater than 1
and known as theoretical coefficient of performance.

EE8251 CIRCUIT THEORY

UNIT I BASIC CIRCUITS ANALYSIS 6+6
Resistive elements - Ohm's Law Resistors in series and parallel circuits – Kirchoffs laws – Mesh current and node voltage - methods of analysis.

UNIT IINETWORK REDUCTION AND THEOREMS FOR DC AND AC IRCUITS 6+6
Network reduction: voltage and current division, source transformation – star delta conversion. Thevenins and Norton Theorems – Superposition Theorem – Maximum power transfer theorem – Reciprocity Theorem – Millman's theorem.

UNIT III TRANSIENT RESPONSE ANALYSIS 6+6
L and C elements -Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. sinusoidal input.

UNIT IV THREE PHASE CIRCUITS 6+6
A.C. circuits – Average and RMS value - Phasor Diagram – Power, Power Factor and Energy.- Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & unbalanced – phasor diagram of voltages and currents – power measurement in three phase circuits.

UNIT V RESONANCE AND COUPLED CIRCUITS 6+6
Series and parallel resonance – their frequency response – Quality factor and Bandwidth - Self and mutual inductance – Coefficient of coupling – Tuned circuits – Single tuned circuits.

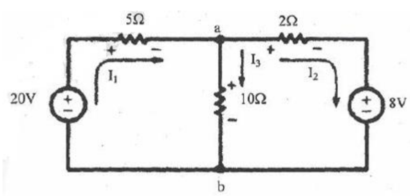
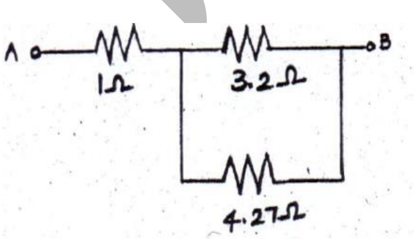
TOTAL: 60 PERIODS

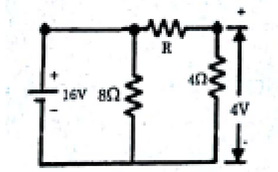
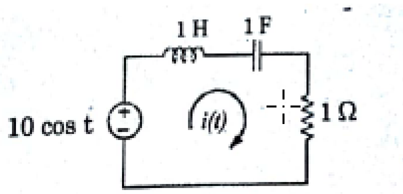
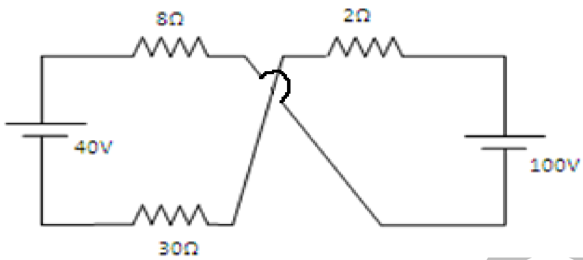
TEXT BOOKS:

1. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", McGraw Hill publishers, edition, New Delhi, 2013.
2. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Second Edition, McGraw Hill, 2013.

Subject Code: EE8251 **Year/Semester: I /02**
Subject Name: CIRCUIT THEORY **Subject Handler : Mr. D. JOSHUA JEYASEKAR**

UNIT I BASIC CIRCUITS ANALYSIS	
Resistive elements - Ohm's Law Resistors in series and parallel circuits – Kirchoffs laws – Mesh current and node voltage - methods of analysis.	
	PART * A
Q.No.	**Questions**
1	**State the Limitation of Ohm's law(JUNE 2013)(APRIL/MAY 2017 REG 2008/2010)**BTL1 Ohm's law doesn't apply to all non-metallic conductors2. Doesn't apply to nonlinear devices like Zener diode, Voltage regulator, tubes etc.,3. It is not applicable for the metallic conductors which changes with temperature
2	**Define i) charge ii) electric current iii) power iv) network& v) circuit.** BTL1 **Charge:** Charge is an electrical property of the atomic particles of which matter consists, measured in coulombs(C). **Electric current**is the time rate of change of charge, measured in amperes (A). i =dq/dt A direct current (DC) is a current that remains constant with time. An alternating current (AC) is a current that varies sinusoidally with time **Power** is the time rate of expending or absorbing energy, measured in watts(w).p = $\frac{dw}{dt}$ p- Power in watts(w);w- energy in joules (J);t - time in seconds (S);(or) p = v i ,v - Voltage in volts(V);i - current in amperes(A). **Network:** The inter connection of two or more simple circuit elements forms an electricalnetwork. **Circuit:** If the network contains at least one closed path, it is an electric circuit.
3	**State Kirchoff's Current law.(NOV 2015)** BTL1 **KCL** (Kirchoff's Current Law) states that the algebraic sum of currents entering a node is zero (or)The sum of the currents entering a node is equal to the sum of the currents leaving the node.
4	**State Kirchoff'sVoltage law.(NOV 2013)** BTL1 **KVL** (Kirchoff's Voltage Law) states that the algebraic sum of all voltages around a closed path is zero. (or) Sum of voltage drop = Sum of voltage rise.
5	**Write the Algorithm for Mesh Analysis.(DEC 2012)** BTL2 Assign mesh currents $i_1,i_2,\ldots.i_n$ to the n meshes. Apply KVL to each of the n meshes. Solve the resulting n simultaneous equations to get the mesh currents.
6	**Distinguish between a Loop & Mesh of a circuit (DEC 2010)(JUNE 2013)(JUNE 2016)(APRIL/MAY 2017 REG 2008/2010)** BTL4 The closed path of a network is called a Loop.An elementary form of a loop which cannot be further divided is called a mesh. In other words Mesh is closed path does not contain an other loop within it.
7	**Define RMS voltage.(JUNE 2014).** BTL1 The RMS value of an AC is defined as the equivalent steady value of the DC which can produce the equal amount of heat, when flow through the given circuit for an equal time.

	$\text{RMSvalue} = \sqrt{\dfrac{\text{Area under the Square Curve for oneCycle}}{\text{TimePeriod}}}$ RMS value of an AC voltage, $V_{RMS} = \frac{V_m}{\sqrt{2}}$ =0.707V_m
8	**An electrical appliance consumes 2kWh in 30 mins at 120V. What is the current drawn by the appliance?(NOV 2014)** BTL3 Energy, W = EIt ,I= $\frac{W}{Et} = \frac{1200 \times 3600}{120 \times 1800}$ = 20A
9	**Write briefly about resistance in a circuit. (JUNE 2015)** BTL1 The electrical resistance of a circuit component or device is defined as the ratio of the voltage applied to the electric current which flows through it: If the resistance is constant over a considerable range of voltage, then Ohm's law, I = V/R, can be used to predict the behavior of the material. The resistance is measured in units of ohms (Ω).
10	**Obtain the current in each branch of the network shown below using Kirchoff's Current Law. (JUNE 2015)** BTL1  $5I_1 + 10(I_1 – I_2) = 20$ $10(I_2 – I_1) + 20I_2 = -8$ $I_1 = 48A$ $I_2 = 0.91A$
11	**The resistance of two wires is 25Ω when connected in series and 6Ω when connected in parallel. Calculate the resistance of each wire.(JUNE 2016)** BTL1 R_1+R_2=25Ω, R_2=25-R_1------------(1) $R_1R_2/(R_1+R_2)$ = 6Ω,--------------(2) Substitueeqn(1) in eqn(2), $R_1^2-25R_1+150=0$ R_1=10Ω,R_2=15Ω (or)R_1=15Ω, R_2=10Ω
12	**Find the equivalent resistance of the circuit shown in fig.(NOV 2015)** BTL1  Equivalent resistance = 1+ $\frac{2\times 27}{2+27}$ Ω= 83 Ω
13	**Find 'R' in the given circuit shown below.(APRIL/MAY 2017)** BTL1

	
14	**Determine the current i(t) for the given circuit.(APRIL/MAY 2017)** BTL1 
15	**Apply KVL and find the current in the circuit from 40V** BTL3  By applying KVL,40-8I+100-2I-30I=0, Ans: I=5A
16	**Define power and energy. Give the expression for electrical power and energy.** BTL1 **Power** is the rate of doing work and its unit is Watt. The unit of electric power is defined in terms of the joule per second. One joule per second is the work done when one coulomb of electricity is moved through a potential difference of one volt in one second. **P = EI = I^2R = E^2/R Watts.** **Energy** is the product of power and time. If the power remains constant at Pduring the period of time t seconds, the energy equals Pt Watt-sec or Joules. **Energy W = Pt = EIt = I^2Rt = E^2t/R J.**
17	**What is a graph of network?** BTL1 When all elements in a network are replaced by lines with circles of dos at both ends.
18	**What is tree of a network?** BTL1 Tree is an interconnected open set of branches which include all the nodes of the given graph.
19	**Give the properties of tree in a graph.** BTL1 It consists of all the nodes of the graph If the graph has N no of nodes the tree will have N-I branches There will be no closed path in the tree There can be many possible different trees for a given graph depending on the no of nodes and branches.
20	**Define Ohms Law**. BTL1 The potential difference across any two ends of a conductor is directly proportional to the current flowing between the two ends provided the temperature of the conductor remains constant
21	**Define Quality factor**.BTL1 The quality factor is defined as the ratio of maximum energy stored to the energy dissipated in one period.
22	**What are half power frequencies?**BTL1

	In RLC circuits the frequency at which the power is half the max/min power are called half power frequencies.
23	**Write the characteristics of series resonance.** BTL1 At resonance impedance in min and equal to resistance therefore current is max. Before resonant frequency the circuit behaves as capacitive circuit and above resonant frequency the circuit will behave as inductive circuit. At resonance the magnitude of voltage across the inductance and capacitance will be Q times the supply voltage but they are in phase opposition.
24	**What is anti resonance?** BTL1 In RLC parallel circuit the current is min at resonance whereas in series resonance the current is max. Therefore the parallel resonance is called anti resonance.
25	**Write the characteristics of parallel resonance**.BTL3 At resonance admittance in min and equal to conductance therefore the current is min. Below resonant frequency the circuits behave as inductive circuit and above resonant frequency the circuit behaves as capacitive circuit. At resonance the magnitude of current through inductance and capacitance will be q times the current supplied by the source but they are in phase opposition.
26	**Define KCL**.BTL1 KCL states that the algebraic sum of currents in node is zero.
27	**Define KVL.**BTL1 KVL states that the algebraic sum of voltages in a closed path is zero.
28	**What is meant by linear and nonlinear elements?** BTL1 Linear element shows the linear characteristics of voltage Vs current. Nonlinear element the current passing through it does not change linearity with the linear change in applied voltage at a particular frequency.
29	**What is meant by active and passive elements?** BTL1 If a circuit element has the capability of enhancing the energy level of a signal passing through it is called an active element. Passive elements do not have any intrinsic means of signal boosting.
30	**Give the steps to draw a Dual Network**. BTL1 In each loop of a network place a node Draw the lines connecting adjacent nodes passing through each element and also to the reference node.
31	**Mention the disadvantages of Ohm's Law.** BTL1 It does not apply to all non metallic conductors It also does not apply to non linear devices such as Zener diode, vacuum tubes etc. It is true for metal conductors at constant temperature. If the temperature changes the law is not applicable.
32	**What is a node?**BTL1 A node is a point in a network in which two or more elements have a common connection. What are the classifications of Circuit elements? Active element Passive element Lumped and distributed elements Bilateral and unilateral elements Linear and non linear elements
33	**State voltage division rule.** BTL1 Voltage across a resistor in series circuit is equal to the total voltage across the series elements multiplied by the value of that resistor divided by the total resistance of the series elements.
34	**State current division rule.** BTL1

The current in any branch is equal to the ratio of the opposite parallel branch resistances to the total resistance value, multiplied by the total current in the circuit.

35 **Define mesh.** BTL1

A mesh is defined as a lo op which does not contain any other loops within it.

36 **Compare series and parallel circuit.**BTL2

S No	Series circuit	Parallel circuit
1	The total effective resistance is the sum of the individual resistance ie $R_{eff}=R_1+R_2+\ldots\ldots R_n$	The reciprocal of the total effective resistance is the sum of the reciprocals of individual resistance $1/R_{eff}= 1/R_1+1/R_2+\ldots.1/R_n$
2	Only one path for the current flow	More than one path for the current to flow
3	The current flowing through all the resistances will be the same and equal to the total current	The current flowing through each resistance is different
4	The voltage is divided across each resistance according to the value of resistance.	The voltage across each resistance is same which will be equal to the input voltage.

PART * B

Three resistances values 2Ω,3Ω and 5Ω are connected in series across 20 V, DC Calculate (a) equivalent resistance of the circuit (b) the total current of the circuit (c) the voltage drop across each resistor and (d) the power dissipated in each resistor. (13M) BTL 3

Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao

(7M+6M)

Total resistance R $= R_1 + R_2 + R_3$.

= 2 +3+5 = 10Ω

Voltage = 20V

Total current I = V/R = 20/10 = 2A.

Voltage drop across 2Ω resistor $V_1 = I R_1$

2× 2 = 4 volts.

Voltage drop across 3Ω resistor $V_2 = IR_2$

2 × 3 = 6 volts.

Voltage drop across 5Ω resistor $V_3 = I R_3$

= 2 ×5 = 10 volts.

Power dissipated in 2Ω resistor is $P_1 = I_2 R_1$

= 22 × 2 = 8 watts.

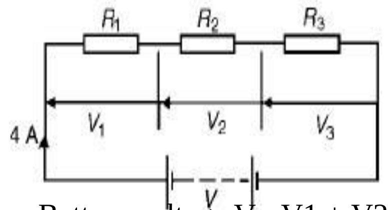
Power dissipated in 3 resistor is $P_2 = I_2 R_2$.

= 22 × 3 = 12 watts.

Power dissipated in 5 resistor is $P_3 = I_2 R_3$

For the circuit shown in Figure 5.2, determine (a) the battery voltage V, (b) the total resistance of the circuit, and (c) the values of resistance of resistors R1, R2 and R3, given that the p.d.'s across R1, R2 and R3 are 5V, 2V and 6V respectively. (13M) BTL 3

Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao



Battery voltage V =V1 + V2 + V3 =5 + 2 + 6=13V (4M)

Total circuit resistance R= V/ I

13/4=3.25Ω

Resistance R1 = V1/ I (4M)

5/4

=1.25 Ω

Resistance R2 = V2/ I (3M)

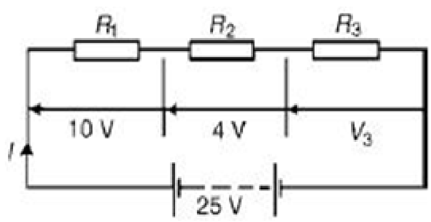
2/4 =0.5 Ω

Resistance R3 = V3/ I

6/4 =1.5 Ω (2M)

For the circuit shown in Figure determine the p.d. across resistor *R*3. If the total resistance of the circuit is 100_, determine the current flowing through resistor *R*1. Find also the value of resistor *R*2. (13M) BTL 3

Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao



P.d. across R3, V3 =25 − 10 − 4=11V

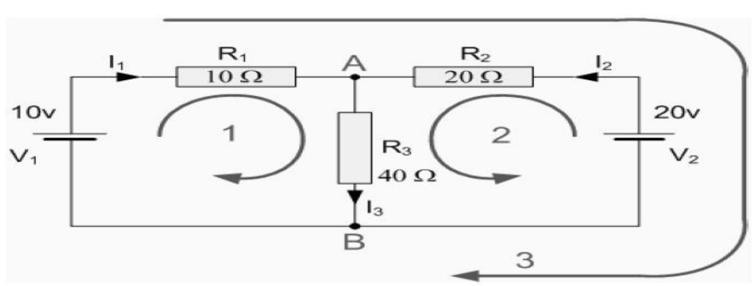
Current I = V/ R

= 25/100

=0.25A, which is the current flowing in each resistor Resistance R2 = V2/ I

4/0.25 =16 Ω

Find the current flowing in the 40Ω Resistor, R3



The circuit has 3 branches, 2 nodes (A and B) and 2 independent loops. (7M+6M)

Using Kirchoff's Current Law, KCL the equations are given as;

At node A: $I_1 + I_2 = I_3$

At node B: $I_3 = I_1 + I_2$

Using Kirchoff's Voltage Law, KVL the equations are given as;

Loop 1 is given as: $10 = R_1 \times I_1 + R_3 \times I_3 = 10I_1 + 40I_3$

Loop 2 is given as: $20 = R_2 \times I_2 + R_3 \times I_3 = 20I_2 + 40I_3$

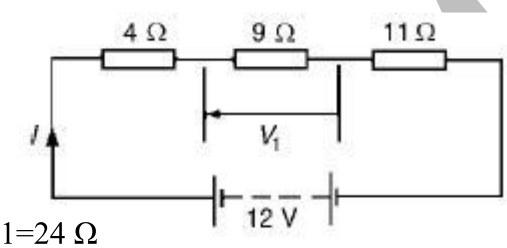
Loop 3 is given as: $10 - 20 = 10I_1 - 20I_2$

As I3 is the sum of $I_1 + I_2$ we can rewrite the equations as; $= 10I_1 + 40(I_1 + I_2) = 50I_1 + 40I_2$

$= 20I_1 + 40(I_1 + I_2) = 40I_1 + 60I_2$

A 12V battery is connected in a circuit having three series-connected resistors having resistances of 4 Ω, 9 Ω and 11 Ω. Determine the current flowing through, and the p.d. across the 9resistor. Find also the power dissipated in the 11 Ω resistor. (8M) BTL 3

Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao



Total resistance R=4 + 9 + 11=24 Ω (8M)

Current I = V/ R

= 12/24

=0.5A, which is the current in the 9 Ω resistor.

P.d. across the 9_ resistor, *V*1 = *I* × 9 = 0.5 × 9

= 4.5V

Power dissipated in the 11 Ω resistor, *P* = *I*2*R*=0.52(11)

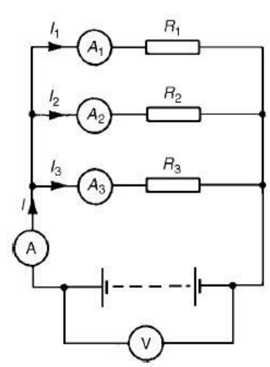
0.25(11)

2.75W

Figure shows three resistors, R1, R2 and R3 connected across each other, i.e. in

parallel, across a battery sourceof V volts. (13M) BTL 3

Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao



In a parallel circuit:

the sum of the currents I1, I2 and I3 is equal to the total circuit current, I, i.e. I =I1 +I2 +I3, and the source p.d., V volts, is the same across each of the (7M+6M)

From Ohm's law:
I1 = V/R1
I2 = V/R2

I3 = V/R3 and I = V/R

where R is the total circuit resistance. Since I =I1 + I2 + I3

then

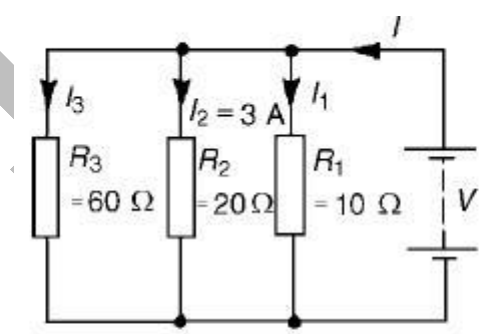
V/R= V/R1+ V/R2+ V/R3 Dividing throughout by V gives:

$$\boxed{\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

This equation must be used when finding the total resistance R of a parallel circuit. For the special case of two
resistors in parallel

$$\boxed{R = \frac{R_1 R_2}{R_1 + R_2}}$$

For the circuit shown in Figure find (a) the value of the supply voltage V and (b) the value of current I. (13M) BTL 3
Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao



P.d. across 20 Ω resistor = I2R2 = 3× 20 = 60V, hence supply voltage V =60V since the circuit is connected in parallel.

Current I1 = V/R1= 60/10= 6A; I2 = 3A
I3 = V/R3= 60/60= 1A
Current I =I1+I2+I3 and hence I =6+3+1=10A (6M)

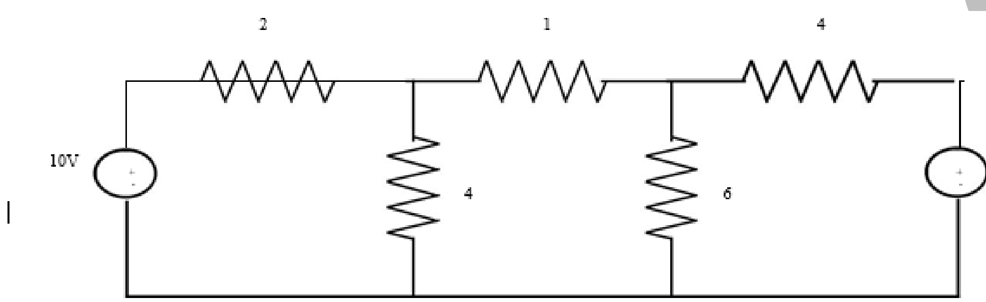
	Alternatively, 1/R= 1/60+ 1/20+ 1/10= 1 + 3 + 6/60= 10/60 Hence total resistance R= 6010=6 Ω Current I = V/R= 60/6=10A $$\frac{I_1}{\begin{vmatrix}-5 & 0 & -4\\16 & -1 & 0\\-1 & 9 & 5\end{vmatrix}}=\frac{-I_2}{\begin{vmatrix}8 & 0 & -4\\-5 & -1 & 0\\0 & 9 & 5\end{vmatrix}}=\frac{I_3}{\begin{vmatrix}8 & -5 & -4\\-5 & 16 & 0\\0 & -1 & 5\end{vmatrix}}=\frac{-1}{\begin{vmatrix}8 & -5 & 0\\-5 & 16 & -1\\0 & -1 & 9\end{vmatrix}}$$ Using determinants, (7M) $$\frac{I_1}{-5\begin{vmatrix}-1 & 0\\9 & 5\end{vmatrix}-4\begin{vmatrix}16 & -1\\-1 & 9\end{vmatrix}}=\frac{-I_2}{8\begin{vmatrix}-1 & 0\\9 & 5\end{vmatrix}-4\begin{vmatrix}-5 & -1\\0 & 9\end{vmatrix}}=\frac{I_3}{-4\begin{vmatrix}-5 & 16\\0 & -1\end{vmatrix}+5\begin{vmatrix}8 & -5\\-5 & 16\end{vmatrix}}=\frac{-1}{8\begin{vmatrix}16 & -1\\-1 & 9\end{vmatrix}+5\begin{vmatrix}-5 & -1\\0 & 9\end{vmatrix}}$$ $$\frac{I_1}{-5(-5)-4(143)}=\frac{-I_2}{8(-5)-4(-45)}=\frac{I_3}{-4(5)+5(103)}=\frac{-1}{8(143)+5(-45)}$$ $$\frac{I_1}{-547}=\frac{-I_2}{140}=\frac{I_3}{495}=\frac{-1}{919}$$ $$\text{Hence } I_1=\frac{547}{919}=0.595\text{ A},$$ $$I_2=\frac{140}{919}=0.152\text{ A, and}$$ $$I_3=\frac{-495}{919}=-0.539\text{ A}$$

Current in the 5 Ω resistance = $I_1 - I_2$

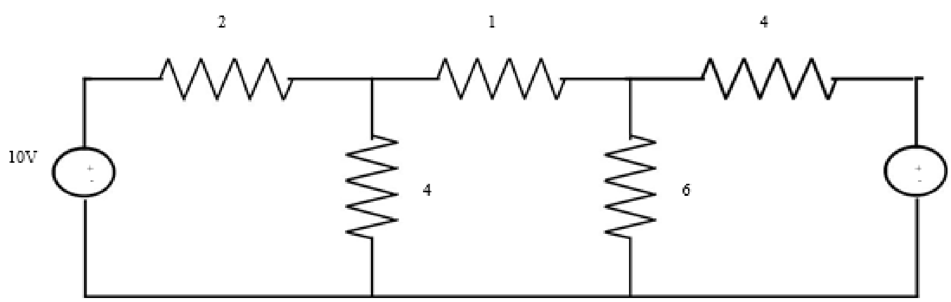
$0.595 - 0.152$
$0.44A$

Current in the 1 Ω resistance = $I_2 - I_3$
$0.152 - (-0.539)$
$0.69A$

Calculate current through 6Ω resistance using loop analysis.(JUNE-12) (13M) BTL 3
Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao



Solution:



Case(1): Consider loop ABGH ; Apply KVL . (7M+6M)

$10 = 2I1 + 4(I_1-I_2)$

$10 = 6I_1-4I_2$ ------------------- (1)

Consider loop BCFG

$I_2+6(I_2+I_3) +4(I_2-I_1) = 0$

$1_1I_2+6I_3-4I_1 = 0$ ------------- (2)

Consider loop CDEF

$20 = 4I_3+6(I_2=I_3)$

$20 = 10I_3+6I_2$ ----------------- (3)

$D = [\,6\,(110 - 36) + 4(-40)] = 284.$

$$D_1 = \begin{vmatrix} 10 & -4 & 0 \\ 0 & 11 & 6 \\ 20 & 6 & 10 \end{vmatrix}$$

$D_1 = 10[110\text{-}36 + (-120)]$

$= 260$

$$D_2 = \begin{vmatrix} 6 & 10 & 0 \\ -4 & 0 & 6 \\ 0 & 20 & 10 \end{vmatrix}$$

$D_2 = 6(-120)-10(-40) = -320$

$$D_3 = \begin{vmatrix} 6 & -4 & 10 \\ -4 & 11 & 0 \\ 0 & 6 & 20 \end{vmatrix}$$

$D_3 = 6(220) +4(-80) +10(-24)$

$D_3 = 760$

$I_1 = D_1/D = 260/284 = 0.915A$

$I_2 = D_2/D = -320/284 = -1.1267A$

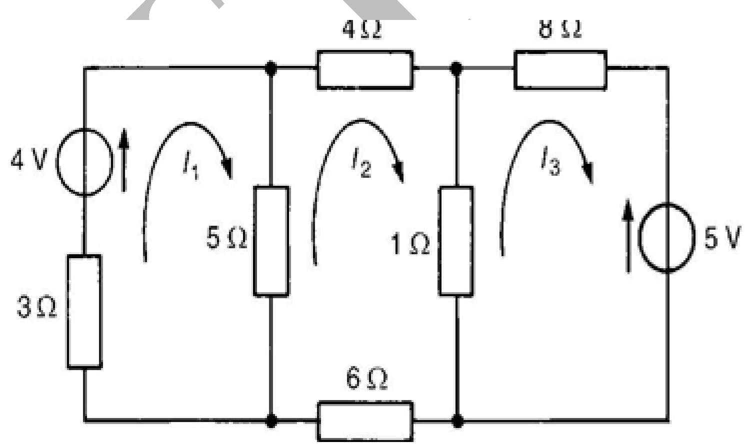
$I_3 = D_3/D = 760/284 = 2.676A$

Current through 6Ω resistance $= I_2+I_3$

$= -1.1267+2.676 = 1.55A$

Use mesh-current analysis to determine the current flowing in (a) the 5Ω resistance, and (b) the 1Ω resistance of the d.c. circuit shown in Figure. (13M) BTL 3

Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao



The mesh currents I_1, I_2 and I_3 are shown in Figure (7M)

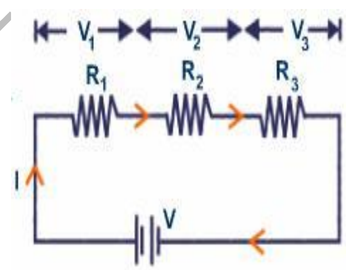
Using Kirchhoff's voltage law:

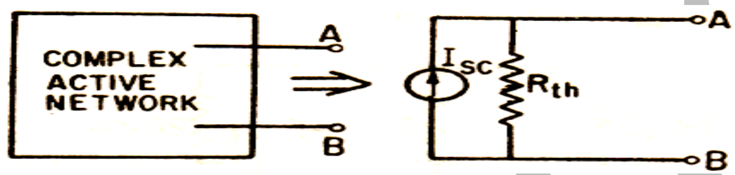
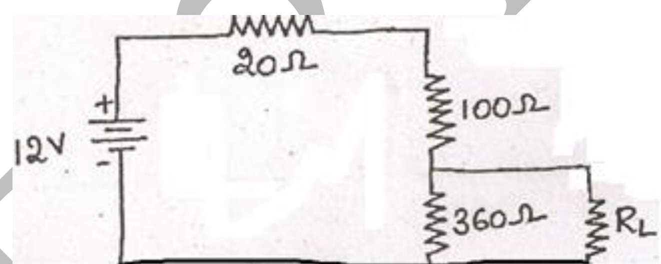
For loop 1, $(3 + 5)\,I_1 - I_2 = 4$ ……………………………………………………………(1)

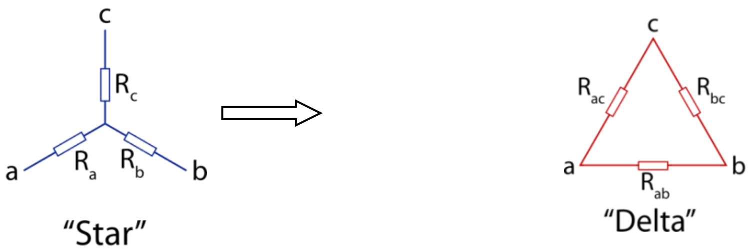
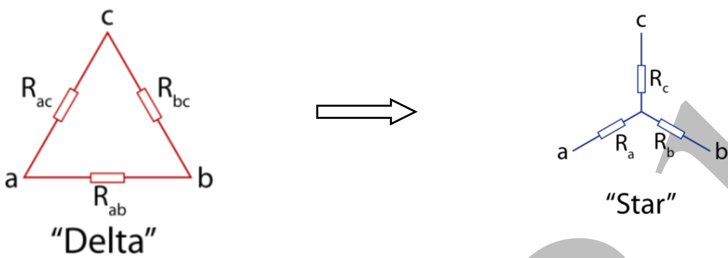
	For loop 2, $(4 + 1 + 6 + 5) I_2 - (5) I_1 - (1) I_3 = 0$……………………………………(2) For loop 3, $(1 + 8) I_3 - (1) I_2 = -5$ ……………………………………………………(3) (6M) Thus $8I_1 - 5I_2 - 4 = 0$ $-5I_1 + 16I_2 - I_3 = 0$ $I_2 + 9I_3 + 5 = 0$

UNIT II NETWORK REDUCTION AND THEOREMS FOR DC AND AC IRCUITS

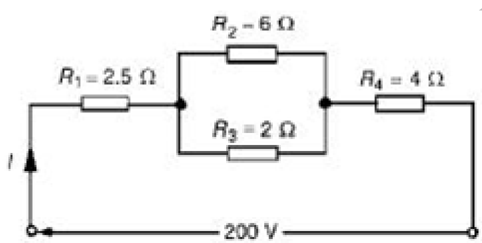
Network reduction: voltage and current division, source transformation – star delta conversion. Thevenins and Norton Theorems – Superposition Theorem – Maximum power transfer theorem – Reciprocity Theorem – Millman's theorem.

	PART * A
Q.No.	**Questions**
1	**Sate superposition theorem.** BTL1 It states that the response of a linear circuit with multiple sources is given by algebraic sum of response due to individual sources acting alone (or) The superposition theorem states that in any linear bilateral network containing two or more sources, the response in any element is equal to algebraic sum of the responses caused by individual sources acting alone, while the other sources are non-operative; that is, while considering the effect of individual sources, other ideal voltage sources and ideal current sources in the network are replaced by short circuit and open circuit across their terminals
2	**State division of current rule for a two branch parallel network.(JUNE 2013,NOV 2013)** BTL1 R_1 and R_2 are connected in parallel, Let I be the total current, I_1 be the current through R_1, I_2 be the current through R_2 Then $I_1 = I * R_2/(R_1+R_2)$; $I_2 = I * R_1/(R_1+R_2)$
3	**State division of voltage rule for a circuit with three resistors in series.(JUNE 2103)** BTL1 R_1,$R_2$and R_3 are connected in series,Let V be the total voltage, V_1 be the voltage across R_1, V_2 be the voltage across R_2, V_3 be the voltage across RThen, $V_1=V*R_1/(R_1+R_2+R_3)$,$V_2=V*R_2/(R_1+R_2+R_3)$ and $V_3=V*R_3/(R_1+R_2+R_3)$ 
4	**State reciprocity theorem. (JUNE 2012,NOV 2013,MAY 2014,JUNE 2016)** BTL1 According to this theorem, In a linear, bilateral network if we apply some input to a circuit which consists of resistors, inductors, capacitors and transformers, the ratio of response in any element to the input is constant even when the position of input and output are interchanged. This is called the Reciprocity Theorem.
5	**State Maximum power transfer theorem. (or) What is the condition for maximum power transfer in DC and AC circuits(JUNE 2013, JUNE 2014, NOV 2014, JUNE 2015,JUNE 2016)**

	BTL1 According to maximum power transfer theorem, maximum power transfer occurs when $R_L = R_{TH}$, that is, when the load resistance is equal to the thevenin resistance.
6	**State Norton's theorem.(APRIL/MAY 2017 REG 2008/2010)** BTL1 Norton's theorem states that any circuit with voltage sources, resistances (impedances) and open output terminals can be replaced by a single current sourceI_{sc} in parallel with single resistanceR_{th}(impedanceZ_{th}.).Where$I_{sc}$is equal to the current passing through the short circuit output terminals $R_{th}$is equal to the resistance seen into the output terminals with all energy sources are replaced by their internal resistance. 
7	**List the applications of Thevenin's theorem. (NOV 2015)** BTL4 It is useful for power system fault current calculation. It is used in transmission line calculation.
8	**Calculate the value of Norton's current (I_N)for the circuit shown in Fig. (NOV 2014)** BTL4  $I_N = \frac{12}{120} = 0.1A$
9	**Write briefly about network reduction technique. (JUNE 2015)** BTL4 In network analysis the number of components can be reduced to simplify the network. This can be done by replacing the actual components with other notional components that have the same effect. A particular technique might directly reduce the number of components, for instance by combining impedances in series. On the other hand it might merely change the form into one in which the components can be reduced in a later operation
10	**A load is connected to a network of the terminals to which load is connected, R_{sh}=10 ohms and V_{sh}=40V.Calculate the maximum power supplied to the load. (APRIL/MAY 2017).**BTL4 Maximum power transferred to the load = $V_s^2R_L / (R_s+ R_L)^2$= 16000/400 =40W
11	**A star connected load of 5ohm each is to be converted in to an equivalent delta connected load. Find the resistance used.(APRIL/MAY 2017).** BTL4 $R_a = (R_{ac}R_{ab})/(R_{ab}+ R_{bc}+ R_{ca})$ = (5*5)/(5+5+5)=25/15=1.67 ohm $R_b = (R_{ab}R_{bc})/(R_{ab}+ R_{bc}+ R_{ca})$ =(5*5)/(5+5+5)=25/15=1.67 ohm $R_c = (R_{ac}R_{bc})/(R_{ab}+ R_{bc}+ R_{ca})$=(5*5)/(5+5+5)=25/15=1.67ohm

12	**Write down the formulae for converting Star to Delta.** BTL1  $R_{ab}=(R_aR_b+R_bR_c+R_cR_a) / R_c$; $R_{bc}=(R_aR_b+R_bR_c+R_cR_a) / R_a$; $R_{ca}=(R_aR_b+R_bR_c+RcR_a) / R_b$.
13	**Write down the formulae for converting Star to Delta.** BTL1  $R_a = (R_{ac}R_{ab})/(R_{ab}+ R_{bc}+ R_{ca})$; $R_b = (R_{ab}R_{bc})/(R_{ab}+ R_{bc}+ R_{ca})$; $R_c = (R_{ac}R_{bc})/(R_{ab}+ R_{bc}+ R_{ca})$
14	**State Thevenins theorem.**BTL1 It states that any linear bilateral network can be replaced by a single current source VTH, in series with single impedance Zth
15	**State Norton's theorem.** BTL1 It states that any linear bilateral network can be replaced by a single current source, IN in parallel with single impedance Zth.
16	**State maximum power transfer theorem.** BTL1 Max power is transferred to load impedance if the load impedance is the complex conjugate of the source impedance**.**
17	**State reciprocity theorem.** BTL1 It states that in a linear, bilateral single source circuit the ratio of excitation to the response is constant when the position of excitation and response are interchanged.
18	**State compensation theorem.** BTL1 Let I be the current through an impedance Z in a brach of circuit. It states that the change in current due to change in impedance in a branch will be produced by a compensation voltage source in the same branch with polarity opposing the original current.
19	**State Millman's theorem.** BTL1 It states that if a number of voltage sources with internal impedance are in parallel then they

	can be combined to give a voltage source with an equivalent emf and internal impedance.
20	**State Tellegen's theorem.** BTL1 It states that the summation of all the product of branch voltage and its current of a circuit is zero
21	**State the steps to solve the Thevenin's theorem.** BTL1 Remove the load resistance and find the open circuit voltage VOC Deactivate the consta t sources (fro voltage source remove it by internal resistance & for current source delete the source by OC) and find the internalresistance (RTH) of the source side looking through the open circuited load terminals Obtain the Thevenin's equivalent circuit by connecting VOCin series with RTH Reconnect the load resistance across the load terminals.
21	**State the steps to solve the Norton's theorem.** BTL1 Remove the load resistor and find the internal resistance of the source N/W by deactivating the constant source. Short the load terminals and find the short circuit current Norton's equivalent circuit is drawn by keeping R TH in parallel with ISC
22	**What is the Load current in a Norton's circuit?** BTL1 IL= (ISC.RTH) / (RTH+RL)
23	**What is the load current in Thevenin's circuit?** BTL1 IL= VOC / (RTH+RL)
24	**What is the maximum power in a circuit?** BTL1 Max power:VO C2/4 RTH
25	**Write some applications of maximum power transfer theorem.** BTL1 Power amplifiers Communication system Microwave transmission
26	**What is the limitation of superposition theorem?** BTL1 This theorem is valid only for linear systems. This theorem can be applied for calculating the current through or voltage across in particular element. But this superposition theorem is not applicable for calculation of the power.
27	**What are the limitations of maximum power transfer theorem?** BTL1 The maximum efficiency can be obtained by using this theorem is only 50% . It is because of 50% of the power is unnecessarily wasted in Rth. Therefore this theorem only applicable for communication circuits and not for power circuits where efficiency is greater importance rather than power **delivered.**
28	**State voltage division rule.** BTL1 Voltage across a resistor in a series ciruict is equal to the total voltage across elements mulitiplied by the value of that resistor divided by the total resistance of the series elements. V1=(R1)*V/ (R1+R2)
29	**State current division rule.** BTL1 Current in any branch is equal to the ratio of the opposite paralel branch resistance to the total resistance value, multiplied by the total current in the circuit. I1=(R2)*I/(R1+R2)

30	**Define source trans formtion.** BTL1 The current and voltage sources may be inter changed without affecting the remainder of the circuit, this technique is the source transformation. It is the tool for simplifying the circuit.
31	**List the applications of Thevinins theorem.** BTL1 It is applied to all linear circuits including electronic circuits represented by the controlled source. This theorem is useful when t is desired to know the effect of the response in network or varying part of the network.
32	**Explain the purpose of star delta transformation.** BTL1 The transformation of a given set of resistances in star to delta or vice versa proves extremely useful in circuit analysis and the apparent complexity of a given circuit can sometime by very much reduced.
	PART * B
1	**For the series-parallel arrangement shown in Figure, find (a) the supply current, (b) the current flowing through each resistor and (c) the p.d. across each resistor.(13M)** BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao** 

The equivalent resistance Rx of R2 and R3 in parallel is: Rx = 6 × 2/6 + 2

12/8

1.5 Ω

The equivalent resistance R_T of R_1, Rx and R_4 in series is:

$R_T = 2.5 + 1.5 + 4 = 8\ \Omega$

Supply current $I = V/R_T$

200/8

25A

The current flowing through R_1 and R_4 is 25A The current flowing through R_2

$$= \left(\frac{R_3}{R_2 + R_3}\right) I = \left(\frac{2}{6+2}\right) 25$$

6.25A

The current flowing through R3

$$= \left(\frac{R_2}{R_2 + R_3}\right) I = \left(\frac{6}{6+2}\right) 25$$

(7M+6M)

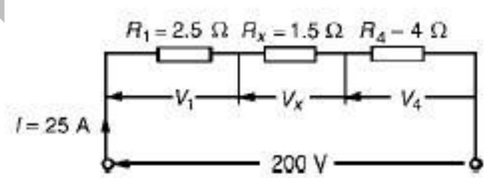
18.75A

p.d. across R1, i.e. V1 =IR1 =(25)(2.5)=**62.5V**

p.d. across Rx, i.e. Vx =IRx =(25)(1.5)=**37.5V**

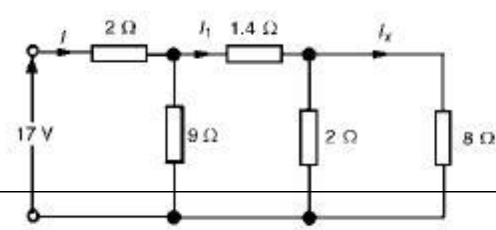
p.d. across R4, i.e. V4 =IR4 =(25)(4)=**100V**

Hence the p.d. across R2 =p.d. across R3 =**37.5V**

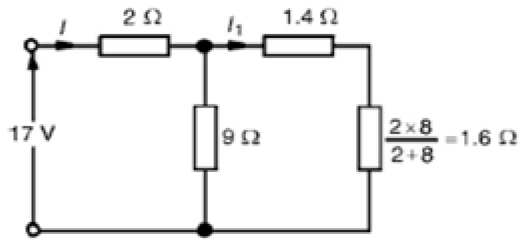


2 **For the arrangement shown in Figure find the current Ix. (13M)**BTL3

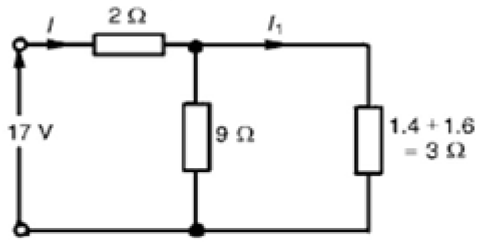
Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao



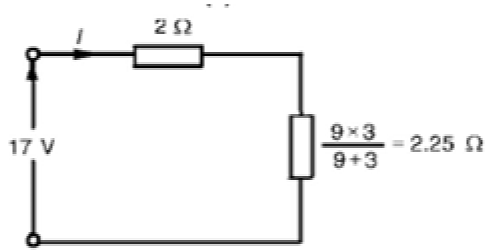
Commencing at the right-hand side of the arrangement shown in Figure, the circuit is gradually reduced in stages as shown in Figure



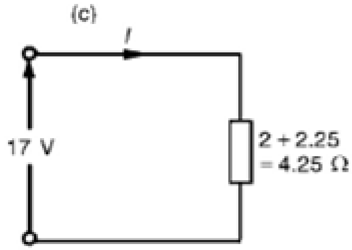
(a)



(b)



(c)



(d)

From Figure (d), I = 17/4.25

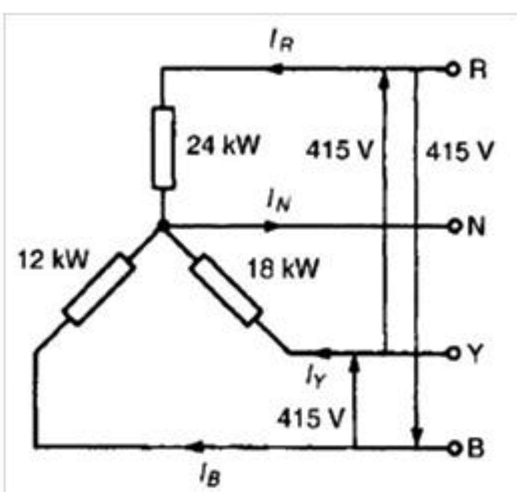
=4A

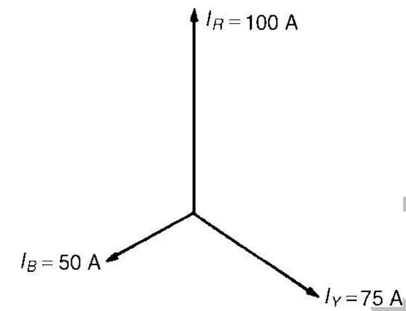
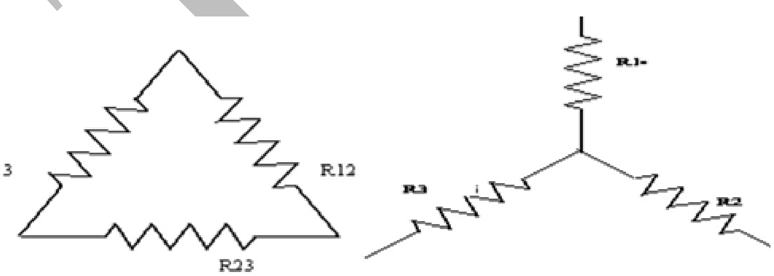
From Figure (b), I_1 =9/9 + 3(I) = 12/ (4) =3A

From Figure, Ix =2/2 + 8(I1) = 2/10(3) =0.6A (7M+6M)

Source transformation:

Source transformation is defined as to concert the sources for easy analysis of circuit.

	In mesh analysis. it is easier if the circuit has voltage sources. In nodal analysis. it is easier if the circuit has current sources.
3	**A star-connected load consists of three identical coils each of resistance 30 Ω and inductance 127.3 mH. If the line current is 5.08 A, calculate the line voltage if the supply frequency is 50 Hz. (13M)**BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao** Inductive reactance $X_L = 2\pi fL$ $= 2\pi\,(50)\,(127.3\times10^{-3})$ $= 40\ \Omega$ Impedance of each phase Zp =√ (R2 + X2L) =√ (302 +402) =50 Ω For a star connection IL =Ip =VpZp Hence phase voltage Vp =IpZp = (5.08)(50)=254V Line voltage **VL** =√3Vp =√3 (254) =440V
4	**A 415V, 3-phase, 4 wire, star-connected system supplies three resistive loads as shown in Figure Determine (a) the current in each line and (b) the current in the neutral conductor. (13M)**BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao**  For a star-connected system VL =√3Vp Hence $V_p = \frac{V_L}{\sqrt{3}} = \frac{415}{\sqrt{3}} = 240\,\text{V}$

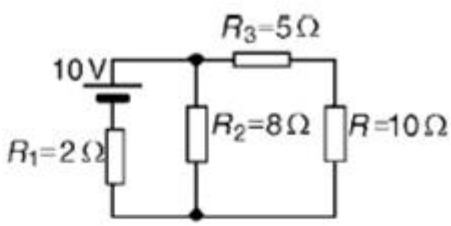
	Since current I = Power P/Voltage V for a resistive load then IR = PR/VR= 24 000/240=100A IY = PY/VY= 18 000/240=75Aand IB = PB/VB= 12 000/240=50A IN = IR + IY + IB phasorially.  , **IN** =43A Alternatively, by calculation, considering IR at 90°, IB at 210° and IY at 330°: Total horizontal component = 100 cos 90° + 75 cos 330°+50 cos 210° = 21.65 Total vertical component = 100 sin 90° + 75 sin 330°+50 sin 210° = 37.50 Hence magnitude of IN =$\sqrt{(21.65^2 + 37.50^2)}$ = 43.3A
	Obtain the delta connected equivalent for the star connected circuit.(13M)BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao**  $R_1 = 10\Omega, R_2 = 20\Omega\ R_3 = 30\Omega$ $R_{12} = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3} = \frac{10\times 20 + 20\times 30 + 30\times 10}{30} = 36.67\Omega$ $R_{23} = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1} = \frac{10\times 20 + 20\ 30 + 30\times 10}{10} = 110\Omega$ $R_{31} = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2} = \frac{10\times 20 + 20\times 30 + 30\times 10}{20} = 55\Omega$
5	**Use Thevenin's theorem to find the current flowing in the 10 Ω resistor for the circuit shown**

in Figure.(13M)BTL3

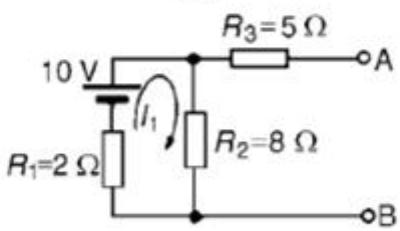
Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao

The 10 Ω resistance is removed from the circuit as shown in Figure
There is no current flowing in the 5 Ω resistor and current I1 is given by:
I1 = 10/R1 + R2

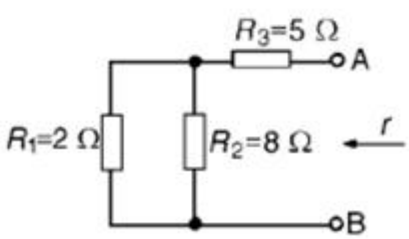
10/2 + 8
1A



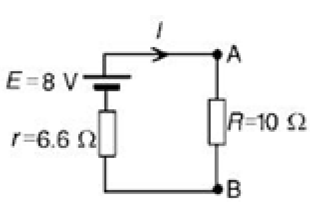
(a)



(b)



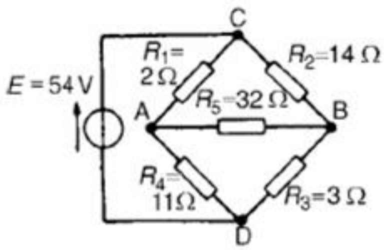
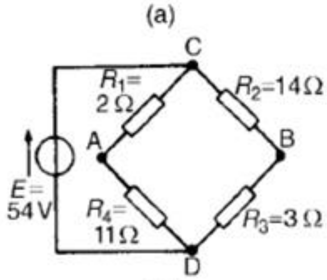
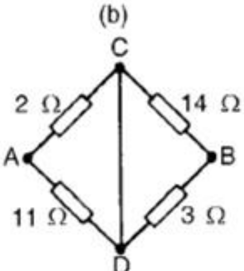
(c)

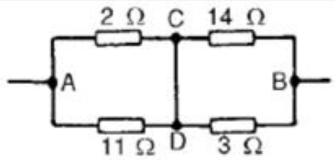


(d)

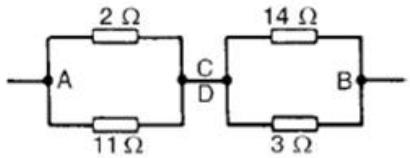
P.d. across R2 =I1R2 =1×8=8V Hence p.d. across AB, i.e. the open-circuit voltage across the break, E =8V

Removing the source of e.m.f. gives the circuit of Figure
Resistance, r = R3 + R1R2/R1 + R2

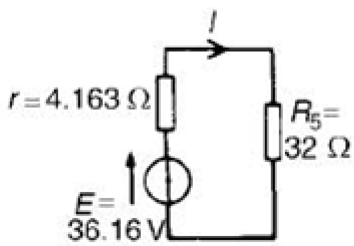
	=5+ (2×8/2+8) 5 + 1.6 = 6.6 Ω The equivalent Thévenin's circuit is shown in Figure Current I = E/R+r= 8/10+6.6= 8/16.6=0.482A
6	**A Wheatstone Bridge network is shown in Figure (a). Calculate the current flowing in the 32 Ω resistor, and its direction, using Thevenin's theorem. Assume the source of e.m.f. to have negligible resistance.(13M)**BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao**  (a)  (b) 



(d)



(e)



(f)

The 32 Ω resistor is removed from the circuit as shown in Figure (b)

The p.d. between A and C,

VAC =R1/R1 +R4 (E) =2/2+11(54) = 8.31V The p.d. between B and C,

VBC =R2/R2 +R3 (E) =14/14+3(54) = 44.47V Hence the p.d. between A and B=44.47−8.31=36.16V

r = 2 × 11/2 + 11+ 14 × 3/14 + 3

22/13+ 42/17

1.692 + 2.471 = 4.163 Ω

The equivalent Thévenin's circuit is shown in Figure (f), from which, current I = E/r +R5

36.16/4.163+32

=1A

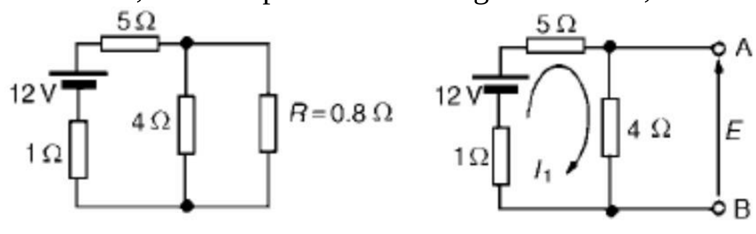
7 **For the network shown in Figure determine the current in the 0.8 Ω resistor using Thévenin's theorem. .(13M)**BTL3

Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao

The 0.8_ resistor is removed from the circuit as shown in Figure

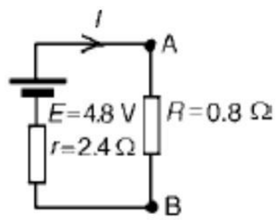
Current I1 = 12/1+5+4= 12/10 =1.2A

<table>
<tr><td></td><td>P.d. across 4 Ω resistor=4I1 =(4) (1.2)=4.8V
Hence p.d. across AB, i.e. the open-circuit voltage across AB, E =4.8V



(a) (b)

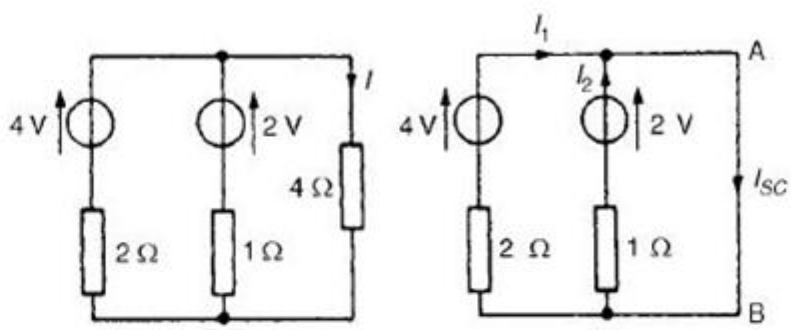
(c) (d)



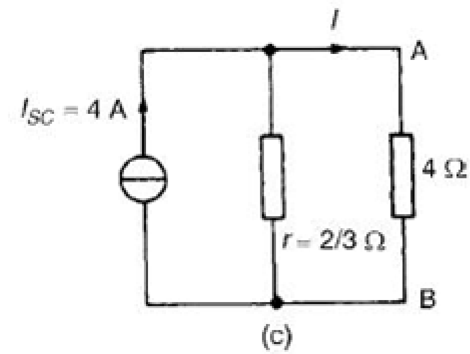
(e)

r = 4×6/4+6= 24/10</td></tr>
<tr><td>8</td><td>Use Norton's theorem to determine the current I flowing in the 4 Ω resistance shown in Figure (a). .(13M)BTL3

Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao



(a) (b)</td></tr>
</table>



The 4 Ω branch is short-circuited as shown in Figure (b).
From Figure (b), $ISC = I1 + I2 = 4A$
If the sources of e.m.f. are removed the resistance ‘looking-in’ at a break made between A and B is given by:
$r = 2 \times 1/2 + 1$
$= 2/3\ \Omega$
From the Norton equivalent network shown in Figure (c) the current in the 4 Ω resistance is given by:

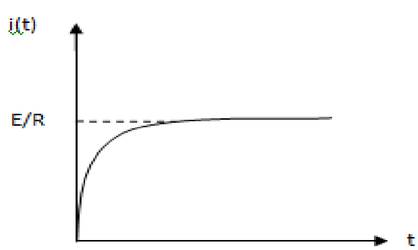
$=(2/3/(2/3) + 4)(4) = 0.571A,$

UNIT III TRANSIENT RESPONSE ANALYSIS

L and C elements -Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. sinusoidal input.

PART * A

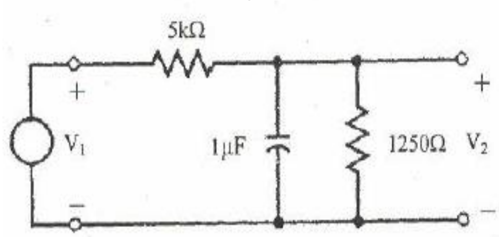
Q.No.	Questions
1	**Define transient state and transient time.(NOV 2013)** BTL1 In a network containing energy storage elements, with change in excitation, the currents and voltage change from one state to another state. The behavior of the voltage or current when it is changed from one state to another state is called the transient state
2	**Draw the current curve of a RL transient connected to a DC source.(APRIL/ MAY 2017)** BTL1



Q.No.	Questions
3	**Distinguish between natural and forced response.(JUNE 2014)** BTL4

Natural Response	Forced Response
It is determined by the internal energy stored in the network	It is determined by the application of external energy source
Voltage source and current sources are not present.	Voltage and current sources are present

Q.No.	Questions
4	**A RLC circuit has R=10Ω, L=2H.What value of capacitance will make the circuit critically damped? (JUNE 2013)** BTL3

<table>
<tr><td></td><td>$\left(\frac{R}{2L}\right)^2=\frac{1}{LC}$; C=0.08F</td></tr>
<tr><td>5</td><td>What is time constant for RL circuit and RC circuit (JUNE 2012, MAY 2014, NOV 2015,JUNE 2016) (APRIL/MAY 2017 REG 2008/2010) BTL1
Time constant of RL circuit ,$\tau=\frac{L}{R}$
Time constant of RC circuit ,$\tau = RC$</td></tr>
<tr><td>6</td><td>Find the Time constant of RL circuit having BTL3
i)R = 10Ω and l = 0.1 mH (JUNE 2013)
ii)R=10ohms and L=20mH?(JUNE 2014)
i)Time constant = L/R = 10µsec
ii) Time constant = L/R = 2milliseconds</td></tr>
<tr><td>7</td><td>Distinguish Steady State and Transient State(NOV 2015) BTL3
<table>
<tr><th>Steady State</th><th>Transient State</th></tr>
<tr><td>A circuit having constant sources is said to be in steady state if the currents and voltages do not change with time.
Thus, circuits with currents and voltages having constant amplitude and constant frequency sinusoidal functions are also considered to be in a steady state.</td><td>In a network containing energy storage elements, with change in excitation, the currents and voltage change from one state to another state.
The behaviour of the voltage or current when it is changed from one state to another state is called the transient state.</td></tr>
</table></td></tr>
<tr><td>8</td><td>Find the frequency response V_2/V_1 for the two port circuit shown below. (JUNE 2015) BTL1


$V_2= \frac{V_1 \times Z_p}{5000+Z_p}$
$Z_p = \frac{Z_1 Z_2}{Z_1+Z_2} = \frac{1250}{1+0.0012S}$
$\frac{V_2}{V_1} = \frac{1250/(1+0.0012S)}{25s+6250} = \frac{1250}{0.0075S^2+.75S+6250}$</td></tr>
<tr><td>9</td><td>Define the frequency response of series RLC circuit.(JUNE 2015) BTL1
The response of a linear circuit for a sinusoidal excitation as a function of angular frequency ω is known as frequency response of the circuit</td></tr>
<tr><td>10</td><td>A 50µF capacitor is discharged through a 100KΩ resistor. If the capacitor is initially charged to 400V, determine the initial energy.(NOV 2014) BTL3
Initial Energy, E = $(1/2)CV^2$ = 4J</td></tr>
<tr><td>11</td><td>Define Natural response or source free response.(JUNE 2014) BTL1
The response of the circuit due to the stored energy in the circuit elements (independent of sources) is called natural response</td></tr>
<tr><td>12</td><td>What do you meant by steady state?(APRIL/MAY 2017) BTL1
A circuit having constant sources is said to be in steady state if the currents and voltages do not change with time. Thus, circuits with currents and voltages having constant amplitude and constant frequency sinusoidal functions are also considered to be in a steady state.</td></tr>
</table>

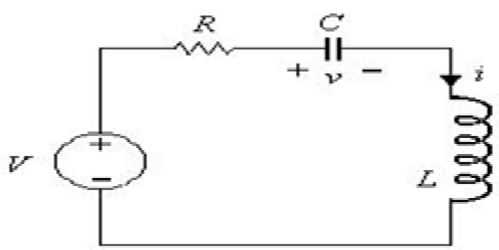
13	**What is transient state**? BTL1 If a network contains energy storage elements, with change in excitation, the current and voltage change from one state to other state the behavior of the voltage or current when it is changed from one state to another state is called transient state.
14	**What is transient time?** BTL1 The time taken for the circuit to change from one steady state to another steady state is called transient time
15	**What is transient response?** BTL1 The storage elements deliver their energy to the resistances, hence the response changes with time, get saturated after sometime, and are referred to the transient response
16	**Define time constant of RLC circuit.** BTL1 The time taken to reach 63.2% of final value in a RL circuit is called the time constant of RL circuit. Time constant=L/R
17	**Define time constant of RC circuit.** BTL1 The time to taken to reach 36.8% of initial current in an RC circuit is called the time constant of RC circuit. Time constant= RC
18	**What is meant by natural frequency?** BTL1 If the damping is made zero then the response oscillates with natural frequency without any opposition, such a frequency is called natural frequency of oscillations.
19	**Define damping ratio.** BTL1 It is the ratio of actual resistance in the circuit to the critical resistance.
20	**Write down the condition, for the response of RLC series circuit to be under damped for step input.** BTL1 The condition for the response of RLC series circuit to be under damped step input is $(R/2L)^2 > (1/LC)$
21	**Write down the condition fo the response of RLC sereis circuit to be over damped for step input.** BTL1 The condition for the response of RLC series circuit to be over damped for step input is, $(R/2L)^2 > (1/LC)$
22	**Write down the few applications of RL, RC, RLC circuits.** BTL1 Coupling circuits, Phase shift circuits, Filters Resonant circuits, AC bridge circuits, Transformers
23	**Define transient response.** BTL1 The transient response is defined as the response or output of a circuit from the instant of

	switching to attainment of steady state.
24	**What is power factor and reactive power?** BTL1 The power factor is defined as the cosine of the phase difference between voltage and current. The reactive power of the circuit is defined as the sine of the phase angle**.**
25	**What is natural response?** BTL1 The response of a circuit due to stored energy alone without external source is called natural response or source free response.
26	**What is forced response?** BTL1 The response of the circuit due to the external source is called forced response.
27	**Define apparent power.** BTL1 The apparent power is defined as the product of magnitude of voltage and magnitude of current.

PART* B

1 **Explain in details about the step response of series RLC circuit. [AU-MAY-11][JUN-12].(13M)**BTL3

Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao



In series RLC circuit, there are two energy storing element which are L and C, such a circuit give rise to second order differential equation and hence called second order circuit.

Consider a series RLC circuit shown in Figure. The switch is closed at t = 0 and a step voltage of V volts gets applied to circuit.

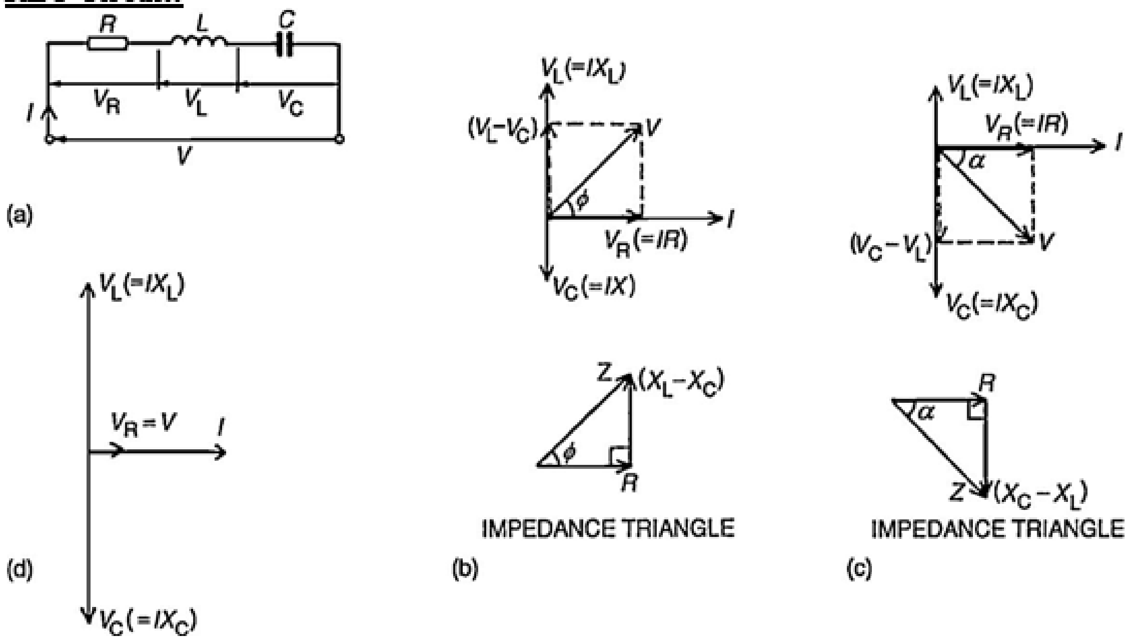
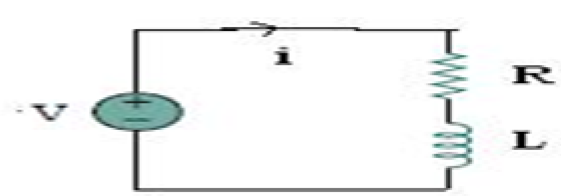
Apply KVL after switching we get

$$L\frac{di}{dt} + Ri + \frac{1}{C}\int i\,dt = V$$

As 'V' is step i.e., constant, differentiating both sides of above equation gives,

$$\frac{Ld^2i}{dt^2} + \frac{Rdi}{dt} + \frac{1}{C}i = 0$$

$$\frac{d^2i}{dt^2} + \frac{R}{L}\frac{di}{dt} + \frac{1}{CL}i0=$$

2	**Draw the phasor diagram for a series RLC circuit energized by a sinusoidal voltage showing the relative position of current, component voltage and applied voltage for the following case** **When $X_L > X_c$** **When $X_L < X_c$** **When $X_L = X_c$.[AU-JUN-12] .(13M)**BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao** **<u>RLC Circuit:</u>** 
3	**An alternating current i= 414 Sin (2π x 50 x t) A is passed through a series circuit of a resistance of 100 and an inductance of 0.31831 H. find the expression for the instantaneous values of voltage across, (MAY-08) .(13M)**BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao** **The resistance ,** **Inductance** **Capacitance** 

Given

$i = 414 \text{ Sin } (2\pi \times 50\, t)$ A

$= 100\ \Omega$

$L = 0.31831$ H

$X_L = 2\pi \times 50 \times 0.31831 = 100\ \Omega$

Voltage across Resistance:

$V_R = iR = 1.414 \sin (2\pi \times 50\, t) \times 100$

$V_R = 141.4 \text{ Sin } (2\pi \times 50\, t)$ V

R.m.s value of $V_R = 141.4/\sqrt{2} = 100$ V

$\Phi = 0^\circ$

$V_R = 100\angle 0^\circ = 100 + j0$ V

(ii) Voltage across Inductance:

$V_L = i\, X_L = 1.414 \text{ Sin } (2\pi \times 50\, t + 90^0) \times 100$

$V_L = 141.4 \text{ Sin } (2\pi \times 50\, t + 90^0)$ V

R.m.s value of $V_L = 141.4/\sqrt{2} = 100$ V , $\Phi = 90^\circ$

$V_L = 100\angle 90^\circ\ \theta\ - j100$ V

$V = V_R + V_L = 100 + j\,0 + 0 + 100j$

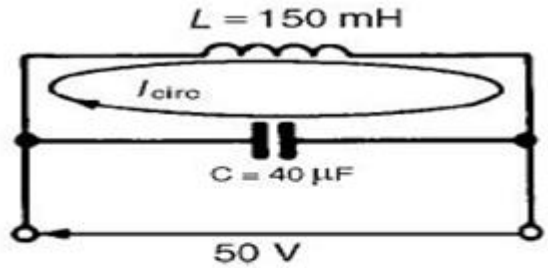
$V = 100 + j100 = 141.42\angle 45^0$ V

$V_m = \sqrt{2} \times 141.42 = 200$ V

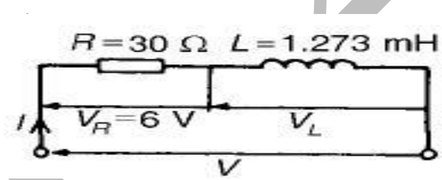
$V = 200 \text{ Sin } (2\pi \times 50\, t + 45^0)$ V

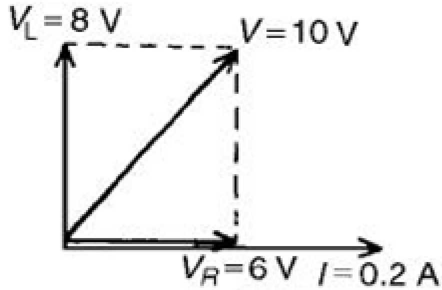
4 **A pure inductance of 150 mH is connected in parallel with a 40 μF capacitor across a 50 V, variable frequency supply. Determine (a) the resonant frequency of the circuit and (b) the current circulating in the capacitor and inductance at resonance..(13M)**BTL3

Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao

	 Parallel resonant frequency, $fr = 1/2\pi\ (1/LC-R^2/L^{2)}$ However, resistance R =0. Hence, $fr = 1/2\pi\sqrt{1/LC}$ $1/2\pi\ \sqrt{(1/150 * 10^{-3(}40 * 10^{-6)}}$ $1/2\pi\sqrt{10^{7/}15*4)}$ $10^{3/}2\pi\ ^{(}1/6)$ **64.97 Hz** Current circulating in L and C at resonance, ICIRC = V/XC V /1/2πfrC = 2πfrCV Hence ICIRC = 2π64.97*40 * $^{10-6}$*50= **0.816 A** Alternatively, ICIRC = V/XL V/2πfrL 50/2π64.9*0.15 **0.817 A**
5	**A series L–R–C circuit has a sinusoidal input voltage of maximum value 12 V. If inductance, L = 20 mH, resistance, R = 80 Ω, and capacitance, C = 400 nF, determine (a) the resonant frequency, (b) the value of the p.d. across the capacitor at the resonant frequency, (c) the frequency at which the p.d. across the capacitor is a maximum, and (d) the value of the maximum voltage across the capacitor.[AU-DEC-10].(13M)**BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao**

	(a) The resonant frequency, $$f_r = \frac{1}{2\pi\sqrt{(LC)}} = \frac{1}{2\pi\sqrt{[(20\times10^{-3})(400\times10^{-9})]}}$$ $$= \mathbf{1779.4\ Hz}$$ (b) $V_C = QV$ and $Q = \frac{\omega_r L}{R}\left(\text{or } \frac{1}{\omega_r CR} \text{ or } \frac{1}{R}\sqrt{\frac{L}{C}}\right)$ Hence $Q = \frac{(2\pi 1779.4)(20\times10^{-3})}{80} = 2.80$ Thus $V_C = QV = (2.80)(12) = \mathbf{33.60\ V}$ (c) From equation (28.7), the frequency f at which V_C is a maximum value, $$f = f_r\sqrt{\left(1-\frac{1}{2Q^2}\right)} = (1779.4)\sqrt{\left(1-\frac{1}{2(2.80)^2}\right)}$$ $$= \mathbf{1721.7\ Hz}$$ (d) From equation (28.9), the maximum value of the p.d. across the capacitor is given by: $$V_{C_m} = \frac{QV}{\sqrt{\left[1-\left(\frac{1}{2Q}\right)^2\right]}} = \frac{(2.80)(12)}{\sqrt{\left[1-\left(\frac{1}{2(2.80)}\right)^2\right]}} = \mathbf{34.15\ V}$$
6	**A coil of inductance 5 mH and resistance 10 Ω is connected in parallel with a 250 nF capacitor across a 50 V variable-frequency supply. Determine (a) the resonant frequency, (b) the dynamic resistance, (c) the current at resonance, and (d) the circuit Q-factor at resonance..(13M)**BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao**

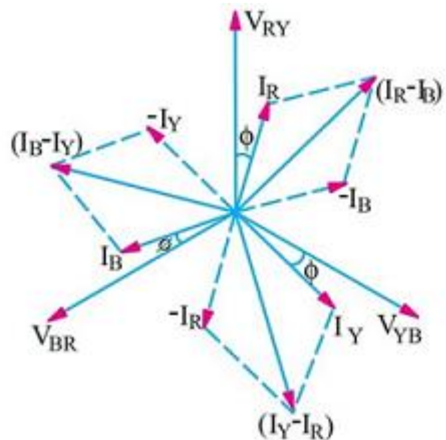
	(a) Resonance frequency $f_r = \frac{1}{2\pi}\sqrt{\left(\frac{1}{LC} - \frac{R^2}{L^2}\right)}$ from equation (29.3), $= \frac{1}{2\pi}\sqrt{\left(\frac{1}{5\times10^{-3}\times250\times10^{-9}} - \frac{10^2}{(5\times10^{-3})^2}\right)}$ $= \frac{1}{2\pi}\sqrt{(800\times10^6 - 4\times10^6)} = \frac{1}{2\pi}\sqrt{(796\times10^6)} = \mathbf{4490\ Hz}$ (b) From equation (29.4), dynamic resistance, $R_D = \frac{L}{CR} = \frac{5\times10^{-3}}{(250\times10^{-9})(10)} = \mathbf{2000\ \Omega}$ (c) Current at resonance, $I_r = \frac{V}{R_D} = \frac{50}{2000} = \mathbf{25\ mA}$ (d) Q-factor at resonance, $Q_r = \frac{\omega_r L}{R} = \frac{(2\pi 4490)(5\times10^{-3})}{10} = \mathbf{14.1}$
7	**A pure inductance of 1.273 mH is connected in series with a pure resistance of 30 Ω. If the frequency of the sinusoidal supply is 5 kHz and the p.d. across the 30Ω resistor is 6 V, determine the value of the supply voltage and the voltage across the 1.273 mH inductance. Draw the phasor diagram. (MAY-07) .(13M)**BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao**  Supply voltage, V = IZ CurrentI = Vr/R= 6/30= 0.20 A Inductive reactance $X_L = 2\pi fL = 2\pi(5 * 10^3)(1.273 * 10^{-3})$=40 Ω Impedance, $Z = \sqrt{R^2 + X^2}$ $= \sqrt{30^{2+} 40^2}$ = 50 Ω Supply voltage V = IZ = (0.20)(50) = **10 V** Voltage across the 1.273 mH inductance, VL = IX_L =(0.2)(40) = **8 V**



(b)

UNIT IV THREE PHASE CIRCUITS	
A.C. circuits – Average and RMS value - Phasor Diagram – Power, Power Factor and Energy.-Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & un balanced – phasor diagram of voltages and currents – power measurement in three phase circuits	
	PART * A
Q.No.	**Questions**
1	**What are the advantages of 3 phase circuits over single phase circuits?(NOV 2013, NOV 2015,JUNE 2016)**BTL1 Generation, transmission and distribution of 3 phase power is cheaper, More efficientand Uniform torque production occurs
2	**State the relationship between line voltage& phase voltage and line current & phase current of a 3 phase delta connected system. (NOV 2013,JUNE 2014)** BTL1 $V_{ph} = V_L$; $I_{ph} = I_L / \sqrt{3}$
3	**State the relationship between line voltage & phase voltage and line current &phase current of a 3 phase star connected system.(NOV 2013)** BTL1 $V_{ph} = V_L / \sqrt{3}$; $I_{ph} = I_L$
4	**Give the expressions for Wattmeter readings in terms of Voltage, Current and Power factor angle in Two – Wattmeter method.** BTL1 $W_1 = V_L I_L \cos(30^0 + \phi)$; $W_2 = V_L I_L \cos(30^0 - \phi)$
5	**A star connected load has 6+j8 ohm impedance per phase. Determine the line current if it is connected to 400V, three phase, and 50Hz supply. (JUNE 2012)** BTL1 $Z_{ph}=\sqrt{R^2+X^2} = \sqrt{6^2+8^2} = 10\Omega$/ph, $I_{ph}=I_L= \frac{V_{ph}}{Z_{ph}} = \frac{400\sqrt{3}}{10} = 23.094$A
6	**Write the expression for the power measured by two watt meters used in 3- phase balanced load, in terms of voltage, current and power factor.(JUNE 2012)** BTL1 $W_1 = V_L I_L \cos(30 + \phi)$; $W_2 = V_L I_L \cos(30 - \phi)$
7	**Write the expression for power factor in two wattmeter method of power measurement** BTL1 $\cos\phi = \cos\left(\tan^{-1}\sqrt{3}\frac{W_1 - W_2}{W_1 + W_2}\right)$

8	**What is phase sequence of a 3-phase system?(JUNE 2013)** BTL1 The order in which the voltage in the three phases reach their maximum positive values is called the phase sequence.
9	**Define Phasor and Phase angle.** BTL1 A sinusoidal wave form can be represented or in terms of a Phasor. A Phasor is a vector with definite magnitude and direction. From the Phasor the sinusoidal wave form can be reconstructed. Phase angle is the angular measurement that specifies the position of the alternating quantity relative to a reference
10	**Distinguish between unbalanced source and unbalanced load.(JUNE 2015)(APRIL/MAY 2017)** BTL3 **Unbalanced Source:** In unbalanced sources it will have negative sequence & zero sequence components whereas inabalanced source it has only positive sequence component. **Unbalanced Load:** If the individual load impedances are not identical then in general neither the line currents nor the line voltages at the load will have equal magnitudes. The phase sequence will affect both the magnitude and phase angle of current & voltage in the circuit.
11	**A delta connected load has (30-j40) ohm impedance per phase. Determine the phase current if it is connected to 415V, three phase, and 50Hz supply.(JUNE 2013)** BTL4 Phase current, $I = \frac{400}{\sqrt{(30^2)+(40^2)}} = 8$ A
12	**Write the equation for the phasor difference between the potentials of the delta connected networks. (NOV 2014)** BTL1 $V_{RY} = V_L \angle 0^O$ V $V_{YB} = V_L \angle -120^O$ V $V_{BR} = V_L \angle -240^O$ V
13	**Three coils, each having a resistance of 20Ω and an inductive reactance of 15Ω are connected in star to a 400V, 3 phase and 50 Hz supply. Calculate (a) line current, (b) power factor and (c) power supplied. (NOV 2014)** BTL4 Line current, $I_L = V_{ph}/ Z_{ph}$= 230.94 / 25 = 23 A Power Factor, $\cos\phi = R_{ph}/ Z_{ph}$= 20/25 = 0.8 lagging Power Supplied, $P = \sqrt{3}\, V_L\, I_L \cos\phi$ = 51178W
14	**A 3 phase 400 V is given to balanced star connected load of impedance 8+6j Ω.Calculate line current.(JUNE 2016)** BTL4 $I_L=I_{ph}$ $V_L = \frac{V_{ph}}{\sqrt{3}} = 400/\sqrt{3} = 230.9$ V $I=\frac{V_L}{Z}$ =230.9/(8+6j) =$23\angle -39^o$A
15	**When a 3 Phase Supply System is Called Balanced Supply System?(NOV 2015)** BTL1 If a three phase system has nominal voltage,frequency and phase shift of 120 degree with each other in all thephases, then the supply systemis said to be balanced

16	**What are the disadvantages of three phase system? (APRIL/MAY 2017 REG 2008/2010)** BTL1 a) The power in a single phase circuit is pulsating.when the power factor of the circuit is unity, the power becomes zero 100 times in a second in a 50Hz supply. Therefore, single phase motors have a pulsating torque. But in a three phase circuit total power supplied by a circuit is constant at every instant of time. b) To transmit a given amount of power over a given length, a three phase transmission circuit requires less conductor materialthan a single phase. c) In a given frame size,three phase motor or generator produces more output than its single phase counterpart.
17	**Draw the phasor diagram of line currents and line voltages of a balanced delta connected load.(APRIL/MAY 2017)** BTL1 
18	**Write the effect of power factor in energy consumption billing.** BTL1 Customers are supplied with power having a power factor near to unity around 0.9 Usage of highly inductive loads by the customers will reduce the power factor. This result in increase transmission losses so the power suppliers impose power factor penalty for customers using highly inductively load
19	**What are the Advantages of 3 phase system?[DEC-10]** BTL1 Most of the electric power is generated and distributed in three-phase. The instantaneous power in a three-phase system can be constant. The amount of power, the three-phase system is more economical that the single-phase. In fact, the amount of wire required for a three-phase system is less than that required for an equivalent single-phase system
20	**Which type of connection of 3Φ system is preferred at the point of utilization? Why?** BTL1 Three phase, 4 wire systems are used in utilization system so that either single phase or three phase load can be connected
21	**What are the three types of power used in AC circuits?** BTL1 Real or Active or True power P=EI cosθ ii) Reactive power Q=EI sinθ iii)Apparent power S=EI
22	**Define Apparent power and Power factor.** BTL1 The Apparent power (in VA) is the product of the rms values of voltage and current. $\mathbf{S = V_{rms}I_{rms}}$ The Power factor is the cosine of the phase difference between voltage and current. It is also the cosine of the load impedance.**Power factor = cos φ**

The pf is lagging if the current lags voltage (inductive load) and is leading when the current leads voltage (capacitive load).

PART * B

1 **A 400V, 3-phase star connected alternator supplies a delta-connected load, each phase of which has a resistance of 30_ and inductive reactance 40_. Calculate (a) the current supplied by the alternator and (b) the output power and the kVA of the alternator, neglecting losses in the line between the alternator and load. .(13M)**BTL3

Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao

Phase current, $I_p = V_p/Z_p$

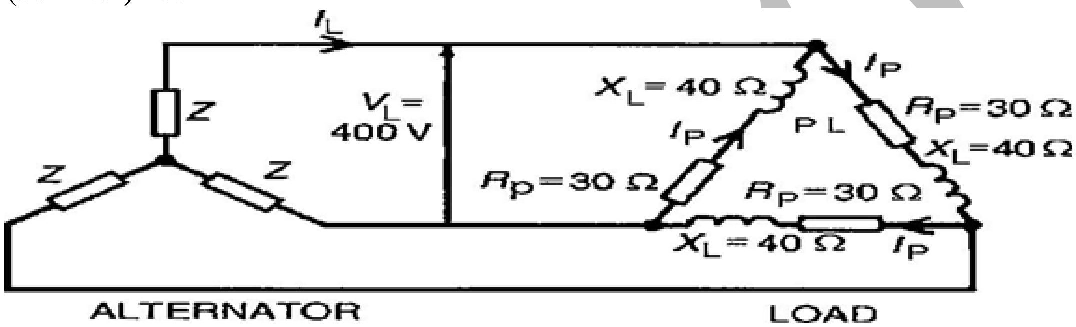
$V_p = V_L$ for a delta connection,

Hence V_p =400V.

Phase impedance,

$Z_p = \sqrt{(R^2+X_L^2)}$

$= \sqrt{(30^2 + 40^2)} = 50$



Figure

Hence $I_p = V_p/Z_p$ =400/50=8A.

For a delta-connection,

Line current, $I_L = \sqrt{3}\, I_p = \sqrt{3}\,(8)$ =13.86 *A*.

Hence **13.86A is the current supplied by the alternator**.

Alternator output power is equal to the power Dissipated by the load

I.e. $P = \sqrt{3}\, V_L I_L \cos\varphi$, Where $\cos\varphi$

$= R_p/Z_p$ = 30/50 = 0.6./

Hence $P = \sqrt{3}\,(400)\,(13.86)\,(0.6)$

5.76kW.

Alternator output kVA,

$= \sqrt{3}\, V_L I_L = \sqrt{3}\,(400)\,(13.86)$

9.60 kVA.

2 **Three identical coils, each of resistance 10*ohm* and inductance 42mH are connected (a) in star and (b) in delta to a 415V, 50 Hz, 3-phase supply. Determine the total power dissipated in each case. .(13M)**BTL3

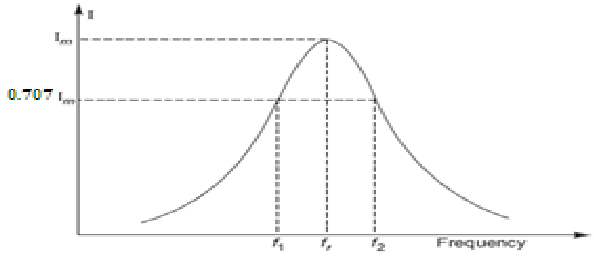
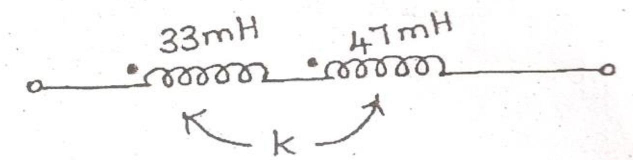
Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao

	Star connection Inductive reactance, $X_L = 2\pi f L = 2\pi\,(50)\,(42\times10-3) = 13.19$ Phase impedance, $Z_p = \sqrt{(R^2 + X_L^2)}$ $= \sqrt{(10^2 + 13.19^2)} = 16.55$ Line voltage, $V_L = 415\ V$ And phase voltage, $V_P = V_L/\sqrt{3} = 415/\sqrt{3} = 240\ V.$ Phase current, $I_p = V_p/Z_p = 240/16.55 = 14.50\ A.$ Line current, $I_L = I_p = 14.50\ A.$ Power factor= $\cos\varphi = R_p/Z_p = 10/16.55$ $= 0.6042$ lagging. **Power dissipated,** $= \sqrt{3}\ V_L I_L \cos\varphi = \sqrt{3}\,(415)\,(14.50)(0.6042) =$ **6.3kW** (Alternatively, $\boldsymbol{P} = 3I^2R = 3(14.50)^2(10) =$ **6.3kW**) **Delta connection** $V_L = V_p = 415$ V, $Z_p = 16.55$_, $\cos\varphi =$ 0.6042 lagging (from above). Phase current, $I_p = V_p/Z_p = 415/16.55 = 25.08$A. Line current, $I_L = \sqrt{3}I_p = \sqrt{3}(25.08) = 43.44$A. **Power dissipated,** $= \sqrt{3}\ V_L I_L \cos\varphi$ $= \sqrt{3}\,(415)(43.44)(0.6042) =$ **18.87kW** (Alternatively, $= 3I^2$R $= 3(25.08)2(10) =$ **18.87 kW)**
3	**A 415V, 3-phase a.c. motor has a power output of 12.75kW and operates at a power factor of 0.77 lagging and with an efficiency of 85 per cent. If the motor is delta-connected, determine (a) the power input, (b) the line current and (c) the phase current.(13M)**BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao**

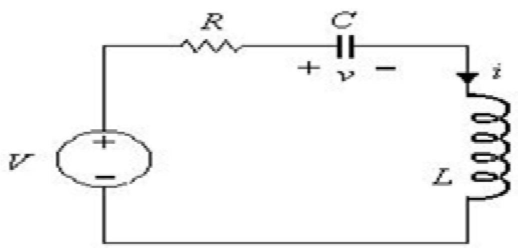
	(a) Efficiency=power output/power input. Hence (85/100)=12.750 power input from which, **Power input** = 12. 750 × 10085 **= 15 000W** or **15Kw** (b) Power, $P=\sqrt{3}\ V_L I_L \cos\varphi$, hence (c) **line current**, $I_L = P/\sqrt{3}\ (415)\ (0.77)$ = 15 000/ √3 (415) (0.77) **= 27.10A** (d) For a delta connection, $I_L=\sqrt{3}\ I_p$, Hence **Phase current**, $I_p = I_L/\sqrt{3}$ = 27.10 /√3 **= 15.65A**
4	**Three loads, each of resistance 30, are connected in star to a 415 V, 3-phase supply. Determine the system phase voltage, (b) the phase current and (c) the line current. (MAY-09) .(13M)**BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao** A '415 V, 3-phase supply' means that 415 V is the line voltage, V_L For a star connection, $V_L=\sqrt{3}V_p$ Hence phase voltage, $V_p = V_L/\sqrt{3}=415/\sqrt{3}$ **=239.6 V or 240 V** correct to 3 significant figures Phase current, $I_p = V_p/R_p$ =240/30 **=8 A** For a star connection, $I_p = I_L$ Hence the line current, I_L = **8 A**
5	**Two wattmeters connected to a 3-phase motor indicate the total power input to be 12kW. The power factor is 0.6. Determine the readings of each wattmeter. (MAY-09) .(13M)**BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao** If the two watt meters indicate P_1 and P_2 respectively Then $P_1 + P_2 = 12$kW ---(1) $\tan\varphi=\sqrt{3}(P_1 - P_2)/(P_1 + P_2)$ And power factor=0.6= $\cos\varphi$. Angle $\varphi=\cos^{-1}0.6=53.13^\circ$ and $\tan 53.13^\circ=1.3333$. $1.3333=\sqrt{3}(P_1 - P_2)/12$ From which, $P_1 - P_2= 12(1.3333)/\sqrt{3}$ i.e. $P_1 - P_2 = 9.237$kW ----(2) Adding Equations (1) and (2) gives:

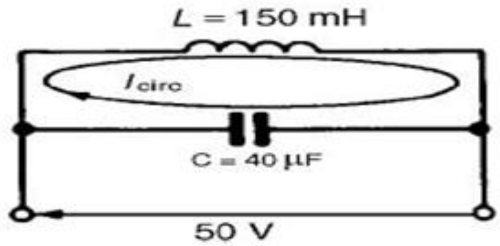
	$2P1 = 21.237$ i.e $P1 = 21.237/2$ 10.62kW Hence wattmeter 1 reads 10.62kW From Equation (1), wattmeter 2 reads (12−10.62)=1.38kW
6	**Two wattmeters are connected to measure the input power to a balanced 3-phase load by the two-wattmeter method. If the instrument readings are 8kW and 4kW, determine (a) the total power input and (b) the load power factor. (MAY-08) .(13M)**BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao** Total input power, $P=P1+P2=8+4=$**12kW** (b) $\tan\varphi = \sqrt{3}(P1-P2)/(P1+P2)$ $=\sqrt{3}\,(8-4)/(8+4)$ $=\sqrt{3}\,(4/12)$ $=\sqrt{3}(1/3)$ $1/\sqrt{3}$ Hence $\varphi = \tan^{-1} 1\ 1\ \sqrt{3} = 30^\circ$ Power factor=$\cos\varphi = \cos 30^\circ =$ **0.866**
UNIT V RESONANCE AND COUPLED CIRCUITS	
Series and parallel resonance – their frequency response – Quality factor and Bandwidth - Self and mutual inductance – Coefficient of coupling – Tuned circuits – Single tuned circuits.	
	PART * A
Q.No.	**Questions**
1	**What is meant by Resonance?** BTL1 An A.C circuit is said to be resonance if it behaves as a purely resistive circuit. The total current drawn by the circuit is then in phase with the applied voltage, and the power factor will then unity. Thus at resonance the equivalent complex impedance of the circuit has no j component.
2	**Define Q - factor or Figure of Merit, Q.(MAY 2014)**BTL1 The quality factor, Q of a resonant circuit is the ratio of its resonant frequency to its bandwidth. The Q - factor of a circuit can also be defined as, $Q = 2\pi \times \frac{\text{Maximum energy stored in the circuit}}{\text{Energy dissipated per cycle in the circuit}}$
3	**What are the resonant conditions?(APRIL/MAY 2017 REG 2008/2010)**BTL1 (i)The total impedance Z is minimum and is equal to R. (ii) The circuit will be purely resistive circuit.(iii) Power factor of the circuit is unity. iv) Circuit element, Imax= V/R. v)Power at resonance, $P_r=I^2R$
4	**Show that in a series RLC circuit, $f_1 f_2 = f_r^2$ where f_r is the resonant frequency and f_1, f_2 are the half power frequencies.** BTL1 $\omega_1 = -\frac{R}{2L} + \sqrt{\{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}\}}$, $\omega_2 = \frac{R}{2L} + \sqrt{\{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}\}}$ $\omega_1\omega_2 = \left(\frac{R}{2L}\right)^2 + \frac{1}{LC} - \left(\frac{R}{2L}\right)^2 = \frac{1}{LC} = \left(\frac{1}{\sqrt{LC}}\right)^2 = \omega_r{}^2$

	Hence, $f_1 f_2 = f_r^{\,2}$
5	**Define Bandwidth, half power frequencies?(JUNE 2013)** BTL1 The difference between the half power frequencies f_1 and f_2 at which power is half of its maximum is called **bandwidth** BW = f_2-f_1 It can be observed that at two frequencies f_1 and f_2 the power is half of its maximum value. These frequencies are called **half power frequencies.** Out of the two half power frequencies, the frequency f_2 is called **upper cut-off frequency** while the frequency f_1 is called **lower cut-off frequency.**
6	**Define Mutual Inductance, M.(JUNE 2015)(APRIL/MAY 2017)** BTL1 Mutual Inductance is the ability of one inductor to induce a voltage across a neighboring inductor, measured in henrys (H).
7	**Define Coefficient of coupling, K. (JUNE 2012,NOV 20, NOV 2015,JUNE 2016)** BTL1 The fraction of the total flux produced by one coil linking a second coil is called the Coefficient of coupling, K.Thus, $K = \Phi_{12} / \Phi_1 = \Phi_{21} / \Phi_2$ $K = M/\sqrt{L_1 L_2}$ Since $\Phi_{12} < \Phi_1$ or $\Phi_{21} < \Phi_2$, the value of K is always less than or equal to
8	**Two coils connected in series have an equivalent inductance of 0.4H when connected in aiding, and an equivalent inductance of 0.2H when the connection is opposite. Calculate the mutual inductance of the coils.** BTL1 Series aiding, $L_{eq} = L_1 + L_2 + 2M = 0.4$ ---------------- (1) Series opposing, $L_{eq} = L_1 + L_2 - 2M = 0.2$ ----------------- (2) Solving equations (1) and (2),4M = 0.2; **M = 0.05 H**
9	**State dot rule.(JUNE 2015)** BTL1 The sign of the mutual induced voltage depends on direction of the winding of the coil. For convenient, dot conventions are used for purpose of indicating direction of winding.
10	**A coil of resistance 2Ω and an inductance 0.01H is connected in series with a capacitor across 220V mains. Find the value of capacitance such that maximum current flows in the circuit at a frequency of 190 Hz. Also find the maximum current. (NOV 2014)** BTL3 At resonance $X_L = X_C$, $2\pi fL = 1/(2\pi fC)$, Capacitance, C = 70.16µF At resonance Z = R, Maximum Current, I = V/R = 100A
11	**What are the applications of tuned circuit?(JUNE 2013)** BTL1 Tuned circuits are used in communication systems, Radio receivers, in defence and etc.
12	**In a series RLC circuit, if the value of L and C are 100 mH and 0.1 µF, find the resonance frequency in Hz.(JUNE 2016)** BTL3 $f_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{(100mH * 0.1\ \mu F)}} = $ 15935 Hz.
13	**Define quality factor of a series resonant circuit. (NOV 2014)** BTL1 Quality factor is the ratio of resonant frequency to bandwidth.$Q_0 = \frac{f_r}{BW}$
14	**Draw the frequency response of RLC series circuit.** BTL1

	
15	**Calculate the total inductance of the circuit, if the coefficient of coupling (k) between the two coils is 0.6 as shown in fig.(NOV 2014)** BTL1  $M = K\sqrt{L_1 L_2} = 0.6\sqrt{33 \times 10^{-3} \times 47 \times 10^{-3}} = 0.023H$ $L_{eq} = L_1 + L_2 + 2M = 0.126H$
16	**Write the Significance of Quality factor?(DEC 2013)** BTL1 The relation between bandwidth and quality factor is Q=Resonant frequency/Bandwidth.This indicates a higher value of Q results in a smaller bandwidth and hence greater the selectivity. This indicates the resonant circuit responds to a certain frequency and eliminates all other frequency
17	**Define Selectivity.(NOV 2015)** BTL1 Selectivity of a resonant circuit is defined as the ratio of bandwidth (BW) to the frequency at resonance (f_r) of the circuit
18	**Define series resonance.** BTL1 A resonance occurs in RLC series circuit called series resonance. Under resonance condition, the input current is in phase with applied voltage.
19	**Define Quality factor.** BTL1 The quality factor is defined as the ratio of maximum energy stored to the energy dissipated in one period.
20	**What are half power frequencies?**BTL1 In RLC circuits the frequencies at which the power is half the max/min power are called half power frequencies.
21	**Write the characteristics of series resonance.** BTL1 At resonance impedance in min and equal to resistance therefore current is max. Before resonant frequency the circuit behaves as capacitive circuit and above resonant frequency the circuit will behave as inductive circuit. At resonance the magnitude of voltage across the inductance and capacitance will be Q times the supply voltage but they are in phase opposition
22	**Define selectivity.**BTL1 It is defined as the ratio of bandwidth and resonant frequency.
23	**What is anti resonance?** BTL1 In RLC parallel circuit the current is min at resonance whereas in series resonance the current is max. Therefore the parallel resonance is called anti resonance.
24	**Write the characteristics of parallel resonance.** BTL1 At resonance admittance in min and equal to conductance therefore the current is min. Below resonant frequency the circuits behave as inductive circuit and above resonant frequency

	the circuit behaves as capacitive circuit. At resonance the magnitude of current through inductance and capacitance will be q times the current supplied by the source but they are in phase opposition.
25	**What is Bandwidth and selectivity?** BTL1 The frequency band within the limits of lower and upper half frequency is called bandwidth. BW=f2-f1,Selectivity= fr / (f2-f1)
26	**What are coupled circuits?** BTL1 It refers to circuit involving elements with magnetic coupling. If the flux produced by an element of a circuit links other elements of the same circuit then the elements are said to be magnetic coupling
27	**What are coupled circuits?** BTL1 When two or more coils are linked by magnetic flux, then the coils are called coupled circuits**.**
28	**State the properties of a series RLC circuit.** BTL1 The applied voltage and the resulting current are in phase, when also means than the p.f of RLC circuit is unity. The net reactance is zero at resonance and the impedance does not have the resistive part only. The current in the circuit is max: and is V/R amperes At resonance the circuit has got minimum impedance and max: current Frequency of resonance is given by $fr=1/(2\pi\sqrt{LC})$
29	**State the properties of a parallel RLC circuit.** BTL1 PF is unity Current at resonance is (V/(L/RC)) and is in phase with the applied voltage. The value of current at resonance is minimum. Net impedance at resonance is max: & is equal to L/RC The admittance is min: and the net susceptance is zero at resonance.
30	**Define self inductance.** BTL1 When permeability is constant the self inductance of a coil is defined as the ratio of flux linkage and current.
31	**Define mutual inductance.** BTL1 When permeability is constant the mutual inductance between two coupled coils is defined as the ratio of flux linkage in one coil due to common flux and current through another coil.
32	**What is DOT convention?** BTL1 The sign of mutual induced emf depends on the winding sense and the current through the coil. The winding sense is decided by the manufacturer and to inform the user about the winding sense a dot is placed at one end of each coil. When current enter at dotted end in one coil then the mutual induced emf in the other coil is positive at dot end
33	**Define coefficient of coupling.** BTL1 In coupled coils the coefficient of coupling is defined as the raction of the total flux produced by one coil linking another coil.
34	**State dot rule for coupled circuit.** BTL1 It states that in coupled coils current entering at the dotted terminal of one coil induce an emf in second coil which is +ve at dotted terminal of second coil. Current entering at the un dotted terminal of one coil induce an emf in second coil which is +ve at un dotted terminal of second coil.
35	**Define coefficient of coupling.** BTL1 The amount of coupling between to inductively coupled coils is expressed in terms of the

	coefficient of coupling. *K=M/√L1L2*
36	**Write the expression for the resonant frequency of a RLC series circuit.** BTL1 Resonant frequency $fr=1/2\pi\sqrt{LC}$
37	**What is resonant frequency?** BTL1 The frequency at which resonance occurs is called resonant frequency. At resonant frequency XL=XC
	PART*B
1	**Explain in details about the step response of series RLC circuit.[AU-MAY-11][JUN-12].(13M)**BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao**  In series RLC circuit, there are two energy storing element which are L and C, such a circuit give rise to second order differential equation and hence called second order circuit. Consider a series RLC circuit shown in Figure. The switch is closed at t = 0 and a step voltage of V volts gets applied to circuit. Apply KVL after switching we get $$L\frac{di}{dt}+Ri+\frac{1}{C}\int idt = V$$ As 'V' is step i.e., constant, differentiating both sides of above equation gives. $$\frac{Ld^2i}{dt^2}+\frac{Rdi}{dt}+\frac{1}{C}i = 0$$ $$\frac{d^2i}{dt^2}+\frac{R}{L}\frac{di}{dt}+\frac{1}{CL}i0=$$
2	**A pure inductance of 150 mH is connected in parallel with a 40 μF capacitor across a 50 V, variable frequency supply. Determine (a) the resonant frequency of the circuit and (b) the current circulating in the capacitor and inductance at resonance..(13M)**BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao**



Parallel resonant frequency, fr = 1/2π (1/LC-R^2 /$L^{2)}$ However, resistance R = 0. Hence,
fr = 1/2π√1/LC
1/2π √ (1/150 * $10^{-3(}$40 * $10^{-6)}$
1/2π√$10^{7/}$15*4)
$10^{3/}$2π $^{(}$1/6)
64.97 Hz
Current circulating in L and C at resonance, ICIRC = V/XC
V /1/2πfrC
= 2πfrCV
Hence ICIRC = 2π64.97*40 * $^{10-6}$*50= **0.816 A**
Alternatively, ICIRC = V/XL
V/2πfrL
50/2π64.9*0.15
0.817 A

3 **Compare the series and parallel resonant circuit.(consider practical parallel resonant circuit) .(10M)**BTL3
Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao

Description	Series RLC circuit	Parallel RLC circuit
Impedance at resonance	Minimum	Maximum
Current at resonance	Maximum= $\frac{V}{R}$	Minimum= $\frac{VCR}{L}$
Effective impedance	R	$\frac{L}{CR}$
Power factor at resonance	Unity	Unity
Resonant frequency	$\frac{1}{2\pi\sqrt{LC}}$	$\frac{1}{2\pi\sqrt{\frac{1}{LC}-\frac{R^2}{L^2}}}$
It magnifies	Voltage	Current
Magnification is	$\frac{\omega o L}{R}$	$\frac{\omega o L}{R}$

4 **A series L–R–C circuit has a sinusoidal input voltage of maximum value 12 V. If inductance, L = 20 mH, resistance, R = 80 Ω, and capacitance, C = 400 nF, determine (a) the resonant frequency, (b) the value of the p.d. across the capacitor at the resonant frequency, (c) the frequency at which the p.d. across the capacitor is a maximum, and (d) the value of the**

	maximum voltage across the capacitor.[AU-DEC-10].(13M)BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao** (a) The resonant frequency, $f_r = \frac{1}{2\pi\sqrt{(LC)}} = \frac{1}{2\pi\sqrt{[(20\times10^{-3})(400\times10^{-9})]}}$ $= \mathbf{1779.4\ Hz}$ (b) $V_C = QV$ and $Q = \frac{\omega_r L}{R}\left(\text{or } \frac{1}{\omega_r CR} \text{ or } \frac{1}{R}\sqrt{\frac{L}{C}}\right)$ Hence $Q = \frac{(2\pi 1779.4)(20\times10^{-3})}{80} = 2.80$ Thus $V_C = QV = (2.80)(12) = \mathbf{33.60\ V}$ (c) From equation (28.7), the frequency f at which V_C is a maximum value, $f = f_r\sqrt{\left(1-\frac{1}{2Q^2}\right)} = (1779.4)\sqrt{\left(1-\frac{1}{2(2.80)^2}\right)}$ $= \mathbf{1721.7\ Hz}$ (d) From equation (28.9), the maximum value of the p.d. across the capacitor is given by: $V_{C_m} = \frac{QV}{\sqrt{\left[1-\left(\frac{1}{2Q}\right)^2\right]}} = \frac{(2.80)(12)}{\sqrt{\left[1-\left(\frac{1}{2(2.80)}\right)^2\right]}} = \mathbf{34.15\ V}$
5	**A coil of inductance 5 mH and resistance 10 Ω is connected in parallel with a 250 nF capacitor across a 50 V variable-frequency supply. Determine (a) the resonant frequency, (b) the dynamic resistance, (c) the current at resonance, and (d) the circuit Q-factor at resonance..(13M)**BTL3 **Answer: Page 1.81-1.86 –Prof.T.Nageswara Rao**

(a) Resonance frequency

$$f_r = \frac{1}{2\pi}\sqrt{\left(\frac{1}{LC} - \frac{R^2}{L^2}\right)} \quad \text{from equation (29.3),}$$

$$= \frac{1}{2\pi}\sqrt{\left(\frac{1}{5 \times 10^{-3} \times 250 \times 10^{-9}} - \frac{10^2}{(5 \times 10^{-3})^2}\right)}$$

$$= \frac{1}{2\pi}\sqrt{(800 \times 10^6 - 4 \times 10^6)} = \frac{1}{2\pi}\sqrt{(796 \times 10^6)} = \mathbf{4490\ Hz}$$

(b) From equation (29.4), dynamic resistance,

$$R_D = \frac{L}{CR} = \frac{5 \times 10^{-3}}{(250 \times 10^{-9})(10)} = \mathbf{2000\ \Omega}$$

(c) Current at resonance, $I_r = \frac{V}{R_D} = \frac{50}{2000} = \mathbf{25\ mA}$

(d) Q-factor at resonance, $Q_r = \frac{\omega_r L}{R} = \frac{(2\pi 4490)(5 \times 10^{-3})}{10} = \mathbf{14.1}$

GE8291 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
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OBJECTIVES:

- ✓ To the study of nature and the facts about environment.
- ✓ To find and implement scientific, technological, economic and political solutions to environmental problems.
- ✓ To study the interrelationship between living organism and environment.
- ✓ To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- ✓ To study the dynamic processes and understand the features of the earth's interior and surface.
- ✓ To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNITI ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14

Definition, Scope and Importance of Environment – Need for Public Awareness - Concept of an Ecosystem – Structure and Function of an Ecosystem – Producers, Consumers and Decomposers – Energy Flow in the Ecosystem – Ecological Succession – Food Chains, Food Webs and Ecological Pyramids – Introduction, Types, Characteristic Features, Structure and Function of the (A) Forest Ecosystem (B) Grassland Ecosystem (C) Desert Ecosystem (D) Aquatic Ecosystems (Ponds, Streams, Lakes, Rivers, Oceans, Estuaries) – Introduction to Biodiversity Definition: Genetic, Species and Ecosystem Diversity – Bio geographical Classification of India – Value of Biodiversity: Consumptive Use, Productive Use, Social, Ethical, Aesthetic and Option Values – Biodiversity at Global, National and Local Levels – India as a Mega-Diversity Nation – Hot-Spots of Biodiversity – Threats to Biodiversity: Habitat Loss, Poaching of Wildlife, Man-Wildlife Conflicts – Endangered and Endemic Species of India – Conservation of Biodiversity: In-Situ and Ex-Situ Conservation of Biodiversity. Field Study of Common Plants, Insects, Birds Field Study of Simple Ecosystems – Pond, River, Hill Slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 8

Definition – Causes, Effects and Control Measures of: (A) Air Pollution (B) Water Pollution (C)Soil Pollution (D) Marine Pollution (E) Noise Pollution (F) Thermal Pollution (G) Nuclear Hazards – Soil Waste Management: Causes, Effects and Control Measures of Municipal Solid Wastes – Role of an Individual in Prevention of Pollution – Pollution Case Studies – Disaster Management: Floods, Earthquake, Cyclone and Landslides. Field Study of Local Polluted Site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

Forest Resources: Use and Over-Exploitation, Deforestation, Case Studies - Timber Extraction, Mining, Dams and Their Effects on Forests and Tribal People – Water Resources: Use and Over-

Utilization of Surface and Ground Water, Floods, Drought, Conflicts Over Water, Dams-Benefits and Problems – Mineral Resources: Use and Exploitation, Environmental Effects of Extracting and Using Mineral Resources, Case Studies – Food Resources: World Food Problems, Changes Caused by Agriculture and Overgrazing, Effects of Modern Agriculture, Fertilizer-Pesticide Problems, Water Logging, Salinity, Case Studies – Energy Resources: Growing Energy Needs, Renewable and Non Renewable Energy Sources, Use of Alternate Energy Sources. Case Studies – Land Resources: Land as a Resource, Land Degradation, Man Induced Landslides, Soil Erosion and Desertification – Role of an Individual in Conservation of Natural Resources – Equitable Use of Resources for Sustainable Lifestyles. Field Study of Local Area to Document Environmental Assets – River / Forest / Grassland / Hill / Mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From Unsustainable to Sustainable Development – Urban Problems Related to Energy – Water Conservation, Rain Water Harvesting, Watershed Management – Resettlement and Rehabilitation of People; its Problems and Concerns, Case Studies – Role of Non-Governmental Organization- Environmental Ethics: Issues and Possible Solutions – Climate Change, Global Warming, Acid Rain, Ozone Layer Depletion, Nuclear Accidents and Holocaust, Case Studies. – Wasteland Reclamation – Consumerism and Waste Products – Environment Production Act– Air (Prevention And Control Of Pollution) Act – Water (Prevention And Control Of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Enforcement Machinery Involved in Environmental Legislation- Central and State Pollution Control Boards- Public Awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population Growth, Variation Among Nations – Population Explosion – Family Welfare Programme – Environment and Human Health – Human Rights – Value Education – HIV / AIDS – Women and Child Welfare – Role of Information Technology in Environment and Human Health – Case Studies.

TOTAL: 45 PERIODS

OUTCOMES:

Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the

- ✓ Public awareness of environmental is at infant stage.
- ✓ Ignorance and incomplete knowledge has lead to misconceptions
- ✓ Development and improvement in std. of living has lead to serious environmental disasters

TEXT BOOKS:

1. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.

2. Benny Joseph, ‘Environmental Science and Engineering’, Tata McGraw-Hill, New Delhi, 2006.

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1. R.K. Trivedi, ‘Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards’, Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, ‘Environmental Encyclopedia’, Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, ‘Environmental law’, Prentice hall of India PVT LTD, New Delhi, 2007.
4. Rajagopalan, R, ‘Environmental Studies-From Crisis to Cure’, Oxford University Press 2005.

Subject Code: GE8291 Year/Semester: I&II /02&04
Subject Name: ENVIRONMENTAL SCIENCE AND ENGINEERING
Subject Handler: Dr.N. BHUVANA

UNIT I - ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems – pond, river, hill slopes,etc.

Q. No.	PART – A
1.	**State the significance and scope of environmental education. May 2011** BTL1 • People will understand the concept of need of development without destruction of environment. • Motivate the active participants in environmental protection and improvement. • Develop a concern and respect for the environment.
2	**Give some important physical hazards and their health effects.** BTL2 • The substance (or) activities that threaten your physical safety. **E.g**. Heat, Cold, Radiation, noise. • **Health effects** – Damage of cells, Skin cancer, Damage of ear drum etc.
3	**Define environment and ecosystem. April 2011, April 2019**BTL1 • **Environment**: The sum of total of all the living and non-living things around us influencing one another. • **Ecosystem**: A group of organisms interacting among themselves and with environment for exchanging energy and matter.
4	**Explain the concept of an ecosystem. (Chen AU Jun 2007, Apr 2011, Dec2013)** BTL2 A group of organism interacting among themselves and with the environment. May be natural like a pond, a lake, a river, an ocean, or a forest or may be manmade like an aquarium, cropland, garden, dam etc.
5	**What are the components of ecosystem?** BTL1 i) Abiotic or Non-living component - Physical components and Chemical components **ii)** Biotic or Living component – Autotrophs (Producers), Heterotrophs (Consumers),

	Saprotrophs (Decomposers-Microconsumers)
6	**Define Ecological succession. (NOV/DEC 2013, April 2019)** BTL1 The progressive replacement of one community by another till the development of stable community in a particular area.
7	**Name the types of consumers.** BTL4 • Herbivores (or) Primary Consumers (plant eater) • Carnivores (or) Secondary Consumers (meat eater) • Omnivores (or) Tertiary Consumers (meat + plant eater)
8	**What are Decomposers?** BTL1 Organisms which feed on dead organisms, plants and animals and decompose them into simpler compounds. Examples – Bacteria, fungi etc.
9	**What are autotrophic and heterotrophic components of an ecosystem? Give examples (Coim. A.U. Dec 2009)** BTL1 • **Autotrophic components** Self-nourishing organisms. The members of autotrophic components are producers. They derive energy from sunlight and make organic compounds from inorganic substances. Examples: Green plants, algae, bacteria, etc., • **Heterotrophic components** Components that dependent on others for food. The members of heterotrophic components are consumers and decomposers. Herbivores, carnivores (or) omnivores. • **Saprotrops:** They are decomposers - bacteria, fungi, etc.
10	**Define the terms producers and consumers. (A.U. May 2008, Dec 2011)** BTL1 • **Producers**-Synthesize their food themselves through photosynthesis. • **Consumers**-Organisms which cannot prepare their own food and depends directly or indirectly on the producers.
11	**Define primary production and secondary production. (Chen A.U. Dec 2008)** BTL1 • **Primary production** - The conversion of radiant energy into organic substances by photosynthesis by producers (Plants). • **Secondary production**- Distribution of energy in the form of food to the consumer (or) the energy stored by the consumer.
12	**What is Ecological pyramids?** BTL1 Graphical representation of structures and function of tropic levels of an ecosystem, starting with producers at the bottom and each successive tropic level forming the apex is known as ecological pyramids.
13	**Name different types of ecosystems**. **(Chen AU Jan 2006)** BTL1 • Natural ecosystem: 1) Terrestrial ecosystem 2) Aquatic ecosystem a. Forest ecosystems b. Grassland ecosystems c. Desert ecosystems d. Pond ecosystem. e. Lake ecosystem f. River ecosystem g. Marine ecosystem • Man-made ecosystem
14	**What are the characteristics of desert ecosystem? (Chen A.U. Dec 2008, June 2018)** BTL1 • The desert air is dry and the climate is hot. • Annual rainfall is less that 25cm.

	• The soil is very poor in nutrients and organic matter. • Vegetation is poor
15	**What is meant by keystone species? (Chen A.U. Dec 2008, June 2018)** BTL1 Within a habitat each species connects and depends on other species. But, while each species contribute to habitat functioning, some species do more than others in the overall scheme of things. Without the work of these key species, the habitat changes significantly. These species are called keystone species. When a keystone species disappears from its habitat, that habitat changes drastically.
16	**What are the types of grassland ecosystem? (Chen A.U. Dec 2010)** BTL1 There are three types of grassland ecosystem based on the climate condition. i) Tropical grassland ii)Temperate grassland iii) Polar grassland
17	**What are food chains? Mention their type**. **(Chen A.U. Dec 2010)** BTL1 **Food chain-**The sequence of eating and being eaten in an ecosystem. **Types :** i) Grazing food chain (from the living green plants goes to grazing herbivores, and on to carnivores) **ii)** Detritus food chain (Primary source of energy is dead organic matter called 'detritus' which are fallen leaves, plant parts or dead animal bodies)
18	**Define Biodiversity (or) What is biodiversity and its significance? (Chen AU Dec 2005, Jun 2006,Apr 2011,Apr 2015)** BTL1 • The variety and variability among all groups of living organisms and the ecosystem in which they occur. **Significance:** • Very important for human life, as we depend on plants, micro-organisms, earth's animals for our food, medicine and industrial products. • Also important for forestry, fisheries and agriculture, which depend on rich variety of various biological resources available in nature. • Protects the fresh air, clean water and productive land. • Loss of biodiversity has serious economic and social costs for any country
19	**Define genetic diversity, species diversity and ecosystem diversity. (TNV AU Dec 2008, Chen AU Dec 2007, May 2008, Dec2010, 2011)** BTL1 • **Genetic diversity**-Diversity of genes within a species. • **Species diversity**–Diversity among species in an ecosystem. • **Ecosystem diversity**-Diversity at the ecological or habitat level.
20	**What are biodiversity hot-spots? (Chen AU Apr 2011)** BTL1 The geographic areas which possess the high endemic species. The two important biodiversity hot spots in India- 1. Eastern Himalayas 2. Western Ghats.
21	**What are the criteria for recognizing hot spots? (Chen AU Dec 2011)** BTL1 • The Richness of the endemic species is the primary criterion for recognizing hot spots • The hot spots should have a significant percentage of specialized species. • The site is under threat. • It should contain important gene pools of plants of potentially useful plants.
22	**India is a mega diversity nation–Account. (Chen A.U. Dec 2008, Dec 2009)** BTL4

	India is one among the 12 mega diversity countries in the world. It has 89,450 animal species accounting for 7.31% of the global faunal species and 47,000 plant species which accounts for 10.8% of the world floral species. The loss of biodiversity or endemism is about 33%.
23	**Give few examples for endangered and endemic species of India. (Chen A.U. Dec 2008)** BTL3 **Endangered species** i) **Reptiles:** Tortoise, python; ii) **Mammals:** Indian wolf, Red fox, Tiger; iii) **Primates:** Hoolock gibbon, Golden monkey; iv) **Plants :** Rauvol serpentina, Santalum **Endemic Species** i) **Flora:** Sapria Himalayan, Ovaria lurida ; **ii) Fauna:** Monitor lizards, Indian salamander
24	**Define endangered and endemic species. (Chen A.U. Dec 2006, Apr 2011, Dec 2014)** BTL2 **EndangeredSpecies**-Species which number has been reduced to a critical level. Unless protected and conserved, it becomes immediate danger of extinction. **Endemic species**-The species which found only in a particular region.
25	**Define in-situ conservation and ex-situ conservation** BTL1 **In-situ conservation** - Protection of fauna and flora within their natural habitat, where the species normally occurs is called in-situ conservation. **Ex-situ conservation** - Protection of fauna and flora outside their natural habitats
26	**Enumerate the human activities which destroy the biodiversity**. **(Chen AU Jan 2006)** BTL2 • The farmers prefer hybrid seeds; as a result many plant species become extinct. • For the production of drugs the pharmaceutical companies collect wild plants, so several medicinal plants now become extinct. • Tropical forest is the main sources of world's medicine. Every year these forests are disappearing due to agriculture, mining and logging
27	**Define food web.** BTL1 A network of food chains where different types of organisms are connected at different tropic levels.
28	**Write the food chain in forest ecosystem.** BTL4 Grasshopper→ Woodpecker →Snake → Owl
29	**Write the food chain in lake ecosystem.** BTL4 Algae → Ciliates →Small fish → Large fish
30	**What is biome?** BTL1 Set of ecosystems which are exposed to same climatic conditions and having dominant species with similar life cyclic, climatic adoptions and physical structure.
31	**What is photosynthesis? (or) How the carbohydrates are produced by plants?** BTL1 Chlorophyll present in the leaves of plants converts CO_2 and H_2O in the presence of sunlight into carbohydrates. $$6CO_2 + 12H_2O \xrightarrow{hr} C_6H_{12}O_6 + 6O_2 + 6H_2O$$
32	**List the different processes of ecological succession.** BTL1 i) Nudation ii) Invasion iii) Competition iii) Reaction iv) Stabilizations
33	**Define extinct, threatened and vulnerable species. (Chen A.U. Dec 2006, Apr 2011, Dec 2014)** BTL2 • **Extinct species –** The species no longer found in the world.

	• **ThreatenedSpecies** Becoming rare and that may become in danger of extinction if current trends continue. • **Vulnerable Species**- Species which population facing continuous decline due to habitat destruction or over exploitation.
34	**Mention the types of lakes.** BTL4 • **Oligotrophic lakes:** Have low nutrient concentrations. • **Eutrophic lakes**: Over nourished by nutrients like N and P. • **Dystrophic lakes**: Have low pH, high humic acid content and brown waters. • **Volcanic lakes**: Receive water from magma after volcanic eruptions. • **Meromictic lakes**: Rich in salts. • **Artificial lakes:** Created due to construction of dams
35	**List the different zones of oceans.** BTL4 • **Coastal zone:** Relatively warm, nutrient rich shallow water, High primary productivity. • **Open sea**: Deeper part of the ocean. Vertically divided into three regions. i) **Euphotic zone:** Receives abundant light and shows high photosynthetic activity ii) **Bathyal zone:** Receives dim light and is usually geologically active. iii) **Abyssal zone:** Dark zone and is very deep (2000 to 5000 meters)
36.	**How do the desert plants adopt to the climate? (MAY 2018)** BTL4 Most of the plants have the ability to lack of rainfall. They have widespread roots which are close to the surface. This enables the roots to absorb water quickly, before it evaporates. Plants like cactus survives because of their thick waxy layer on the outside of its stems and leaves. This helps to retain water and protect tissues severe sunlight.
37.	**Define nitrogen cycle and oxygen cycle.** BTL1 **Nitrogen cycle**-Exchange of nitrogen between the lithosphere and atmosphere in cyclic manner. **Oxygen cycle**-Exchange of O_2 between the lithosphere and atmosphere and hydrosphere in a cyclic manner. Cyclic process of Photosynthesis and respiration.
38.	**What is an indicator species? (MAY 2018)** BTL1 An indicator species is an organism whose presence, absence or abundance reflects a specific environmental condition. Indicator species can signal a change in the biological condition of a particular ecosystem, and thus may be used as a proxy to diagnose the health of an ecosystem**.** Example:Plants or lichens sensitive to heavy metals or acids in precipitation may be indicators of air pollution**.**
PART – B	
1.	
	What is environment? List its types. Explain its scope and significance of environment studies.(13M) BTL2 **Answer: Page: 1.2–1.4-A. Ravikrishnan** **Definition-** The sum of all living and non-living things around us influence one another. (2 M) **Types-** i) Natural environment – naturally created all biotic and non-biotic components. ii) Man-made environment- Created by man. (2 M) **Scope of environmental studies** i) Awareness and sensitivity + related problems.

ii) Motivate active participation.
iii) Identification and solving environmental problems.
iv) Awareness on conservation of natural resources. (4 M)

Significance or importance

i) Environment issues being of internal importance.
ii) Problems cropped in the wake of development.
iii) Explosively increase in pollution.
iv) Need for an alternative solution.
v) Need to save Humanity from extinction.
vi) Need for Wise planning of development. (5 M)

2.

Explain the flow of energy through the atmosphere and its utilities in an ecosystem. (8M)(AU Dec. 2008) BTL2

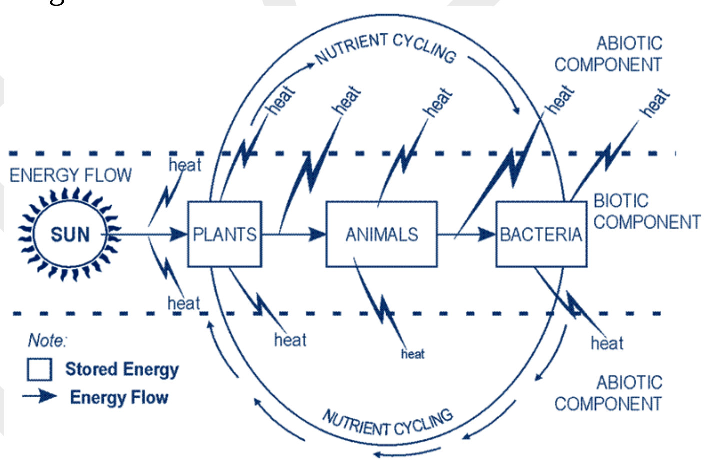
Answer: Page: 2.10–2.11-**A. Ravikrishnan**

Atmosphere → Sunlight major source of energy → Plants (Photosynthesis) Primary Consumer → Secondary consumer → Decomposer

First law of thermodynamics. Plants (Photosynthesis)

Second law of thermodynamics. Primary Consumer → Secondary consumer → Decomposer

- Loss of energy takes place through respiration, running, hunting etc
- Biotic components and abiotic components are linked together through energy flow and nutrient cycling. (5 M)



(3 M)

3.

Explain abiotic and various biotic components of an Ecosystem with neat sketch. (13M) (A.U. Dec 2007, Jan 2018) BTL2

Answer: Page:2.6–2.8-**A. Ravikrishnan**

Abiotic-Nonliving components-Physical and chemical components.(2 M)

Biotic components-Living organisms.

i) **Autotrophs-Producers (Plants)**–Self nourishing Organisms. (3 M)
ii) **Consumers (Animals)** (**Heterotrophs**)–Cannot make their own food. Herbivores-

Carnivores-Omnivores. (3 M)

iii) **Decomposers (Micro-Organisms) (Saprotrops)-** Feed on dead organisms. (3 M)

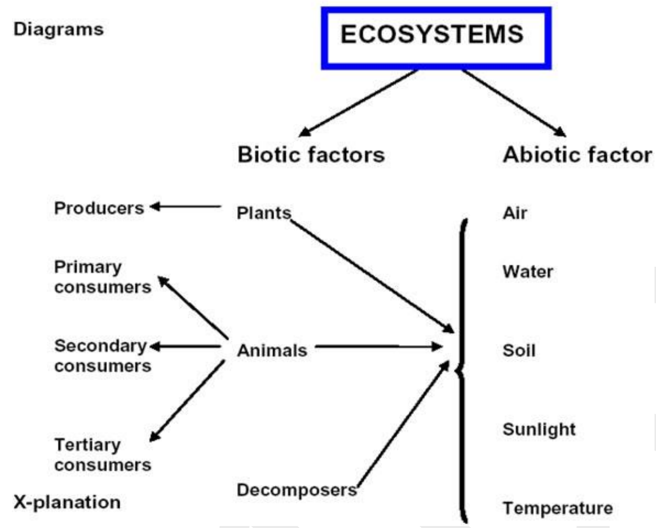


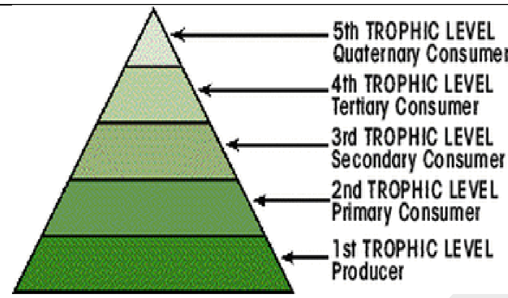
Diagram – (2M)

4.

Write down the ecological succession and ecological pyramid. (13M) (A.U. Dec 2010, Apr 2015, May 2006, Dec 2019) BTL1

Answer: Page: 2.16 – 2.17-A. Ravikrishnan

- **Ecological succession-**The progressive replacement of one community by another till the development of stable community in a particular area. (1 M)
- **Stages of ecological succession** (1 M)
- (i) Pioneer community – First group of organism established their community in the area.
- Seral or seres stage- Variuos developmental stages of a community.
- **Types of ecological succession:**(4M)
- **Primary succession**– Gradual establishment of biotic communities on a lifeless ground
- (a) Hydrarch (or) Hydrosere: Establishment starts in a watery area like pond and lake.
- (b) Xerarch or Xerosere: Establishment starts in a dry area like, desert and rock.
- **Secondary succession**: Establishment of biotic communities in an area, where some type of biotic community is already present.
- **Process of Ecological Succession:** i) Nudation ii) Invasion–migration and establishment iii) competition iv) Reaction and v) Stabilization. (4 M)
- **Ecological Pyramids-**Graphic representation of tropic structure and function of an ecosystem



(3 M)

5.

Explain the structure and function of the following. (i) Forest ecosystem (ii) Grassland ecosystem (iii) Desert ecosystem (iv) Aquatic ecosystem (13M) (A.U. May2011, May 2006) BTL2

Answer: Page: 2.30 – 2.31, 2.33 – 2.34, 2.36 – 2.37, 2.38 – 2.40, 2.43 – 2.44-A. Ravikrishnan

(i) Structure and Function offorest ecosystem:

- **Abiotic components** - Physical components found in the soil and atmosphere. Exs: Climatic factors (temperature, light, rainfall) and minerals.
- **Biotic components-Producers**-Plants-Photosynthesis-Trees, shrubs and ground vegetation.
- **Consumers**-Primary consumers (herbivores)-Ants, flies, insects, mice, deer, squirrels.
- **Secondary consumers** (primary carnivores)- Snakes, birds, fox.
- **Tertiary consumers**-Tigre, lion, etc.
- **Decomposers**–Bacteria and fungi. (3M)

(ii) Structure and Function of Grassland Ecosystem.-

- **Abiotic**–C, H, O, N, P, S etc.–Supplied by rates, nitrates, phosphates and sulphates.
- **Biotic**–Producers–Grasses, forbs and shrubs
- **Consumers**–Cows, cows, buffaloes, deer, sheep
- **Decomposers**–Fungi and bacteria. (3M)

(iii) Structure & Function of Desert Ecosystem-

- **Abiotic**–temperature, rainfall, sunlight, water,
- **Biotic** – Producers – shrubs, bushes, grasses,
- **Consumers**–Squirrels, mice, foxes;
- **Decomposers** – fungi and bacteria. (3M)

(iv) Structure and Function of Aquatic Ecosystem-Pond–Temporary-Fresh water body.

- **Abiotic**– Temperature, light, water, organic and inorganic compounds.
- **Biotic**–Producers–green photosynthetic organisms,
- **Consumers**–Protozoa, small fish, ciliates, flagellates
- **Decomposers**–Fungi, bacteria and flagellates. (2M)

Structure and Function of Aquatic Ecosystem-Lakes–Natural shallow water bodies

- **Abiotic**–Temperature, light, proteins and lipids, turbidity, oxygen and carbon dioxide.
- **Biotic–Producers**–Phytoplanktons, algae, flagellates,
- **Consumers**–Protozoans, insects, small fishes, large fish;

	• **Decomposers**–Bacteria, fungi and actinomycetes. (2M)
6.	
	Classify and explain the values of biodiversity. (13M) (A.U. Dec 2010, May 11, Jan 2018) BTL2 **Answer:Page:3.5 – 3.9-A. Ravikrishnan** **Classify values biodiversity** – Consumptive use values; Productive use values; Social values; Ethical values; Optional values. (1M) **Consumptive use values**–Direct use values; products are harvested and consumed directly. Food, Drugs, Fuel. (2 M) **Productive use values**–Products derived from the animals and plants-commercial value. (2M) **Social values**–Bio-resources used to the society. Associated with the social life, religion and spiritual aspects of the people. (2M) **Ethical values**–"All life must be preserved". In India biodiversity have great value on religious and cultural basis. (2M) **Optional values**–Any species may be proved to be a valuable species after someday. (2M) **Aesthetic values-** Beautiful nature of plants and animals insist us to protect the biodiversity. "Eco-tourism" (2M)
7.	
	Explain the role of biodiversity at global, national and local levels. (13M) (A.U. May 07, Apr 10, May 11, June 2019) BTL2 **Answer: Page: 3.9 – 3.14-A. Ravikrishnan** **Role of Global biodiversity-** Total number of living species in the world are about 20 million. But, of which only about 1.5 million species are found and given scientific names. Tropical deforestation alone is reducing the biodiversity by 0.5% every year. **Terrestrial biodiversity or biomass** i) Largest ecological units present in different geographic areas named in different ways ii) Tropical rain forests –About 50 to 75% of global biodiversity lies in these tropical rain forest. iii) More than 25% of the world's prescription drugs are extracted from plants in tropical rain forest iv) Nearly 1,30,000 flowering plants are found available v) Temperate rain forests - Have much less biodiversity. 1,70,000 flowering plants, 30, 000 vertebrates, 2,50,000 other group of species are found. (3M) **Marine diversity** i) Much higher than terrestrial biodiversity ii) Estuaries coastal waters and oceans are biologically diverse but the diversity is very low iii) Out of 35 existing phyla of multicellular animals, 34 are marine iv) List of few living species (2M) **National level biodiversity**: i) India is second largest nation containing 5% of world's biodiversity and 2% of the earth surface. The second largest nation containing 50% of world's biodiversity and 2% of earth surface.

	ii) 10th rank among the plant rich countries of the world. iii) 11th rank among the endemic species of higher vertebrates. iv) 6th rank among the centers of diversity and origin of agricultural crops. v) An agricultural country and its economic growth depend on the production of many crops. vi) India "mega - diversity" nation because it is rich in both fauna and flora. vii) Many species in India has Medicinal value and Commercial value (5M) **Biodiversity at local level** -1. Point richness 2. Alpha richness 3. Beta richness 4. Gamma richness. (3M)
8.	
	(i) Give the various hot spots of biodiversity.(ii) Explain the various threats to biodiversity along with the means to conserve them. (13M) (May 2008, MAY/JUNE 2013, Dec 2019) BTL4 **Answer: Page: 3.18 – 3.25-A. Ravikrishnan** (i) **Biodiversity hotspot-**The geographic areas which possess high endemic species. Eastern Himalayas, Western Ghats. (2M) **(ii)Threatsto biodiversity** • **Habitat loss-**The loss of populations of interbreeding organisms. Threatened a wide range of animals and plants. Factors influencing habitat loss and any two remedies. (3M) • **Poaching-**Killing of animals (or) commercial hunting. Leads to loss of animal biodiversity. Factors influencing poaching loss and any two remedies to overcome. (3M) • **Man-Wild life conflict-** Arise when wildlife starts causing immense damage and danger to the man. Factor influencing man-wild life conflict and two conserve methods. (3M) • **Over exploitation of natural resources** i) Serious threat to the wildlife. ii) Disturbance in migratory routes of animals. iii) Cause of destruction of many species. (2M)
9.	
	Explain in-situ and ex-situ conservation along with their merits and limitations. (A.U. May 2008, Dec 2010, May 11, Dec 11) (13M) BTL2 **Answer: Page: 3.34 – 3.40-A. Ravikrishnan** **Conservation of Biodiversity:** management of biosphere so that it will yield the greatest sustainable benefit to present generation while maintaining its potential to meet the needs of future generation. (1M) **In-Situ Conservation (within habitat)** - Protection of wild flora and fauna within their habitat nature. (1 M) Biosphere reserves, National Parks, Sanctuaries, Reserve forests etc. (Each 1 M = 4M) **Advantages:** Cheap and convenient method. Species gets adjusted the natural disasters like drought, floods, forest fires. (1 M) **Limitations:** Large surface area of the earth required – shortage of staff and pollution may lead to improper maintenance of the habitat. (1 M)

Ex-Situ Conservation (outside habitat) – Protection of flora and fauna outside their habitat nature. (1 M)
Gene banks, seed banks, zoos, botanical gardens, culture collections. (2 M)
Advantages: Special care and attention lead, Assured food, water, shelter and security, Longer life span. (1 M)
Limitations: Expensive method- Loss of freedom of wild life – Animals cannot survive in such environments. (1 M)

10.

Write a note on endangered and endemic species of India. (13M) (A.U. Dec 2009) BTL2

Answer: Page: 3.28 – 3.33-A. Ravikrishnan
Endangered Species – Species number has been reduced to a critical level. Unless it is protected and conserved, it is in immediate danger of extinction.

i) In India 450 plant species identified as endangered species.
ii) About 100 mammals and 150 birds are endangered species.
iii) India biodiversity threatened due to habitat destruction, degradation and over exploitation.
iv) No. of endangered species in India

Group of Threatened species	Number of Threatened species
Plants	250
Birds	70
Mammals	86
Reptiles	25
Amphibians	3
Fishes	3
Molluscs	2

(6M)

Factors affecting endangered species

- Pollution
- Over exploitation
- Climate change

Remedial measures

- International Treaties on Endangered Species (ITES) (1M)

Endemic Species-Species found only in a particular region

i) In India, Out of 47,000 species 7,000 plants are endemic.
ii) About 62% endemic flora found in Himalayas, Khasi Hills and Western Ghats.
iii) **Fauna-**Animals present in particular region or period. E.g. Sapriya Himalayan, Ovaria lurida, Nepenthes Khasiana, Pedicularis parroter, Pitcher plants and Orchids etc.
iv) Out of 81,000 animal species–Large number of species are described to be endemic
v) 62% amphibians, 50% Lizards are endemic to Western Ghats
vi) No. of endemic species in India
vii)

Group	No. of Species

Land	878
Freshwater	89
Insecta	16214
Amphibia	110
Reptilia	214
Aves	69
Nannakua	38

viii) **Flora**–Plantspresent in a particular region or period. Friendly bacteria which helps to protect the human body against invasion by pathogens. E.g. Monitor lizards, reticulated python, Indian Salamander, Viviparous toad

Group	No. of Species
Pteridophyta	200
Angiosperms	4950

(5M)

Factor affecting endemic species

- Habitat loss and fragmentation
- Pollution (1M)

11.

What are the major causes of Man- wild life conflict? Discuss the remedial steps that can curb the conflict. (13M) (A.U. Dec 2011, Apr 2015) BTL4

Answer: Page: 3.26–3.28-A. Ravikrishnan

Man-Wildlife Conflicts-Causes:

i) Shrinking of forest
ii) Human encroachment into forest areas
iii) Animals suffering from illness, weak and injured take humans
iv) Lack of alternate cultivation practices by forest department
v) Electric fencing causes injury to animals, which in return turn violent
vi) Poor cash compensation by govt. to farmers
vii) Food crops near forest areas attract wild animals. (10 M)

Remedies to curb the conflict

i) Adequate crop and cattle compensation schemes must be started.
ii) Solar powered fencing must be provided along with electric current proof trenches.
iii) Cropping pattern should be changed near the forest borders.
iv) Adequate food and water should be made available within the forest areas.
v) The development and constructional work near the forest area must be avoided. (3 M)

PART – C

1.

(i) Elaborate about the different biological zones of India. (5M) BTL6

(ii) Discuss a case study on (a) Man and wild life conflicts (b) Productive use of biodiversity. (10M) BTL6

Answer: Page: 3.4 – 3.5, 3.26–3.28, 3.8-3.9 A. Ravikrishnan

(i) Biogeographically Classification of India:

i) Division of India according to biogeographic characteristics. The study of the distribution of species, organisms, and ecosystems in geographic space and through geological time. The biogeographic zones of India are as follows:
ii) Himalayan zone; Desert zone; Semiarid zone; Western Ghats zone; Deccan plateau zone; Gangetic plain zone; North east zone; Coastal zone; Islands present near the shore line; Trans Himalayan zone. (5 M)

(ii) Case study on Man-Wildlife Conflicts:

i) Wildlife causing damage and danger to humans and properties – crops/houses
ii) In Samalpur (Orissa) 195 humans were killed in the last 5 years by elephants.
iii) Humans responded by killing 98 elephants and injuring 30 elephants.
iv) In Nepal, 17 peoples were killed in the Royal Chitwan National Park by a man-eating tiger.
v) Electrical fencing, explosives were some of the methods adopted by villages to kill wild animals.

Causes:

i) Shrinking of forest
ii) Human encroachment into forest areas
iii) Animals suffering from illness, weak and injured take humans
iv) Lack of alternate cultivation practices by forest department.
v) Electric fencing causes injury to animals, which in return turn violent
vi) Poor cash compensation by govt. to farmers
vii) Garbage near human settlements or food crops near forest areas. (7 M)

Productive use of biodiversity

Products derived from the animals and plants have obtained a commercial value.

Plant product	Industry
Wood	Paper and pulp industry, plywood industry Railway sleeper industry.
Cotton	Textile industry
Fruits, vegetables	Food industry
Leather	Leather industry
Ivory	Ivory - works
Pearl	Pearls industry

(3M)

2.

Inspect about the characteristic features of a pond, river and marine ecosystem and also quote a typical food chain based on that respective ecosystem. (15M) BTL4

Answer: Page: 2.27 – 2.29, 2.33 – 2.36-A. Ravikrishnan

Pond Ecosystem

i) Small bodies of freshwater with shallow and still water, marsh, and aquatic plants.
i) Temporary, only seasonal.
ii) Stagnant fresh water body.
iii) Get polluted easily due to limited amount of water

iv) The size and depth of ponds often varies greatly
v) Diverse array of aquatic life
vi) Top predators may include large fish, herons, or alligators.(3 M)

Food Chain–Producers-Green plants, phytoplanktons like hydrilla, vallisneria, pistia, sagittaria→**Primary consumers**-Zooplanktons like insects, dragon fly larvae, crustaceans, Larvae of insects, beetles, fishes, molluscs →**Secondary consumers**-Insects like water beetles, frogs, fishes →**Tertiary Consumers-**Big fishes, kingfisher, water birds →**Decomposers**–Fungi, bacteria.
(2M)

River Ecosystem:

i) River viewed as a system operating in its natural environment includes biotic as well as abiotic.
i) Fresh water and free flowing water systems.
ii) Due to mixing of water, dissolved oxygen content is more.
iii) River deposits large amount of nutrients
iv) Unidirectional flow.
v) State of continuous physical change.
High degree of spatial and temporal heterogeneity at all scales. (3M)

Food Chain–**Producers**-Phytoplankton, algae, water grasses, aquatic masses, amphibious plants →**Primary consumers**-Water insects, snails, fishes →**Secondary consumers**-Birds and mammals →**Decomposers**–Fungi, bacteria. (2M)

Ocean Ecosystem:

i) Largest of Earth's aquatic ecosystems.
ii) Include oceans, salt marsh and intertidal ecology estuaries and lagoons, mangroves and coral reefs, the deep sea and the sea floor.
iii) Since ship, submarines can sail in ocean, commercial activities may be carried out.
iv) Rich in biodiversity.
v) Moderates the temperature of the earth
vi) Contrasted with freshwater ecosystems.
vii) Very important for the overall health of both marine and terrestrial environments. (3M)

Food Chain–**Producers**-Phytoplanktons, marine plants →**Consumers-Primary consumers**-Crustaceans, moiluscs, fish →**Secondary consumers**-Herring sahd, mackerel→**Tertiary Consumers**-Cod, Haddock → Decomposers–Fungi, bacteria and flagellates. (2M)

3.

What is forest ecosystem? List the types of forest ecosystem. Explain the features, characteristics, structure and function forest ecosystem. (15M) BTL1

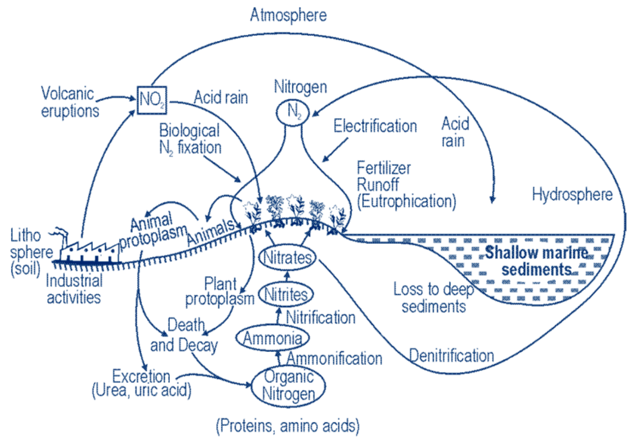
Answer: Page: 2.17–2.21-A. Ravikrishnan

Definition - Contains tall and dense trees grow that support many animals and birds. (2M)

Types of Forest ecosystem

i) Tropical rain forests.
ii) Tropical deciduous forests.
iii) Tropical scrub forests.
iv) Temperate rain forests.

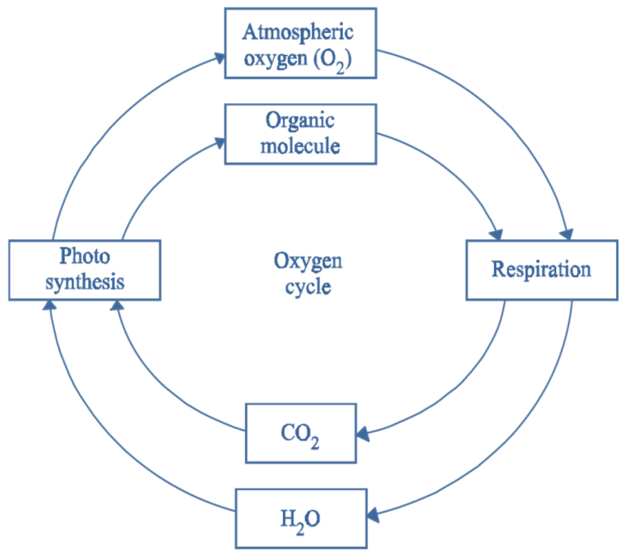
	v) Temperate deciduous forests. (2M) **Features of Forest ecosystems** i) **Tropical rain forests:** Found near the equator. High temperature. Broad leaf trees and lion, tiger and monkey are present. ii) **Tropical deciduous forests:** Found little away from the equator. Warm climate and rain only during monsoon. Have deciduous trees and deer, fox, rabbit and rat. iii) **Tropical scrub forests:** Dry climate for longer time. Have small deciduous trees and shrubs and deer, fox, etc., iv) **Temperate rain forests:** Found in temperate areas with adequate rainfall. Coniferous trees and squirrels, fox, cats, bear etc., v) **Temperate deciduous forests:** Found in areas with moderate temperatures. Broad leaf deciduous trees and deer, fox, bear, etc (4M) **Characteristics of forest ecosystem:** i) Warm temperature and adequate rainfall → Generation of number of ponds, lakes etc., ii) Maintains climate and rainfall. iii) Supports many wild animals and protects biodiversity. iv) The soil is rich in organic matter and nutrients, which support the growth of trees. v) The conversion of organic matter into nutrients is very fast. (2M) **Structure and Function of forest ecosystem:** i) **Abiotic components** - Physical components found in the soil and atmosphere. E.g. Climatic factors and minerals. ii) **Biotic components-Producers**-The plants absorb sunlight and produce food through photosynthesis–E.g. Trees, shrubs and ground vegetation. iii) **Consumers**-Herbivores-E.g. Ants, flies, insects, mice, deer, squirrels. Secondary consumers -primary carnivores-E.g. Snakes, birds, fox. Tertiary consumers- Tiger, lion, etc. iv) **Decomposers**–E.g. Bacteria and fungi. (5M)
4.	
	(i) Survey the following topics with a neat diagram. (a) Nitrogen cycle b) Oxygen cycle c) Energy flow in the ecosystem. (12M) BTL4 **(ii) Analyze in detail about hydrosere and xerosere (3M)** BTL4 **Answer: Page: 2.13 - 2.15 and 2.9 – 2.11 and 2.16-A. Ravikrishnan** **(i)(a) Nitrogen cycle**-Exchange of nitrogen between the lithosphere and atmosphere in cyclic manner. Atmosphere nitrogen → Plants (protein, vitamin, amino acids) → Consumer → Decomposer Nitrates→ammonia by anaerobic bacteria → nitrites by Nitrosomonas → nitrates by Nitrobacter -→ Rhizobium fixing N_2 in the roots. (3M)



(2 M)

(i)(b) Oxygen cycle – Exchange of O_2 between the lithosphere and atmosphere and hydrosphere in a cyclic manner. Cyclic process of Photosynthesis and respiration. (4M)

$$6CO_2 + 6H_2O + Energy \rightarrow C_6H_{12}O_6 + 6O_2\ (Photosynthesis)$$
$$6O_2 + C_6H_{12}O_6 \rightarrow 6O_2 + 6H_2O + Energy\ \ (Respiration)$$



(1 M)

(i)(c)Energy Flow In The Ecosystem

Sunlight → Plants (photosynthesis) → Primary Consumer → Secondary consumer → decomposer

- Loss of energy takes place through respiration, running, hunting etc
- Biotic components and abiotic components are linked together through energy flow and nutrient cycling. (2 M)

(ii) **Hydrosere**–Establishment starting in a watery area; **Xerarch**–Establishment starting in a dry area like, desert and rock. (3 M)

5. **Compare the physical and chemical characteristics of Marine water with terrestrial water. (15 M) (Dec 2018)**BTL4

Answer: Page: 2.37 - 2. and 2.9 – 2.11 and 2.16-A. Ravikrishnan

Marine Ecosystem:

i) Largest of Earth's aquatic ecosystems.
ii) Include oceans, salt marsh and intertidal ecology estuaries and lagoons, mangroves and coral reefs, the deep sea and the sea floor.
iii) Since ship, submarines can sail in ocean, commercial activities may be carried out.
iv) Rich in biodiversity.
v) Moderates the temperature of the earth
vi) Contrasted with freshwater ecosystems.
vii) Very important for the overall health of both marine and terrestrial environments.

Food Chain–**Producers**-Phytoplanktons, marine plants →**Consumers-Primary consumers**-Crustaceans, moiluscs, fish →**Secondary consumers**-Herring sahd, mackerel→**Tertiary Consumers**-Cod, Haddock → Decomposers–Fungi, bacteria and flagellates.

Terrestrial Ecosystem

Characteristics of Forest ecosystem:

vi) Warm temperature and adequate rainfall →Generation of number of ponds, lakes etc.,
vii) Maintains climate and rainfall.
viii) Supports many wild animals and protects biodiversity.
ix) The soil is rich in organic matter and nutrients, which support the growth of trees.
x) The conversion of organic matter into nutrients is very fast.

Structure and Function of forest ecosystem:

v) **Abiotic components** - Physical components found in the soil and atmosphere. E.g. Climatic factors and minerals.
vi) **Biotic components-Producers**-The plants absorb sunlight and produce food through photosynthesis–E.g. Trees, shrubs and ground vegetation.
vii) **Consumers**-Herbivores-E.g. Ants, flies, insects, mice, deer, squirrels. Secondary consumers -primary carnivores-E.g. Snakes, birds, fox. Tertiary consumers- Tiger, lion, etc.

Decomposers–E.g. Bacteria and fungi.

UNIT – II ENVIRONMENTAL POLLUTION

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

Q. No. **PART * A**

1. **Define the term pollution. List its types**. BTL1

Pollution-The unfavorable alteration of our surroundings

Types of Pollution-

- Air Pollution
- Water Pollution
- Soil Pollution
- Marine Pollution
- Noise Pollution
- Thermal Pollution and
- Nuclear hazards

2. **What is air pollution?** BTL1

The presence of one or more contaminants like dust, smoke, mist and odour in the atmosphere which are injurious to human beings, plants and animals.

3. **Define bio-degradable pollutant and non-biodegradable pollutant.** BTL1

Bio-degradable pollutant - Decompose rapidly by natural processes

Non-biodegradable pollutant - Do not decompose or decompose slowly in the environment

4. **State the composition of atmospheric air.** BTL1

Constituents	%
Nitrogen	78
Oxygen	21
Argon (Ar)	< 1
CO_2	0.037
Water vapour	Remaining
O_2, He, NH_3	Trace amount

5. **State the Indian ambient air quality standards.** BTL1

Category	Area	Concentration in µg/m3			
		SPM	SO_2	NO_X	CO
A	Industrial and mixed use	500	120	120	5,000
B	Residential and rural	200	80	80	2,000
C	Sensitive (hill stations, tourist resorts, monuments	100	30	30	1,000

6. **Outline the causes of air pollution?** BTL2

- Incomplete burning of fossil fuels, liberate CO, NO_2, Suspended Particulate Matter (SPM) etc.

- Coal burning in power plants, liberate SO_2
- Ozone
- Agriculture, decay of plants, liberate hydrocarbons.

7.

Define photochemical smog. (NOV/DEC 2006) BTL2

It is not related to smoke (or) fog. It is formed by the combination of NO, NO_2, CO_2, H_2O, CO, SO_2 and unburnt hydrocarbon particles. The important reaction is dissociation of NO_2 in sunlight. It is also named as los Angeles smog.

8.

What are the effects of various air pollutants on human health? BTL1

Name of the Pollutant	Name of the Diseases
NO_2	Lung irritation and damage
CO	Reacts with hemoglobin in red blood cells and reduces the ability of blood to bring oxygen to body cells and tissues, which causes headaches and anemia. At high levels it causes coma, irreversible brain cell damage and death.
SO_2	Breathing problems for healthy people.
SPM	Nose and throat irritation, lung damage, bronchitis, asthma, reproductive problems and cancer
Hydrocarbon	Carcinogenic

9.

What are oxygen demanding wastes? (APR/MAY 2011) BTL1

Oxygen demanding wastes is the one to reduce amount of oxygen water in water is known as oxygen demanding wastes. The oxygen demanding wastes are BOD and COD

BOD is the amount of oxygen required for the biological decomposition of organic matter present in the water.

COD is the amount of oxygen required for chemical oxidation of organic matter using some oxidizing agent like $K_2Cr_2O_7$ and $KMnO_4$

10.

What Is PAN? Give Its Detrimental Effects. BTL1

PAN

- Peroxy Acetyl Nitrates - Secondary Pollutant Present In Photochemical Smog.
- It is a lachrymatory substance.
- It is thermally unstable and decomposes into peroxy ethanol radicals and nitrogen dioxide gas.
- It is an oxidant and more stable than ozone

Detrimental Effects

- It is a powerful respiratory and eye irritants, toxic in nature.
- Cause extensive damage to vegetation, causing skin cancer
- Damages plants and art.
- React explosively.
- Plays a very large role in photochemical smog

11.	**How CFC's are accumulated in atmosphere. (MAY/JUNE 2006)** BTL1 CFC's are accumulated in atmosphere through • Propellant in Aerosol spray cans • Cleaning solvents • Refrigerants (Freon) in refrigerators, air conditioners • Foam plastic blowing agent • Blowing agent
12.	**Define primary air pollutant and secondary air pollutant.** BTL1 **Primary air pollutants -** Those emitted directly in the atmosphere in harmful form. E.g. CO, NO, SO_2, **Secondary air pollutant** – New pollutants formed by the reaction of some of the primary air pollutants with one another or with the basic components of air. E.g. NO /$NO_2 \rightarrow HNO_3$ / NO_3
13.	**State the composition of soil.** BTL1
14.	**State the water quality standards.** BTL1
15.	**List the self-cleaning processes of atmosphere.** BTL4 • Dispersion • Gravitational settling • Flocculation • Absorption • Rain washout and so on

Composition of soil (13):

Components	%
Mineral matter (inorganic)	45
Organic matter	5
Soil water	25
Soil air	25

Water quality standards (14):

S. No.	Parameter	WHO standard in mgs/litre	ISI standard in mgs/litre.
1.	Colour, odour and taste	Colourless, odourless and tasteless	Colourless, odourless and tasteless
2.	p^H	6.9	6.9
3.	Total dissolved solids	1500	-
4.	Dissolved oxygen	-	3.0
5.	Chloride	250	600
6.	Sulphate	400	1000
7.	Nitrate	45	-
8.	Cyanide	0.2	0.01
9.	Fluoride	1.5	3.0
10.	Chromium	0.05	0.05
11.	Lead	0.05	0.1
12.	Arsenic	0.05	0.2

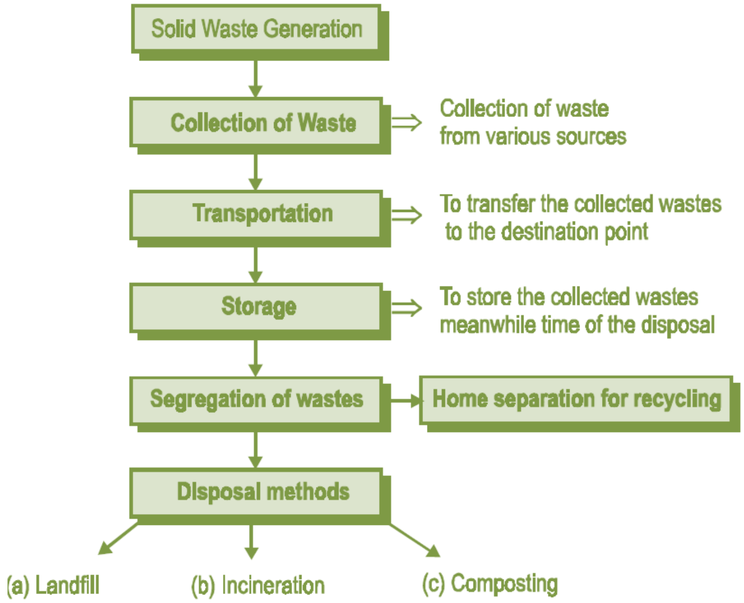
16.	**What are point and non-point sources of water pollution?** BTL1 Point sources are discharged pollutants at specific location through pipes, ditches or sewers into bodies of surface water. Non-point sources: They cannot be traced at any single site of discharge. They are usually large land areas or air sheds that pollute water by runoff, subsurface flow or deposition from the atmosphere.
17.	**Write any four major water pollutants. (MAY/JUNE 2006)** BTL1 • Infectious agents • Oxygen demanding wastes • Inorganic chemicals • Organic chemicals • Plant nutrients • Sediments • Radioactive materials • Heat (any four)
18.	**What is marine pollution? Name the sources and effects of marine pollution. (MAY/JUNE 2005, NOV/DEC 2014)** BTL1 The discharge of waste substances into the sea resulting in harm to living resources, hazards to human health, hindrance to fishery and impairment of quality for use of sea water. • Dumping the wastes - Marine birds ingest plastic which causes gastrointestinal disorders • Oil - Damage to marine fauna and flora, retard the rate of O_2 uptake by water.
19.	**Define noise pollution. When a sound does cause noise pollution? (NOV/DEC 2013, APR/MAY 2015)** BTL1 • Noise pollution is defined as the unwanted, unpleasant or disagreeable sound that causes discomfort for all living beings. • The sound intensity is measured in decibel (dB), which is tenth part of the longest unit Bel. One dB is equal to the faintest sound, a human ear can hear. If the intensity of the sound exceeds 80 dB, noise pollution occurs. Noise above 140 dB becomes painful.
20.	**Give any four methods to control noise pollution. (MAY/JUNE 2007)** BTL1 • Source Control • Transmission Path Intervention • Receptor control • Oiling
21.	**Define thermal pollution. (NOV/DEC 2005, NOV/DEC 2008)** BTL1 The addition of excess of undesirable heat to water that makes it harmful to man, animal or aquatic life or otherwise causes significant departures from the normal activities of aquatic communities in water.
22.	**What are the causes of thermal pollutions?** BTL 1 • Nuclear power plants • Coal-fired power plants • Industrial effluents • Domestic sewage

	• Hydro-electric power
23.	**Define hazardous wastes. Why nuclear hazards are so dangerous? (NOV/DEC 2006)** BTL1 • Wastes like toxic chemicals, radioactive or biological substances which contribute to an increase in mortality or in serious irreversible illness to human health and environment are called hazardous wastes. • Radioactive radiation, liberated by nuclear hazards, affects the cells in the body and the function of glands and organs. People suffer from blood cancer and bone cancer if exposed to doses around 100 to 1000 roentgens. Unlike the other pollution, radioactive pollution can cause genetic disorders even in the subsequent generations.
24.	**What are the various sources of radioactive pollution? (NOV/DEC 2008, APR/MAY 2015)** BTL1 • Natural sources. The very important natural source is space, which emit cosmic rays. Soil, rocks, air, water, food, radioactive radon-222 etc. also contain one or more radioactive substances. • Man-made sources Man-made sources are nuclear power plants, X-rays, nuclear accidents, nuclear bombs, diagnostic kits, etc., where radioactive substances are used.
25.	**List any four causes of floods. (NOV/DEC 2010)** BTL4 • Heavy rain, rainfall during cyclone causes flood. • Sudden snow melt also raises the quantity of water in streams and causes flood. • Clearing of forests for agriculture has also increased severity of floods. • Reduction in the carrying capacity of the channel, due to accumulation of Sediments cause floods
26.	**What are the types of solid wastes? (NOV/DEC 2006, MAY/JUNE 2007)** BTL2 a. Municipal wastes ; b. Industrial wastes ; c. Hazardous wastes
27.	**Mention the sources of solid wastes. (NOV/DEC 2009)** BTL1 • Domestic wastes – cloth, waste papers • Commercial wastes – cans, bottle, polythene bags • Construction wastes – Wood, Concrete • Biomedical wastes – Infectious wastes • Industrial wastes – Nuclear and thermal power plants • Hazardous wastes – Toxic wastes, chronic toxicity
28.	**Differentiate between recycling and reuse. (NOV/DEC 2007, APR/MAY 2011)** BTL4 • Reuse The refillable containers, which discarded after use can be reused. Rubber rings can be made from the discarded cycle tubes which reduces the waste generation during manufacturing of rubber bands. • Recycling Recycling is the reprocessing of the discarded materials into new useful products Example • Old aluminum cans and glass bottles are melted and recast into new cans and bottles

	• Preparation of cellulose insulation from paper.
29.	**What are the roles of women in environmental pollution? (NOV/DEC 2008)** BTL1 In rural areas women plant trees and grass, grow vegetables with the drip-irrigation method on order to save water. b. In urban areas they go shopping using cloth bags to reduce white pollution.
30.	**What are the effects of thermal pollution? (APR/MAY 2011)** BTL1 • Reduction in dissolved oxygen • Increase in toxicity • Interference with biological activity • Interference with reproduction • Direct mortality • Food storage for fish
31.	**What do you meant by soil pollution? Or Define soil pollution. (NOV/DEC 2010) Write the causes of soil pollution.** BTL1 The pollution affects and alter the chemical and biological properties of soil. As a result, hazardous chemical can enter into human food chain from the soil or water disturbs the biochemical process and finally lead to serious effects on living organism.
32.	**What are causes of noise pollution? (NOV/DEC 2010)** BTL1 • By machine like mechanical saws and pneumatic drill. • From transport, rail, air craft, road vehicles like scooters, cars, motorcycles, buses. • Common noise makers are musical instruments, TV, VCR, radios, transistors, • Telephone and loudspeakers.
33.	**What is a Dobson unit? (MAY/JUNE 2007)** BTL1 The amount of atmospheric ozone is measured by "Dobson spectrometer" and is expressed in Dobson units (DU). 1 DU is equivalent to a 0.01 mm thickness of pure ozone at the density it possesses if it is brought to the ground level (1atm) pressure • In temperate latitude its concentration is 350 DU • In tropics its concentration is 250 DU • In sub polar region its concentration is 450 DU
34.	**What are the harmful effects of landslides?** BTL1 • Landslides block the roads and diverts the passage • Erosion of soil increases. • Sudden landslides damage the houses, crop yield, live stock etc.
35.	**What do you know about particulate? (MAY/JUNE 2018)** BTL1 Particulate refers to all atmospheric substances that are not gases. They can be suspended droplets or solid particles or mixtures of the two. Particulates can be composed of materials ranging in size from 100mm to 0.1mm and less. The chemical composition of particulate pollutants is very much dependent upon the origin of the particulate.
36.	**What are landslides? (MAY/JUNE 2018)** BTL1 The movement of earthy materials like coherent rock, mud, soil and debris from higher region to lower region due to gravitational pull is called landslides.
37.	**Define the term Tsunami.** BTL2 A tsunami is a large wave that is generated in a water body when the sea floor is deformed by seismic activity. This activity displaces the overlying water in the ocean.

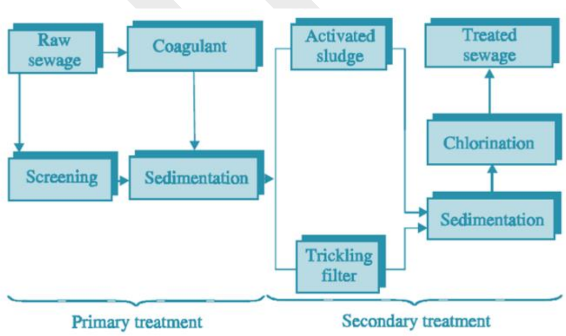
PART * B	
1	**Discuss the causes, effects and control of marine pollution. (7 M) (NOV/DEC 2009, APR/MAY 2010, NOV/DEC 2011)** BTL6 **Answer : Page: 4.32 - 4.34- A. Ravikrishnan** • Definition- The discharge of waste substances into the sea resulting in harm to living organisms, hazards to human health, hindrance to fishery and impairment of quality for use of sea water. (1 M) • Sources (Causes) of marine pollution Dumping the wastes-large amount of sewage, garbage, agricultural discharge, pesticides and huge amount of plastics. (1 M) Oil pollution of marine water-Imposed by petroleum and its products. (1 M) • Effects of marine pollution on human health and environment – Oil spilling in sea inhibit the photosynthesis-damage to marine fauna and flora including algae, fish, birds, invertebrates-hydrocarbons and benzpyrene accumulate in food chain and consumption of fish by man cause cancer. (2 M) • Control measures – Plans for conserving marine biodiversity-education about marine ecosystems-industrial units on the coastal lines equipped with pollution control instruments-urban growth should be regulated-fisherman needs should be accommodated. (2 M)
2	**What is an earthquake? Write about its causes, effects and measures to face the earthquake. (8 M) (APR/MAY 2008, NOV/DEC 2008, NOV/DEC 13, NOV/DEC 2014)** BTL4 **Answer : Refer : 4.78 – 4.80 - A. Ravikrishnan** • Definition: An earthquake is a sudden vibration caused on the earth's surface due to the sudden release of tremendous amount of energy stored in the rocks under the earth's crust. (2 M) • Causes- disequilibrium in any part of the earth crust-volcanic eruption, hydrostatic pressure and manmade activities-underground nuclear testing-decrease of groundwater level. (2M) • Effects- hilly and mountains cause landslides-collapses houses due to poor construction, peoples die increases depending on the severity-seismic waves caused by earth quakes under the sea. (2 M) • Preventive measures-constructing earthquake resistant buildings, wooden houses are preferred – information about magnitude of intensity should give by seismic hazard map by Seismologist. (2 M)
3	**Describe the sources, effects and various measures to control of noise pollution. (7 M) (NOV/DEC 2009, MAY/JUNE 11, NOV/DEC 2014)** BTL4 **Answer : Page:4.37 to 4.40 - A. Ravikrishnan** • **Definition** – The unwanted , unpleasant or disagreeable sound that causes discomfort for all the living beings (1 M) • **Types and sources** Industrial noise-by machines, particularly mechanical saws and pneumatic drill is unbearable and is a nuisance to public.

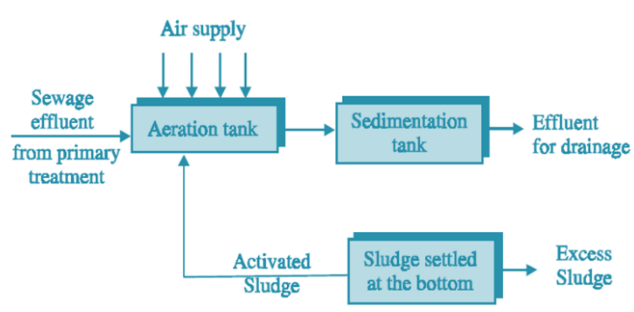
	(1 M) Transport noise-road traffic noise, rail traffic noise and craft noise. (1M) Neighborhood noise-household gadgets and community like musical instruments, transistors, telephones, TV, VCR, radios, etc. (1M) • **Effects** (2M) Interferescommunication Hearing damage (90dB) Physiological and Psychologicaldisorders • **Control and preventive measures** (1M) Reduction in source ofnoise Noise making machines should be kept in containers with sound absorbingmedia Proper oiling will reduce noise frommachinery Using silencers – fibrousmaterial Plantingtrees Legislation can prevent excess sound production, unnecessary horn blowingetc.
4	**What are types, sources and the effects of improper municipal solid waste management? State the measures recommended for proper management for the solid wastes. (7M + 6M) (MAY/JUNE 2005, APR/MAY 2010, NOV/DEC 2010, MAY/JUNE 2011, NOV/DEC 2011, NOV/DEC 2013, APR/MAY 2015)** BTL1 **Answer : Page: 4.61 to 4.70 - A. Ravikrishnan** • Effects of solid wastes (2 M) • Types Urban or municipal wastes Industrial wastes Hazardous wastes (1 M) • Sources Urban or municipal wastes Domestic wastes Commercial wastes Construction wastes Biomedical wastes (1 M) Industrial wastes Nuclear power plants Chemical industries Other industries (1 M) Hazardous wastes Toxic wastes Reactive wastes Corrosive wastes Radioactive wastes Infectious wastes Heavy metals (2 M) • Process of solid waste management Flow chart

	 (2 M) Reduce the usage of raw materials Reuse of waste materials Recycling of material (1 M) • Discarding wastes Landfill – Advantages - Disadvantages (1 M) Incineration - Advantages - Disadvantages (1 M) Composting - Advantages - Disadvantages (1 M)
5	**Mention any five air pollutants with their source, effects and control measures. (7 M) (NOV/DEC 2005, APR/MAY 2006, NOV/DEC2005, MAY/JUNE 2013)** BTL1 **Answer : Page:4.4 to 4.11 - A. Ravikrishnan** • Any five air pollutants (1 M) • Sources, health effects, environmental effects and control measures Carbon monoxide (CO) (1 M) Nitrogen dioxide (NO_2) (1 M) Sulphur dioxide (SO_2) (1 M) Suspended Particulate Matter (SPM) (1 M) Ozone (1 M) Hydrocarbons (Aromatic and aliphatic) (1 M) Any five (5 M) • Control measures (1 M)
6	**How can you, as an individual, prevent environmental pollution? Why such an effort at an individual level is important. (6 M) (NOV/DEC 2009, NOV/DEC 2010,MAY/JUNE 2014, NOV/DEC 2014, APR/MAY 2015)** BTL4 **Answer : Page:4.61 to 4.62 - A. Ravikrishnan** **Role and responsibility of individual participation:** Use stairs instead ofelevators

	Use public transportation walk or ride abicycle Plant trees aroundbuilding Turn off lights, television sets and computer when not inuse. Pay immediate attention to leaks inpipes. Install waste savingequipments. Recycle glass metal andpaper. Compost gardenwaste Segregate waste andrecycle Buy locally made long losingmaterial Buy environmentally degradableproducts. Take some bag from home to market topurchase.
7	**Explain the causes, effects and control measure of water pollution. (13 M) (MAY/JUNE 2013) (NOV/DEC 2013)** BTL42 **Answer : Page: 4.12 to 4.24 A. Ravikrishnan** • **Definition** – The alteration and physical, chemical and biological characteristics of water which may cause harmful effects on humans and aquatic life (1 M) • **Causes:** (4M) Infectious agents Oxygen demanding wastes Inorganic chemicals Organic chemicals Plant nutrients Sediments Radioactive materials Heat Point and non-point sources **Effects of water pollution** (4M) 1. Objectionable colour and odour is unacceptable and unsuitable for drinking and other purposes. 2. highly turbid and very hard water is unpleasant to drink, foodprocessing 3. acid and alkaline water cause serious healthproblem 4. water borne infectious enteric disease like typhoid, cholera, dysentery, are the predominant health hazard arising from drinking contaminatedwater 5. radioactive pollution enter human body through food and get accumulated in thyroid gland, liver, bones andmuscles 6. biodegradable waster deplete D O in the receiving stream, affect the flora cause creates anaerobicconditions 7. non biodegradable waste and pesticides travel the food chain and ultimately reach human where they accumulate in fattytissues 8. thermal discharge in stream depletes DO 9. phosphate, nitrate, promote the growth of algae and encourageeutrophication 10. Industrial effluents result in addition of poisonous chemicals such as arsenic, mercury, lead may reach human body through contaminatedfood.

	Control measures of water pollution (4M) a) lay down standardfor a. drinkingwater b. disposal of waste water into watercourse/sewer/land monitoring b) Waste watertreatment • preliminarytreatment • primarytreatment • secondarytreatment • advancedtreatment
8	**Explain the sources, effects and various measures to control of thermal pollution. (13 M) (MAY/JUNE 2013, NOV/DEC 2013)** BTL4 **Answer : Page:4.40 to 4.46 - A. Ravikrishnan** • Definition The addition of excess of undesirable heat to water that makes it harmful to man, animal or aquatic life of otherwise causes significant departures from the normal activities of aquatic communities in water (1 M) • Sources of thermal pollution Nuclear power plants Coal-fired power plants Industrial effluents Domestic sewage Hydro-electric power (5 M) • Effects of thermal pollution on human health Reduction in dissolved oxygen Increase in Toxicity Interference with biological activities Interference with reproduction Direct mortality Food storage for fish (3 M) • Control measures Cooling towers Cooling ponds Spray ponds Artificial lakes (4 M)
9.	**Give a note on** **(a) Floods** **(b) Cyclone** **(c) Landslides** **(13M)** BTL2 **Answer : Refer : 4.72 – 4.77 - A. Ravikrishnan** • Definition of flood: Whenever the magnitude of water flow exceeds the carrying capacity of the channel within its banks, the excess of water over flows on the surroundings causes

<table>
<tr><td></td><td>floods (1 M)
• Causes and effects (2 M)
• Preventive measures of floods (1 M)
• Definition: Cyclone is a meteorological phenomenon, intense depressions forming over the open oceans and moving towards the land. On reaching the shores, it move into the interior of the land or along the shore lines. (1 M)
• Causes and effects (2 M)
• Preventive measures of cyclone (1 M)
• Definition: The movement of earthy materials like coherent rock, mud, soil and debris from higher region to lower region due to gravitational pull is called landslides. (1 M)
• Causes and effects (2 M)
Preventive measures of landslides (2 M)</td></tr>
<tr><td>10.</td><td>Discuss the significance of parameters of drinking water quality standards. (7 M) (Dec. 2008) BTL2
Answer : Page:4.22 to 4.23 - A. Ravikrishnan
• Physical parameters
Colour
Tastes and Odours
Turbidity and Sediments (2 M)
• Chemical parameters
P^H
Acidity
Alkalinity
Flouride
Nitrogen
Chlorides
Sulphates
Nitrates
Arsenic (6 M)</td></tr>
<tr><td>11.</td><td>With a flow diagram explain the waste water treatment. (7 M) (Dec. 2007) BTL2
Answer : Page:4.20 to 4.22 - A. Ravikrishnan
Flow charts and Diagrams




Activated Sludge Process</td></tr>
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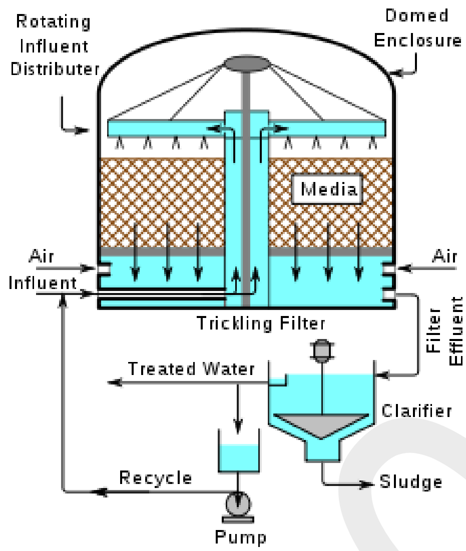


	(1 + 1M) Step-I Preliminary treatment (1 M) Step-II Primary Treatment or Settling Process (1 M) Step-III Secondary or Biological Treatment Trickling Filter Process (1 M) Activated Sludge Process (1 M) Step-IV Tertiary Treatment (1 M) Step-V Disposal of Sludge (1 M)
12.	**Write a note on nuclear hazards (Nuclear pollution). (or) Explain the sources, effects and control measures of radioactive pollution. (7 M) (Dec. 2006)** BTL2 **Answer : Page:4.48 to 4.50 - A. Ravikrishnan** Definition – The presence of radioactive elements in the environment (1M) **Causes**:- (2M) a)Natural Sources: Solar rays Radio nuclides in earth‟s crust Environmental radiation b)Manmade Sourse: Medical X-rays Radio isotopes Nuclear test Nuclear installations Nuclear reactor **Effects:-** (2M) Causes skin burns, loss of teeth, vomiting anemia Blood cancer Brain damage **Control measures:-** (2M) Radiation exposure protection Radiation contamination protection

	Controlled area Disposal of radioactive waste
13.	**Explain the sources, effects and control measures of soil pollution. (8 M)** BTL2 **Answer : Page:4.54 - A. Ravikrishnan** Definition- The contamination of soil which may cause harmful to environment (1 M) Sources and effects Industrial wastes (1 M) Urban wastes (1 M) Agricultural practices (1 M) Radioactive pollutants (1 M) Biological agents (1 M) Control Measures Control of soil erosion Proper dumping of unwanted materials Production of natural fertilizers Proper hygienic conditions Public awareness Recycling and reuse of wastes Ban on toxic chemicals (2M)
	PART – C
1	**Discuss about the following case study (a) Bhopal gas tragedy (b) Gulf War (c) Mercury wastes (15 M)** BTL6 **Answer : Page:4.65,4.68 to 4.69 - A. Ravikrishnan** • **Causes and effects of Bhopal gas tragedy:** (5M) Pesticide factory-Union Carbide- corporation leak large volume of methyl iso cyanate – atmosphere Bhopal- India-midnight on December 3,1984-city- change- gas chamber-within a week 10,000 people died – 1000 people turned blind-lakhs of people still continue to suffer various diseases • **Causes and effects of Gullf War**: (5 M) Gulf war was fought between Iraq and US-Period of 6 weeks in 1991-American fighters dropped a lakh of bombs-force the Iraq army to withdraw from Kuwait- retreat of Iraq-burning of 700 oil wells-near sea shore –oil from well spills out into the sea-the floating oil oversea water nearly 80 km long-burning of oil wells nearly 10 months-released huge amounts of pollutants likeCO_2 and SO_2 into the atmosphere-1 million birdskilled. • **Causes and effects of mercury wastes**: (5 M) Minamata- Small hostel village in Japan –Chicago-chemical company produces Venyl polymer plastics-industry release its effluent into Minamata sea-Effluents by fishes – affect human being through food chain-damage central nervous system-loss of vision and hearing-loss of muscular coordination and severe headache- nervous disorders.
2	**Discuss about the following case study (a) Palar river pollution (b) Textile and dye industries**

	(c) Chernobyl nuclear disaster. (15 M) BTL4 **Answer : Page:4.66, 4.69 - A. Ravikrishnan** **Explanation of Palar river pollution** (5 M) Palar river originates in Nandidurgam of Karnataka state and flows for about 350 km through Karnataka, Andra Pradesh and Tamil Nadu.Palar supply drinking water for several municipalities, towns and villages in Vellore district, Tamil Nadu**.** The effluent from the above industries affect the surface and underground water and make the water unfit for domestic work. The effluent also increase the pH of the soil and affect the cultivation. The rivers like Bhavani, Noyyal and Cauvery get polluted due to mixing of effluent from the above industries. Tamil Nadu Pollution Control Board (TNPCB) has directed all textile printers and dyers of Thirupur to not allow the effluent to mix in the river systems. **Explanation of Textile and dye industries** (5 M) There are nearly 500 dying units and 195 bleaching units operating in and around Tirupur. They consume large quantity of water for processing and later discharge waste water.The effluent from the above industries affect the surface and underground water and make the water unfit for domestic work. The effluent also increase the pH of the soil and affect the cultivation. The rivers like Bhavani, Noyyal and Cauvery get polluted due to mixing of effluent from the above industries. Tamil Nadu Pollution Control Board (TNPCB) has directed all textile printers and dyers of Thirupur to not allow the effluent to mix in the river systems. **Explanation of Chernobyl nuclear disaster** (5 M) Occur at Chernobyl in USSR 28 th April,1986-the reactor exploded- result of uncontrolled nuclear reactions-radioactive fuel spread out in to the surrounding areas –killed at least 20,000 people-damage to soil, water and vegetation around 60km.
3.	**Compare the physical and chemical characteristics of Marine water with terrestrial water. (15 M) (May 2018)**BTL4 **Answer : Page:4.23 to 4.25 and 2.44 to2.46 - A. Ravikrishnan** **Physical and Chemical Characteristics of terrestrial water: (8M)** **The common specifications recommended by the U.S Public Health for Drinking Water are given below.** 1. Water should be clear and odourless. 2. It should be cool. 3. It should be pleasant to taste. 4. Turbidity of the water should not exceed 10 ppm. 5. pH of the water should be in the range of 7.0 - 8.5. 6. Chloride and sulphate contents should be less than 250 ppm. 7. Total hardness of the water should be less than 500 ppm. 8. Total dissolved solids should be less than 500 ppm. 9. Fluoride content of the water should be less than 1.5 ppm. 10. The water must be free from disease-producing bacteria. 11. Water should be free from objectionable dissolved gases like H_2S.

S. No.	Parameter	WHO standard in mgs/litre	ISI standard in mgs/litre.
1.	Colour, odour and taste	Colourless, odourless and tasteless	Colourless, odourless and tasteless
2.	p^H	6.9	6.9
3.	Total dissolved solids	1500	-
4.	Dissolved oxygen	-	3.0
5.	Chloride	250	600
6.	Sulphate	400	1000
7.	Nitrate	45	-
8.	Cyanide	0.2	0.01
9.	Fluoride	1.5	3.0
10.	Chromium	0.05	0.05
11.	Lead	0.05	0.1
12.	Arsenic	0.05	0.2

12.

Water should be free from objectionable minerals such as lead, chromium, manganese and arsenic salts.

UNIT III – NATURAL RESOURCES	
Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and overutilization of surface and ground water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Energy Conversion processes – Biogas – production and uses, anaerobic digestion; case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Introduction to Environmental Biochemistry: Proteins –Biochemical 39 degradation of pollutants, Bioconversion of pollutants. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.	
Q.No.	**PART * A**
1.	**How are forest classified?** BTL2 1. Evergreen forests; 2. Deciduous forests; 3. Coniferous forests
2	**What are the preventive measures of deforestation?** BTL1 • Steps should be taken by the government to discourage the migration of people into the islands from mainland. • To counter the depletion of forest areas, tree plantation programs have been started. • Education and awareness programmes must be conducted. • Strict implementation of law of Forest Conservation Act • Forest fire must be controlled by modern techniques • Use of wood for fuel should be discouraged
3	**Define sustainable forestry (Chen AU Dec 2005)** BTL1 Sustainable forestry is the optimum use of forest resources, which meet the needs of the present without compromising the ability of future generations to meet their own needs.
4.	**Write the functions of forests**. **(Chen A.U. Jun 2006)** BTL2 • Forests perform very important functions both to humans and nature. • They are habitats to millions of plants, animals and wildlife. • They recycle rainwater and remove pollutants from air. They control water quality and quantity • They moderate temperature and weather and help to maintain humidity. • They influence soil Conditions and prevent soil erosion and perform watershed functions. • They promote tourism and contribute aesthetic beauty
5	**Define deforestation. What are the causes of deforestation? (Chen A.U. Jun 2006, Dec 2010)** BTL1 **Deforestation:** The process of destruction of forest (or) process of removal of or elimination of

forest resources due to many natural or man-made activities.
The process of removal
Causes of deforestation: 1. Developmental projects. 2. Mining operations. 3. Raw-materials for industries. 4. Fuel requirements. 5. Shifting cultivation. 6. Forest fires

6 **Differentiate between deforestation and forest degradation. (Chen A.U. Dec 2007, Dec2010)** BTL4

Forest Degradation	**Deforestation**
It is the process of deterioration forest materials.	It is the process of destruction of forest materials.
Slow process	Rapid process.
Can be removed.	Cannot be recovered.

7. **What are the consequences of timber extraction?** BTL1
- Large scale timber extraction causes deforestation.
- Timber extraction leads to soil erosion, loss of fertility, landslides and loss of biodiversity.
- Timber extraction also leads to loss of tribal culture and extinction of tribal people.
- Timber extraction reduces thickness of the forest

8. **List the adverse effects of mining. (TNV A.U. Dec 2009, 2013)** BTL1
- During mining operations, the vibrations are developed, which leads to earthquake.
- When materials are disturbed in significant quantities during mining process, large
- quantities of sediments are transported by water erosion
- Noise pollution is another major problem from mining operations.
- Mining reduces the shape and size of the forest areas.
- Destruction of natural habitat at the mine and waste disposal sites.

9 **State the problems caused by the construction of Dam. (Chen AU Jan 2006)** BTL3
- Displacement of tribal people.
- Loss of non-forest land.
- Loss of forests, flora and fauna.
- Landslips, sedimentation and siltation occur.
- Stagnation and water logging around reservoirs retards plant growth.
- Breeding of vectors and spread of vector-borne diseases.
- Reservoir induced seismicity (RIC) causes earthquakes.
- Navigation and aquaculture activities can be developed in the dam area.

10 **What are the effects of dams on tribal?** BTL1
- The greatest social cost of big dam is the widespread displacement of tribal people, such a biodiversity cannot be tolerated.
- Displacement and cultural change affects the tribal people both mentally and physically. They do not accommodate the modem food habits and life styles
- Tribal people are ill-treated by the modem society.
- Many of the displaced people were not recognized and resettled or compensated.
- Tribal people and their culture cannot be questioned and destroyed.
- Generally, the body conditions of tribal people (lived in forest) will not suit with the new areas and hence they will be affected by many diseases.

11. **Compare merits and problems of dams**. (**Chen A.U. Jun 2007)** BTL4

Merits of dams	Problems of dams
Dams are built to control flood and store flood water.	Displacement of tribal people.
Sometimes dams are used for diverting part or all of the water from river into	Loss of non-forest land.
Dams are used mainly for drinking and agricultural purposes.	Loss of forests, flora and Fauna.
Dams are built for generating electricity.	Water logging and salinity due to over irrigation.
Dams are used for recreational purposes.	Reduced water flow and silt deposition in rivers.
Navigation and fishery can be developed in the dam areas.	Salt water intrusion at river mouth.

12. **Explain flood management**. BTL2

- Floods can be controlled by constructing dams or reservoirs.
- Channel management and embankments also control the floods.
- Encroachment of flood ways should be banned.
- Flood hazard may also be reduced by forecasting or flood warning.

13. **Write short note on mineral resources of India**. **(Coim A.U. Dec 2009)** BTL3

India has the following mineral resources

S.No.	Mineral	Place
1.	Iron	Bihar, Orissa, Tamil Nadu, Goa
2.	Coal	A.P, Bihar, MP, West Bengal
3.	Manganese	MP, Orissa, A.P, Rajasthan
4.	Copper	Bihar, A.P, MP, Orissa
5.	Gold	Karnataka, A.P
6.	Aluminum	MP, TN, Bihar, Orissa
7.	Tin	Bihar, Orissa and Rajasthan
8.	Chromium	Bihar, Orissa, MP, TN

14. **State the environmental effects of (mining) extracting and using mineral resources. (Chen AU Jun 2005)** BTL1

- Devegetation and defacing of landscape
- Ground water contamination
- Surface water pollution
- Air pollution
- Subsidence of land
- During mining operations, the vibrations are developed, which leads to earthquake.
- When materials are disturbed in significant quantities during mining process, large
- quantities of sediments are transported by water erosion
- Noise pollution is another major problem from mining operations.
- Mining reduces the shape and size of the forest areas.
- Destruction of natural habitat at the mine and waste disposal sites.

15	**What do you mean by environmental impact? (Chen A.U. Dec 2006) (or) Define environmental impact statement. (Coim. A.U. Dec 2009)** BTL1 Environmental impact is nothing but the effect on the natural environment caused by various human actions. It includes two types (j) Indirect effects. Example: Pollution. (ii) Direct effects. Example: Cutting down trees
16	**Define overgrazing**. **Write the adverse effects caused by overgrazi**ng. (**TNV A.U. Dec 2008, A.U. May 2008 ,Dec 2013, Chen AU Dec 2006)** BTL1, BTL3 **Overgrazing:** Process of "eating away the forest vegetation without giving it a chance to regenerate". **Effects of overgrazing:** (i) Land degradation (ii) Soil erosion (iii) Loss of useful species
17	**What is water logging? List the effects of water logging.** (**Coim A.U. Dec 2009, Chen AU Dec 2006, Apr 11)** BTL1 Water logging is the land where water stand for most of the year or time. **Problems in water logging**: During water-logged conditions, pore-voids in the soil get filled with water and the soil-air gets depleted. In such a condition the roots of the plants do not get adequate air for respiration. So, mechanical strength of the soil decreases and crop yield falls.
18.	**Enumerate the desired qualities of an ideal pesticide**. (**A.U. Dec 2007)** BTL3 • An ideal pesticide must kill only the target species. • It must be a biodegradable. • It should not produce new pests. • It should not produce any toxic pesticide vapour. Excessive synthetic pesticide should not be used. • Chlorinated pesticides and organophosphate pesticides are hazardous, so they should be used.
19	**Define desertification, land degradation and land slide.** BTL1 **Desertification:** A progressive destruction or degradation of arid or semiarid lands to desert **Land degradation or Soil degradation:** The process of deterioration of soil or loss of fertility of the soil **Land slide:** Landslides are the downward and outward movement of a slope composed of earth materials such as rock, soil, artificial fills.
20	**What are the advantages in conjunctive use of water? (Chen A.U. Dec 2006)** BTL3 • Control of water logging. • Use of saline water, especially for cooling purposed. • Control of salt intrusion in coastal aquifers. • Controlled withdrawal of water from ground water aquifer
21	**What are renewable and non-renewable energy resources? (Chen. A.U. Dec 2009, TCY A.U. Dec 2008, Dec 2009,Apr 2015)** BTL1 Renewable energy resources are natural resources which can be regenerated continuously by the ecological process within a reasonable time period and are inexhaustible. They can be used again and again in an endless manner. Examples: solar energy, wind energy, tidal energy, ocean thermal energy Non-Renewable energy resources are natural resources which cannot be regenerated. E.g. coal,

	petroleum, minerals, oils, ground water
22	**Differentiate renewable and non-renewable sources of energy. (TNV A.U. Dec 2008, 11**) BTL4

Renewable energy	Non-renewable energy
It is regenerated continuously	Cannot be regenerated.
In exhaustible	Exhaustible
It can be used again and again	Cannot be used again
It is pollution free	It pollutes the atmosphere
Available in unlimited amount in nature	Available in limited amount
It is developed in a short period	It is developed in a long period It is developed in a long period

23	**What are the conventional sources of energy for the mankind? (Chen AU Jan 2006)** BTL1 Non-renewable energy resources are natural resources, which cannot be regenerated once they are exhausted. They cannot be used again.
24	**What is geothermal energy? (Coim A.U. Dec 2009)** BTL1 The energy harnessed form the high temperature present inside the earth is called geothermal energy
25	**What is meant by soil erosion? List its types. (Chen A.U. Jun 2007)** BTL1 Soil erosion is the process of removal of superficial layer of the soil from one place to another. Soil erosion also removes the soil components and surface litter. 1. Normal erosion 2. Accelerated erosion
26	**Explain soil leaching**. **(Chen A.U. Dec 2006)** BTL2 1. It removes valuable nutrients from the soil. 2. It may catty buried wastes into ground water and contaminates it.
27	**Mention the factors causing soil erosion**. (**TCY A.U. Dec2008**) BTL4 1. Water 2. Wind 3. Biotic agents 4. Landslides 5. Construction
28.	**What are the present food problems of the world? (Chen A.U. Dec 2010)** BTL4 We know that 79% of the area is covered with water and rest is land, of which most of the areas are forest, desert, mountain, barren area only less percentage of land is cultivated. So the food supplied from the rest of the land is not enough to feed all the people. The problem of population explosion has made it worse. The world population increases and cultivable land area decreases therefore the world food problem arises. Urbanization is another problem in developing countries which deteriorates the agricultural lands.
29.	**What are the effects of over utilization of groundwater? (Chen A.U. Dec 2010)** BTL1 1. Decrease ground water 2. Ground subsidence 3. Lowering of water table 4. Intrusion of salt water 5. Earthquake and landslides 6. Drying up of wells 7. Pollution of water
30.	**Define the term Nuclear energy. (A.U DEC2014, A.U.Apr.2018)** BTL1 Energy released during a nuclear reaction is called nuclear energy. Nuclear reactors produce the nuclear energy either by nuclear fission (or) nuclear fusion. The nuclear power (or) nuclear energy is clean and safe
31.	**Define sustainable life style and bio gas.** BTL1 **Sustainable life style:** Sustainable development is the development of healthy environment without damaging the natural resources. In other words, all the natural resources must be used in such a way that it must be available for the future generation also.

	Bio gas: Mixture of various gases formed by anaerobic degradation of biological matter in the absence of oxygen
	PART * B
1	**Discuss the causes, ill effects and preventive measures of deforestation. (13M) (A.U. Dec 2005, Dec 2014, Apr 2015, A.U. Jan 2006, Dec 09, Apr 2015, A.U. Dec 2006, June 2007, A.U. May 2008)** BTL2 **Answer :Page : 5.7 – 5.9 - A. Ravikrishnan** **Causes (Sources) of Deforestation** **Developmental Projects:** Development projects cause deforestation in two ways. (i) Through submergence of forest area underwater. (ii) Destruction of forest area. Examples. Big dams, hydroelectric projects, construction (1 M) **Mining operations** Mining have a serious impact on forest areas. Mining operation reduces the forest area. Examples Mica, coal, manganese, limestone, etc. (1 M) **Raw materials for industries** Wood is the important raw material for so many purposes. Example - For making boxes, furniture, match-boxes, pulp, etc., (1 M) **Fuel requirements** In India both rural and tribal population depend on the forest for meeting their daily need of fuel wood, which leads to the pressure on forest, ultimately to deforestation. (1 M) **Shifting cultivation:**Replacement of forest ecosystem for monospecific tree plantation can lead to disappearance of number of plant and animal species. Examples: India is the richest nation with more than 15,000 species of plants, many of which is endangered due to deforestation (1M) **Forest fires:**Forest fire is one of the major causes for deforestation. Due to human interruption and rise in ambient temperature, forest fire is happened often nowadays. Thus, due to forest fire thousands of forest area gets destructed. (1 M) **Ill effects of deforestation on the environment** **Global warming:**Cutting and burning of forest trees increases the CO_2 content in the atmosphere, which in turn changes the global climatic pattern, rising sea levels and depletion of the protective ozone layer. **Loss of genetic diversity:**Destruction of our forest destroys the greatest storehouse of genetic diversity on earth, which provides new food and medicines for the entire world **Soil erosion:**Deforestation also causes soil erosion, landslides, floods and drought. Natural vegetation acts as a natural barrier to reduce the wind velocity, this in turn reduces soil erosion. 6000 million tons of soil gets eroded every year in India **Loss of biodiversity:**Most of the species are very sensitive to any disturbance and changes. When the plants no longer exist, animals that depend on them for food and habitat become extinct. **Loss of food grains:**As a result of soil erosion, the countries lose the food grains **Unemployment problems:**The people living around forest areas lose their livelihood **Flood and Landslides:**Frequent floods, landslides in hilly areas and wind speed are heavy. (Any

five Each 1 M = 5 M)

Preventive measures (or) avoid of deforestation (or) methods of conservation of forest

- New plants of more or less the same variety should be planted to replace the trees cut down for timber.
- Use of wood for fuel should be discouraged.
- Forest pests can be controlled by spraying pesticides by using aeroplanes.
- Forest fire must be controlled by modem techniques.
- Over grazing by cattle must be controlled.
- Steps should be taken by the government to discourage the migration of people into the islands from mainland.
- Education and awareness programmes must be conducted.
- Strict implementation of law of Forest Conservation Act (2 M)

2

What are the measures recommended for conservation of natural resources? (7 M) (A.U. June 2005, Jan 2006, A.U. Apr 2010, Dec 2013) BTL2

Answer : Page : 5.76 – 5.80 - A. Ravikrishnan

Measures recommended for (Role of Individual)conservation of natural resource

Conservation of Energy

- Switch off lights, fans and other appliances when not in use.
- Use solar heater for cooking your food on sunny . days, which will cut down your LPG expenses.
- Dry the clothes in sunlight instead of driers.
- Grow trees near the houses and get a cool breeze and shade. This will cut off your electricity charges on AC and coolers.
- Use always pressure cooker.
- Ride bicycle or just walk instead of using car and scoot (2 M)

Conservation of water

- Use minimum water for all domestic purposes.
- Check for water leaks in pipes and toilets and repair them promptly.
- Reuse the soapy water, after washing clothes, for washing off the courtyards, drive ways, etc.,
- Use drip irrigation to improve irrigation efficiency and reduce evaporation.
- The wasted water, coming out from kitchen, bath tub, can be used for watering the plants.
- Build rainwater harvesting system in your house (2 M)

Conservation of soil

- Grow different types of plants, herbs, trees and grass in your garden and open areas, which bind the soil and prevent its erosion.
- While constructing the house don't uproot the trees as far as possible.
- Don't irrigate the plants using a strong flow of water, as it will wash off the top soil.
- Soil erosion can be prevented by the use of sprinkling irrigation.
- Use green manure in the garden, which will protect the soil.
- Use mixed cropping, so that some specific soil nutrients will not get depleted (1 M)

Conservation of Food Resources

- Eat only minimum amount of food. A void over eating.

	• Don't wastes the food instead gives it to someone before getting spoiled. • Cook only required amount of the food. • Don't cook food unnecessarily. • Don't store large amounts of food grains and protect them from damaging insects (1 M) **Conservation of Forest** • Use non-timber products. • Plant more trees and protect them. • Grassing, fishing must be controlled. • Minimise the use of papers and fuel wood. • Avoid of executing developmental work like dam, road, construction in forest areas (1 M)
3	**What are the effects, causes of soil erosion and the methods of preventing it? (7 M)(A.U. Dec 2005,11)** BTL3 **Answer : Page : 5.70 – 5.73 - A. Ravikrishnan** **Soil erosion-** Damage or removal of top soil renders the soil infertile. Erosion may occur in many ways **Effects of soil erosion** (1M) **Causes of (factors causing) soil erosion** Water ; wind; biotic agents; landslides; construction (1 M) **Control of soil erosion (Soil conservation practices)** • Conservation of till farming or no-till-farming (1 M) • Contour farming (1 M) • Terracing (1 M) • Alley cropping or agro forestry (1 M) • Wind breaks or shelter belts (1 M) Decreasing soil pollution is also a method which helps in soil conservation
5	**Discuss briefly on the consequences of overdrawing of ground water. (13 M) (A.U. Dec 2006)** BTL2 **Answer : Page : 5.19 – 5.21 - A. Ravikrishnan** **Decrease of Ground Water :** Due to increased usage of ground water, the ground water level decreases. Reason (a) The erratic and inadequate rainfall results in reduction in storage of water in reservoirs. (b) The building construction activities are sealing the permeable soil zone, reducing the area for percolation of rain water and increase in surface runoff (2 M) **Ground subsidence** When the ground water withdrawal is more than the recharge rate, the sediments in the aquifer get compacted which results in sinking of over lying land surface. This process is known as ground subsidence. (2M) **Lowering of water table** Over utilization of ground water in arid and semi-arid regions for agriculture disturbs the state of equilibrium of the reservoir (disturb the hydrological cycle) in the region. This causes following problems. (1 M) **Intrusion of salt water**

	In coastal areas, over exploitation of ground water would lead to rapid intrusion of salt water from sea.(2M) **Earthquake and landslides** Over-utilization of ground leads to decrease in water level, which cause earth quake, landslides and famine (2M) **Drying up of wells** As a result of over utilization of ground water, the level of ground water getting depleted at much faster rates than they can be regenerated. This leads to drying up of dug as well as bore wells. (2M) **Pollution of water** When ground water level near the agricultural land decreases, water, containing the nitrogen as nitrate fertilizer, percolates rapidly into the ground and pollute the ground water (2M)
6	**Write a brief note on changes caused by agricultural and overgrazing. (7 M) (A.U May 2007, Dec 2014)** BTL2 **Answer : Page : 5.36 – 5.38 - A. Ravikrishnan** **<u>Overgrazing:</u>** Process of, "eating away the forest vegetation without giving it a chance to regenerate" **<u>Agriculture</u>**: An art, science and industry of managing the growth of plants and animals for human use. (1 M) **<u>Effects (or) impacts of overgrazing</u>** **<u>Land degradation</u>** ✓ Overgrazing removes the cover of vegetation over the soil and the exposed soil gets compacted. ✓ So the roots of plant cannot go much deep into the soil and the adequate soil moisture is not available. ✓ Thus, overgrazing leads to organically poor, dry, compacted soil, this cannot be used for further cultivation. (1 M) **<u>Soil erosion</u>** ✓ Due to overgrazing by livestock, the cover of vegetation gets removed from the soil. ✓ The roots of the grass are very good binders of the soil. ✓ The soil becomes loose by the action of wind and rainfall. (1 M) **<u>Loss of useful species</u>** ✓ Overgrazing also affects the composition of plant population and other regeneration capacity. ✓ When livestock grazes the grasses heavily, the root stocks, which carry the food reserve gets destroyed. (1 M) **<u>Traditional agriculture:</u>** ✓ It involves small plot, simple tools, surface water, organic fertilizers and a mix of crops. ✓ They produce enough and a mix of crops. They produce enough food for their families and to sell it for their income **<u>Effects (or) impacts of Traditional agriculture</u>** **<u>Deforestation:</u>** ✓ Cutting and burning of trees in forests to clear the land for cultivation results in loss of forest cover.

	Soil erosion: ✓ Clearing of forest cover exposes the soil to wind and rainfall, resulting in loss of top fertile soil layer. **Loss of nutrients:** ✓ During cutting and burning of trees, organic matter in the soil gets destroyed and most of the nutrients are taken up by the crops within a short period (each 1M)
7	**Explain how the alternate energy sources play an important role in environmental impact.(8 M) (A.U. May 2007)** BTL4 **Answer : Page : 5.63 – 5.64 - A. Ravikrishnan** **Need of Alternate (Renewable) Energy Sources (or) Role of Alternate (Renewable) Energy sources in environmental impact** 1. The importance of solar energy can be emphasized particularly in view of the fact that fossil fuels and other conventional sources are not free from environmental implications. 2. Energy sources which have least pollution, safety and security snags and are universally available have the best enhance of large scale utilization in future. 3. Hydro-electric power generation is expected to upset the ecological balance existing on earth. 4. Besides space heating, hydroelectric power plants critically pollute the aquatic and terrestrial biota 5. Radioactive pollutants released from nuclear power plants are chronically hazardous. The commissioning of boiling water power reactors (BWRS) have resulted in the critical accumulation of large number of long lived radionuclides in water. 6. The dangerous radiowaste cannot be buried in land without the risk of polluting soil and underground water. Nor the waste can be dumped into the rivers without poisoning aquatic life and human beings as well. 7. The burning of coal, oil, wood, dung cakes and petroleum products have well debated environmental problems. The smoke so produced causes respiratory and digestive problems leading to lungs, stomach and eye diseases. 8. The disposal of fly ash requires large ash ponds and may pose a severe problem considering the limited availability of land. So, the non conventional sources of energy needed (8 M)
8	**Discuss the effects of timber extraction, effects of dams on forests and tribal people. (7 M) (A.U. May 2008, Dec 2013)** BTL2 **Answer : Page : 5.11, 5.13 – 5.15 - A. Ravikrishnan** **Consequences (or) effects of timber extraction** 1. Large scale timber extraction causes deforestation. 2. Timber extraction leads to soil erosion, loss of fertility, landslides and loss of biodiversity. 3. Timber extraction also leads to loss of tribal culture and extinction of tribal people. 4. Timber extraction reduces thickness of forest (1M) **Effects of dam on Forest** 1. Thousands of hectares of forest have been cleared for executing river valley projects. 2. In addition to the dam construction, the forest is also cleared for residential accommodation, office buildings, storing materials, laying roads, etc., 3. Hydroelectric projects also have led to widespread loss of forest in recent years.

	4. Construction of darns under these projects led to killing of wild animals and destroying aquatic life. 5. Hydroelectric projects provide opportunities for the spread of water borne diseases. **6.** The big river valley projects also cause water logging which leads to salinity and in tum reduces the fertility of the land. (3M) **Effects of dam on tribal people** 1. The greatest social cost of big dam is the widespread displacement of tribal people, such a biodiversity cannot be tolerated. 2. Displacement and cultural change affects the tribal people both mentally and physically. They do not accommodate the modem food habits and life styles. 3. Tribal people are ill-treated by the modem society. 4. Many of the displaced people were not recognized and resettled or compensated. 5. Tribal people and their culture cannot be questioned and destroyed. **6.** Generally, the body conditions of tribal people (lived in forest) will not suit with the new areas and hence they will be affected by many diseases (3 M)
9	**(i) Discuss the problems of fertilizer and pesticide on modern agriculture. (7 M) (A.U. May 2008, Dec 2010)** BTL2 **(ii) List the desired qualities of pesticide. (2M)** BTL4 **(i) Answer : Page : 5.38 – 5.40 - A. Ravikrishnan** **Problems in using fertilizer** **<u>(a) Micronutrient imbalance</u>** ✓ Most of the chemical fertilizers, used in modem agriculture, contain nitrogen, phosphorus and potassium (N, P, K), which are macronutrients. ✓ When excess of fertilizers are used in the fields, it causes micronutrient imbalance. ✓ Examples: Excessive use of fertilizer in Punjab and Haryana has caused deficiency of the micronutrient zinc in the soil, which affects the productivity of the soil. (1M) **<u>(b) Blue Baby syndrome (Nitrate pollution)</u>** ✓ When Nitrogenous fertilizers are applied in the fields, they leach deep into the soil and contaminate the ground water. ✓ The nitrate concentration in the water gets increased. ✓ When the nitrate concentration exceeds 25 mg / lit, they cause serious health problem called "Blue Baby syndrome". ✓ This disease affects infants and leads even to death. (1M) **<u>(c) Eutrophication.</u>** ✓ A large proportion of N and P fertilizers, used In crop field is washed off by the runoff water and reaches the water bodies causing over nourishment of the lake. This process is known as Eutrophication. ✓ Due to eutrophication lake gets attacked by algal bloom. ✓ These algal species use up the nutrients rapidly and grow very fast. ✓ Since the time of algal species is less they die quickly and pollute the water, which in turn affect the aquatic life. (1M) **<u>Problems in using pesticides</u>**

	In order to improve the crop yield, lot of pesticides are used in the agriculture. (i) First generation pesticides - Sulphur, arsenic, lead or mercury are used to kill the pests. (ii) Second generation pesticides - DDT (Dichloro Diphenyl Trichloromethane) kill the pests. Although these pesticides protect our crops from huge losses due to pests, they produce number of side-effects. **i. <u>Death of non-target organisms</u>** ✓ Some pest species usually survive even after the pesticide spray, which generates highly resistant generations. ✓ They are immune to all type of pesticides and are called super pests. (1 M) **i. Producing new pests** ✓ Some pest species usually survive even after the pesticide spray, which generates highly resistant generations. ✓ They are immune to all type of pesticides (1 M) **(c)Bio-magnification** ✓ Many of the pesticides are non-biodegradable and keep on concentrating in the food chain. ✓ This process is called bio-magnification. ✓ These pesticides in a bio-magnified form are harmful to the human beings. (1 M) (d)**Risk of cancer** ✓ Pesticides enhance the risks of cancer in two ways. ✓ It directly acts as carcinogens. ✓ It indirectly Suppress the immune system. (1 M) **(ii) Answer : Page : 5.40 - A. Ravikrishnan** **<u>Desired qualities of an ideal pesticide</u>** ✓ An ideal pesticide must kill only the target species. ✓ It must be a biodegradable. ✓ It should not produce new pests. ✓ It should not produce any toxic pesticide vapour. ✓ Excessive synthetic pesticide should not be used. ✓ Chlorinated pesticides and organophosphate pesticides are hazardous, so they should not be used (2 M)
10	**Explain the environmental impacts of mineral extraction (mining) and uses (7 M) (A.U. Dec 2009, Apr 2015)** BTL2 **Answer : Page : 5.29 – 5.31 and 5.24 – 5.26 - A. Ravikrishnan** **Mining:** Mining is the process of extraction of metals from a mineral deposit. **Types of mining** (a) **Surface mining:** Surface mining is the process of extraction of raw materials from the near surface deposits (b) **Underground mining**: The process of extraction of raw materials below the earth's surface. It includes, (c) **Open-pit mining**: Open-pit mining machines dig holes and remove the ores. Example: Iron, copper, limestone, and marble etc

	Environmental damage, caused by mining activities **Devegetation and defacing of landscape:** Topsoil as well as the vegetation are removed from the mining area. Large scale deforestation or devegetation leads to several ecological losses and also landscape gets badly affected**.** (1 M) **Groundwater contamination**: Mining disturbs and also pollutes the ground water. Usually sulphur, present as an impurity in many ores, gets converted into sulphuric acid due to microbial action, which makes the water acidic. Some heavy metals also get leached into groundwater (1 M) **Surface water pollution:** Drainage of acid mines often contaminates the nearby streams and lakes. The acidic water is harmful to many aquatic lives. Radioactive substances like uranium also contaminate the surface water and kill many aquatic animals.(1 M) **Air pollution:** Smelting and roasting are done to purify the metals, which emits enormous amounts of air pollutants damaging the nearby vegetation. The suspended particulate matter (SPM), SOx arsenic particles, cadmium, lead, etc., contaminate the atmosphere and public suffer from several health problems.(1 M) **Subsidence of land:** It is mainly associated with underground mining. Subsidence of mining area results in cracks in houses, tilting of buildings, bending of rail. (1 M) **Effects of over exploitation of Mineral resources** 1. Rapid depletion of mineral deposits. 2. Over exploitation of mineral resources leads to wastage and dissemination of mineral deposits. 3. Over exploitation of mineral resources causes environmental pollution. 4. Over exploitation needs heavy energy requirement (1 M) **Uses of mining** The extraction of metals and other materials from a mineral deposit by mining has verity of uses. 1. Development of industrial plants and machinery. Examples - Iron, aluminium, copper, etc., 2. Construction, housing, settlements. Example - Iron, aluminium, nickel, etc., 3. Jewellery – Example - Gold, silver, platinum and diamond 4. Generation of energy. Example – Coal, Lignite, Uranium etc 5. Designing of defence equipments, weapons, ornaments **6.** Agriculture purposes, as fertilizers, seed dressings and fungicides. Example Zineb – containing zinc and Maneb - containing manganese. (1 M)
11	**Explain the various food resources. (7 M) (A.U. Apr 2010, Apr 2015, Dec 2010)** BTL2 **Answer : Page : 5.33 – 5.36 - A. Ravikrishnan** **Food Resources** Food is an essential requirement for the human survival. Each person has a minimum food requirement. The main components of food are carbohydrates, fats, proteins, minerals and vitamin (1 M) **Types of Food Supply** Historically humans have dependent on three systems for their food supply. **1. Croplands:** It mostly produces grains and provide about 76% of the world's food. (1 M)

	Examples: Rice, wheat, maize, barley, sugarcane, potato, etc **2. Rangelands:** It produces food mainly from the grazing livestock and provide about 17% of the world's food. Examples: Meat, milk, fruits, etc., (1 M) **3. Oceans:** Oceanic fisheries supply about 7% of the world's food. Examples: Fish, prawn, crab, etc. (1 M) **Major Food Sources** Earth is provided with more than thousands of edible plants and animals. However only 15 plants and 8 terrestrial animal species supply 90% of our global intake of calories. Examples: Rice, wheat, maize, potato, barley, sugarcane, pulses, fruits, vegetables, milk, meat, fish and sea food. Rice, wheat and maize are the major grains, provide more than 50% of the calories people consume.(2 M) **World food problem** (1 M)
13	**Explain the various conventional (nonrenewable) energy resources. (7 M) (A.U. Dec 2010)** BTL2 **Answer : Page : 5.56 – 5.60 - A. Ravikrishnan** Coal – (1 M), Petroleum – (2 M) LPG - (1 M) Natural gas - (1 M) Nuclear energy - (2 M)
12	**Discuss in detail the over-exploitation of forests. (7 M) (A.U. Dec 2010)** BTL2 **Answer : Page : 5.6 – 5.7 - A. Ravikrishnan** **Over Exploitation of Forest** • Due to overpopulation the materials supplied by the forest like food, medicine, shelter, wood and fuel is not sufficient to meet the people's demand. • Hence exploitation of forest materials is going on increasing day by day. • With growing civilization, the demand for raw materials like timber, pulp, minerals, fuel wood, etc., increases resulting in large scale logging, mining, road building and cleaning of forests (3 M) **Reason for over exploitation in India** It has been estimated that in India the minimum area of forests required to maintain good ecological balance is about 33% of total area. But, at present it is only about 22%. So over exploitation of forest materials occur. (2 M) **Causes of over exploitation** (a) Increasing agricultural production. (b) Increasing industrial activities. (c) Increase in demand of wood resources (2 M)
13	**Discuss any four factors responsible for land degradation. (8 M) (A.U. Dec 2010,May 11,Dec 2013, A.U. Dec 2014)** (BTL2 **Answer : Page : 5.69 – 5.70 - A. Ravikrishnan** **Causes of (or factors influencing) land degradation** 1. **Population:** As population increases, more land is needed for producing food, fibre and fuel wood. Hence there is more and more pressure on the limited land resources, which are getting degraded due to over exploitation. (2 M) 2. **Urbanization:** The increased urbanization due to population growth reduce the extent of

	agricultural land. To compensate the loss of agricultural land, new lands comprising natural ecosystems such as forests are cleared. Thus urbanization leads to deforestation, which intum affects millions of plant and animal species. (2 M) 3. **Fertilizers and pesticides:** Increased applications of fertilizers and pesticides are needed to increase farm output in the new lands, which again leads to pollution of land and water and soil degradation. (1 M) 4. **Damage of top soil:** Increase in food production generally leads to damage of top soil through nutrient depletion. (1 M) 5. Water-logging, soil erosion, salination and contamination of the soil with industrial wastes all cause land degradation. (2 M)
15	**What are the ecological services rendered by forests? Discuss. (7 M) (A.U. Dec 2010)** BTL2 and BTL1 **Answer : Page : 5.2 – 5.5 - A. Ravikrishnan** List the ecological uses of forest (1 M) **Ecological Uses or services rendered by forest** **Production of oxygen:** During photosynthesis trees produce oxygen which is essential for life on earth. (1 M) **Reducing global warming:** The main greenhouse gas carbon dioxide (CO_2) is absorbed by the trees (forests). Trees absorb the main greenhouse gas CO_2 which is a raw material for photosynthesis. Thus the problem of global warming, caused by greenhouse gas CO_2, is reduced. (1 M) **Soil conservation:** Roots of trees (forests) bind the soil tightly and prevent soil erosion. They also act as wind breaks. (1 M) **Regulation of hydrological cycle:** Watersheds in forest act like giant sponges, which absorb rainfall, slow down the runoff and slowly release the water for recharge of springs. (1 M) **Pollution moderators**: Forests can absorb many toxic gases and noises and help in preventing air and noise pollution. (1 M) **Wildlife habitat:** Forests are the homes of millions of wild animals and plants. (1 M)
16.	**What is land degradation? Explain the causes and effects land (soil) degradation. (7 M) (AU A.U. Dec 2010,May 11,Dec 2013, A.U. Dec 2014)** BTL2 **Answer : Page : 5.69 – 5.70 - A. Ravikrishnan** **Land degradation:** The process of deterioration of soil or loss of fertility of the soil (1 M) **<u>Causes of land degradation (or) factors responsible for land degradation</u>** **1. Population:** ✓ As population increases, more land is needed for producing food, fibre and fuel wood. ✓ Hence there is more and more pressure on the limited land resources, which are getting degraded due to over exploitation.(1M) **2. Urbanization:** ✓ The increased urbanization due to population growth reduce the extent of agricultural land. To compensate the loss of agricultural land, new lands comprising natural ecosystems such as forests are cleared. ✓ Thus urbanization leads to deforestation, which in turn affects millions of plant and animal species. (1M)

	3. **Fertilizers and pesticides:** ✓ Increased applications of fertilizers and pesticides are needed to increase farm output in the new lands, which again leads to pollution of land and water and soil degradation. (1M) **4. Damage of top soil:** ✓ Increase in food production generally leads to damage of top soil through nutrient depletion. (1M) 5. Water-logging, soil erosion, salination and contamination of the soil with industrial wastes all cause land degradation (1M) **<u>Harmful effects of land (soil) degradation</u>** ✓ The soil texture and structure are deteriorated. ✓ Loss of soil fertility, due to loss of invaluable nutrients. ✓ Increase in water logging, salinity, alkalinity and acidity problems. ✓ Loss of economic social and biodiversity. (1 M)
17.	**What is desertification? Describe the causes and effects of desertification. (7 M) (AU May 2015, Dec. 2016)** BTL2 **Answer : Page : 5.74 – 5.75 - A. Ravikrishnan** **Desertification:** A progressive destruction or degradation of arid or semiarid lands to desert (1M) **<u>Causes of desertification (or) reason for desertification</u>** **1. <u>Deforestation:</u>** ✓ The process of denuding and degrading a forest land initiates a desert. ✓ If there is no vegetation to hold back the rain water, soil cannot soak and groundwater level do not increases. ✓ This also increases, soil erosion, loss of fertility. **2. <u>Over grazing:</u>** ✓ The increase in cattle population heavily graze the grass land or forests and as a result denude the land area. ✓ The denuded land becomes dry, loose and more prone to soil erosion and leads to desert. **3. <u>Water Management:</u>** ✓ Over utilization of groundwater, particularly in coastal regions, resulting in saline water intrusion into aquifers, which is unfit for irrigation. **4. <u>Mining and quarrying :</u>** ✓ These activities are also responsible for loss of vegetal cover and denudation of extensive land area leading to desertification. **5. <u>Climate change:</u>** ✓ Formation of deserts may also take place due to climate change, ie., failure of monsoon, frequent droughts. 6. **<u>Pollution:</u>** ✓ Excessive use of fertilizers and pesticides and disposal of toxic water into the land also leads to desertification (Each 1 M; any 5 = 5 M) **<u>Harmful effects of desertification</u>** ✓ Around 80% of the productive land in the arid and semi-arid regions are converted into

desert.

- ✓ Around 600 million people are threatened by desertification. (1 M)

18.

Describe the following effects and their remedies on modern agriculture. (a) Water logging (b) Salinity. (7 M) BTL2

(a) Answer : Page : 5.40 - A. Ravikrishnan

Water logging: The land where water stand for most of the year.

Causes of water logging

- ✓ Excessive water supply to the croplands.
- ✓ Heavy rain.
- ✓ Poor drainage. (1 M)

Problems (or) Effects in water logging

- ✓ During water-logged conditions, pore-voids in the soil get filled with' water and the soil-air gets depleted.
- ✓ In such a condition the roots of the plants do not get adequate air for respiration. So, mechanical strength of the soil decreases and crop yield falls. (1 M)

Remedy for water logging

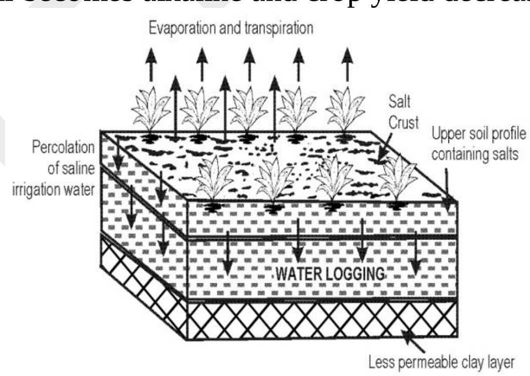
- ✓ Preventing excessive irrigation, sub surface draining technology and bio-drainage by trees like Eucalyptus tree are some method of preventing water logging. (1 M)

(b) Answer : Refer page : 5.41 - A. Ravikrishnan

Salinity: The water, not absorbed by the soil, undergo evaporation leaving behind a thin layer of dissolved salts in the topsoil**.** This process of accumulation of salts is called the salinity. (1 M)

Problems in Salinity

- ✓ Most of the water, used for irrigation comes only from canal or ground, which unlike rainwater contains dissolved salts. Under dry climates, the water gets evaporated leaving behind the salt in the upper portion of the soil.
- ✓ Due to salinity, the soil becomes alkaline and crop yield decreases. (1 M)



(1M)

Remedy for salinity

- ✓ The salt deposit is removed by flushing them out by applying more good quality water to such soils.
- ✓ Using sub-surface drainage system the salt water is flushed out slowly (1 M)

PART – C QUESTIONS

1 **Discuss the world food problems in detail and how does it affects other resources. (15 M) (A.U. May2011)** BTL4

	Answer : Page : 5.34 – 5.42 - A. Ravikrishnan **World Food problems** 1. We know that 79% of the total area of the earth is covered with water. Only 21% of the earth surface is land, of which most of the areas are forest, desert, mountains, barren areas, only less percentage of the land is cultivated. So the food supplied from the rest of the land is not enough to feed all the people. The problem of population explosion has made it worse. The world population increases and cultivable land area decreases. Therefore world food problem arises. 2. Environmental degradation like soil erosion, water logging, water pollution, salinity, affect agricultural lands. 3. Urbanisation is another problem in developing countries, which deteriorates the agricultural lands. 4. Since the food grains like rice, wheat, com and the vegetable like potato are the major food for the people all over the world, the food problem raises. 5. A key problem is the human activity, which degrade most of the earth's net primary productivity which supports all life (5 M) **Effects (or) impacts of overgrazing** **1. Land degradation 2. Soil erosion 3. Loss of useful species**(3 M) **Effects (or) impacts of agriculture** **Effects (or) impacts of Traditional agriculture** **a.** Deforestation: Cutting and burning of trees in forests to clear the land for cultivation results in loss of forest cover. b. Soil erosion: Clearing of forest cover exposes the soil to wind and rainfall, resulting in loss of top fertile soil layer. c. Loss of nutrients: During cutting and burning of trees, organic matter in the soil gets destroyed and most of the nutrients are taken up by the crops within a short period (2 M) **Effects (or) impacts of modern agriculture (or) adverse effects of agricultural practices (or) Environmental effects of agriculture** (a) Micronutrient imbalance (b) Blue Baby syndrome (Nitrate pollution) (c) Eutrophication. d) Water logging e) Salinity (5 M)
2	**What are the natural resources availability in India and discuss any two of them. (15 M) (A.U. May2011)** BTL4 List the natural resources available in India (5M) Any two natural resources available in India (Each 5M)
3.	(i) **Relate the role-play of Environmental Issues in the modern world. (5 M) (ii) Generalize the different methods to propagate environmental awareness. (10 M)** BTL6 **Answer: Page: 5.76 - A. Ravikrishnan** The role-play of environmental issues (5M) Different methods to propagate environmental awareness (10M)
4.	**Discuss the different types of renewable energy resources.(15 M) (A.U. June 2006)** BTL2 **Answer : Page : 5.43 – 5.58 - A. Ravikrishnan**

Renewable energy resources (or) Non-Conventional energy resources

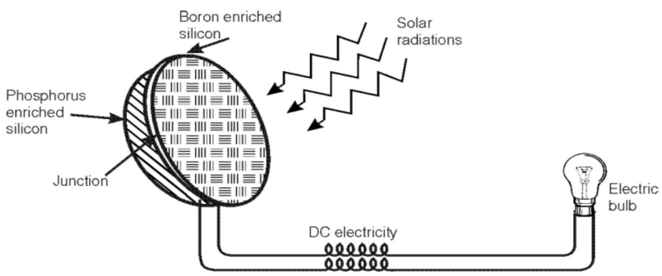
Natural resources which can be regenerated continuously and are inexhaustible. They can be used again and again in an endless manner. Examples: Solar energy, wind energy, tidal energy, etc. (1M)

Renewable energy resources (or) Non-Conventional energy resources

1. **Solar energy -** The energy that we get directly from the sun is called solar energy. The nuclear fusion reactions occurring inside the sun release enormous amount of energy in the form of heat and light.

- **Solar cells**

1. Solar cells (or) photovoltaic cells (or) PV cells

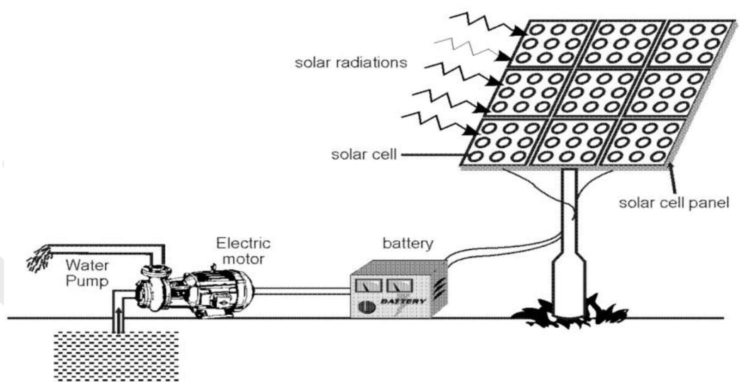


Solar cell (PV cell)

When solar energy falls on the P-type semiconductor, the electrons in the conduction band transferred to conduction band so that a potential difference is developed across the PN junction. Therefore a current is flowing across the junction. (2M)

- **Solar battery**

When solar cells are connected in series, a solar battery is formed. Using solar battery we can run electrical machines such as pump, fan, etc.



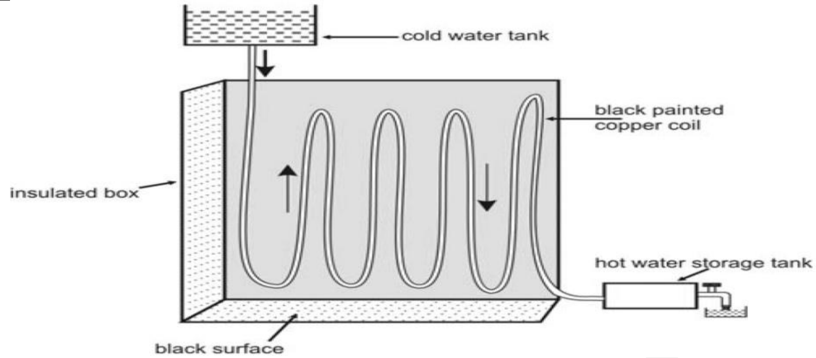
(2 M)

- **Solar Heat Collectors**

Solar heat collectors consist of natural materials like stones, bricks (or) materials like glass, which can absorb heat during the day time and release it slowly at night. (1M)

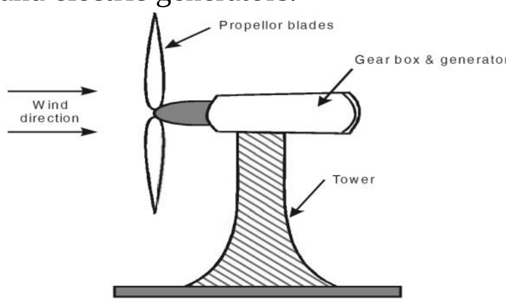
- **Solar water heater**

It consists of an insulated box inside of which is painted with black paint. It is also provided with a glass lid to receive and store solar heat. Inside the box it has black painted copper coil, through which cold water is allowed to flow in, wl1ich gets heated up and flows out into a storage tank. From the storage tank water is then supplied through pipes.



(2M)

2. **Wind energy :** Energy recovered from the force of wind (moving air) is wind energy
   - **Wind mill:** When fast moving air strikes the wind mill blades, it starts to rotate. This rotational motion of the blades derives a number of machines like water pumps, flour mills and electric generators.



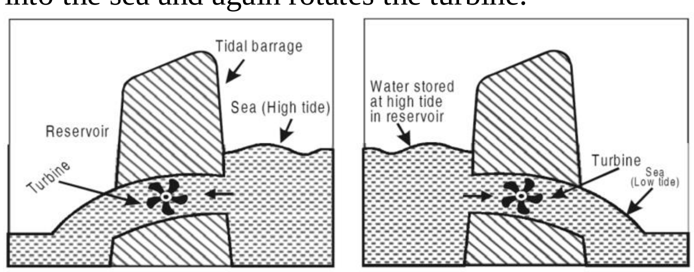
   - **Wind Farms.**

   When a large number of wind mills are installed and joined together in a definite pattern ir forms a wind farm. The wind farms, produce a large amount of electricity (2M)

3. **Ocean energy**

   Ocean can also be used for generating energy of the following ways.

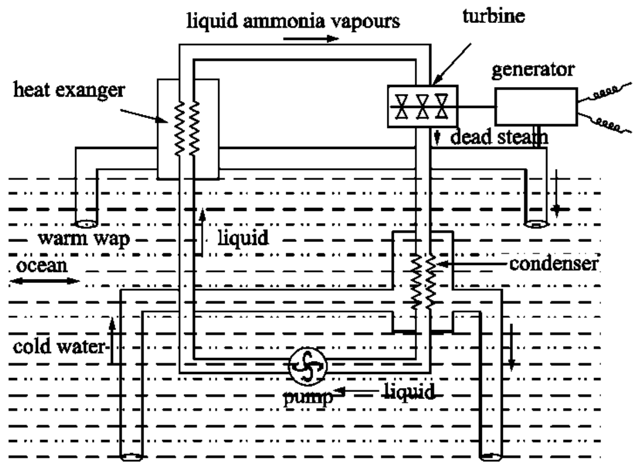
- **Tidal energy (or) Tidal power**
  - ✓ Ocean tides, produced by gravitational forces of sun and moon, contain enormous amount of energy.
  - ✓ The 'high tide' and 'low tide' refer to the rise and fall of water in the oceans.
  - ✓ The tidal energy can be harnessed by constructing a tidal barrage.
  - ✓ During high tide, the sea-water is allowed to flow into the reservoir of the barrage and rotates the turbine, which in turn produces electricity by rotating the generators.
  - ✓ During low tide, when the sea level is low, the sea water stored in the barrage reservoir is allowed to flow into the sea and again rotates the turbine.



(2M)

4. **Ocean thermal energy (OTE)**

Energy available due to the difference in temperature of water known as ocean thermal energy.



Warm surface water boils the liquid ammonia, thus high pressure steam is produced. This steam rotates the turbine which in turn produces electricity by a generator.

Dead steam passing through condenser condensed by the cold water at deep ocean. This liquid again pumped upwards using a pump. This process is repeated to produce the electricity using OTE. (3 M)

5.

Discuss the different types of nonrenewable energy resources.(15 M) (A.U. June 2006) BTL2

Answer : Page : 5.43 – 5.58 - A. Ravikrishnan

Non-renewable (Conventional) energy resources: Energy resources are natural resources, which cannot be regenerated once they are exhausted. They cannot be used again. Examples: Coal, petroleum, natural gas and nuclear fuels. (1M)

Non-renewable energy resources (or) Conventional energy resources

1. **Coal**

Coal is a fossil fuel formed as several stages as buried remains of land plants that lived 300-400 million years ago.

Various stages of coal formation

Wood → **Peat** → **Lignite** → **Bituminous coal** → **Anthracite** (1M)

The carbon content of Anthracite is 90% and its calorific value is 8700 k.cal. The carbon content of bituminous, lignite and peat are 80, 70 and 60% respectively.

Disadvantages of coal

- ✓ When coal is burnt it produces CO_2, causes global warming.
- ✓ Since it contains S, N, O, produces toxic gases during burning (1M)

2. **Petroleum**

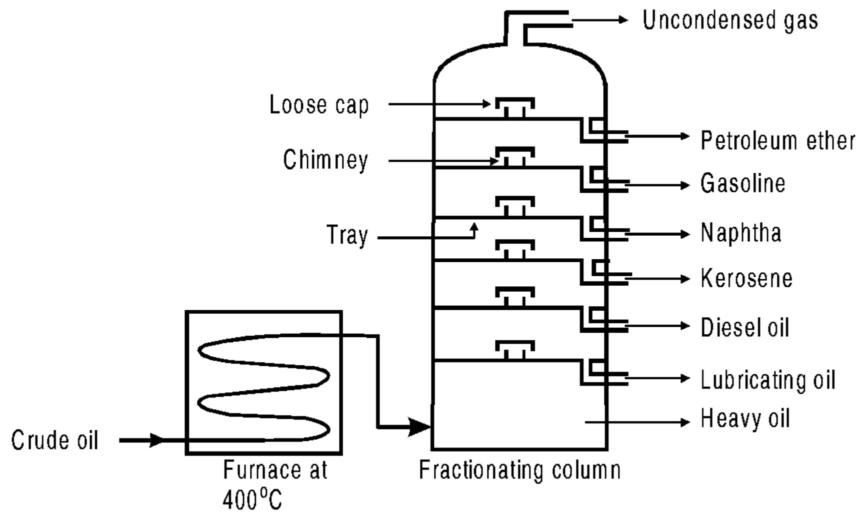
Petroleum or crude oil is a thick liquid contains more than hundreds of hydrocarbons with small amount of S, N, O as impurities.

<u>Occurrence of petroleum</u>

Petroleum or Coal is formed by decomposition of dead animals and plants that were buried under lake and ocean at high temperature and pressure for millions of years. (1M)

Fractional distillation of petroleum

From petroleum various hydrocarbons are separated by purifying and fractionating using fractionating coloumn. (Fig.)

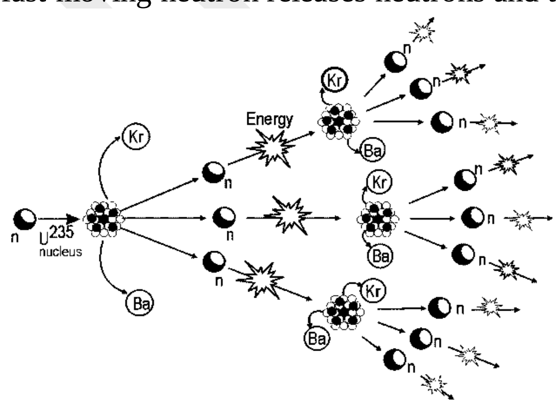


(2 M)

3. **LPG**
   - ✓ Petroleum gas, obtained during cracking and fractional distillation, can be easily converted into liquid under high pressure as LPG.
   - ✓ LPG is colourless and odourless gas.
   - ✓ But during bottling some mercaptans is added, which produces bad odour, thereby any leakage of LPG from the cylinder can be detected instantaneously. (1M)
4. **Natural gas**
   - ✓ Natural gas is found above the oil in oil well.
   - ✓ It is a mixture of 50-90% methane and small amount of other hydrocarbons.
   - ✓ Its calorific value ranges from 12,000-14,000 k . cal/m3 (1M)
5. **Nuclear energy**

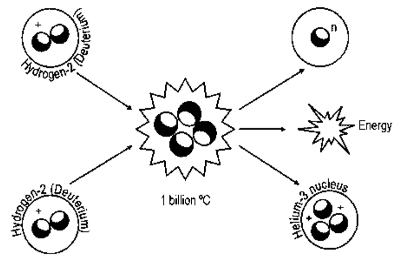
   Energy released by nuclear fission or nuclear fusion.

   Nuclear Fission: When a heavier nucleus split up in to two lighter nucli by bombardment of a fast moving neutron releases neutrons and tremendous energy.



(1 M)

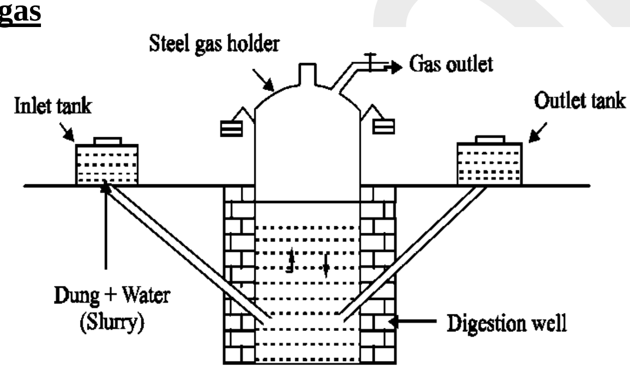
Nuclear Fusion: When two lighter nuclei combined together to form a heavier nucleus at very high temperature releases tremendous energy and neutrons.



Nuclear reactions are effectively used in nuclear power plants. (1M)

6. **Bio gas or Gobar Gas:**Mixture of various gases formed by anaerobic degradation of biological matter in the absence of oxygen. (1 M)

Production of bio gas



(1M)

Bio-gas plant or Gobar gas plant consists of a well like under ground tank (called digester) covered with dome shaped roof with a gas out let pipe. The dome of the digester acts as gas holder. On the left hand side of the digester there is a sloping inlet chamber through which cattle dung + water slurry is introduced. On the right hand side, there is a outlet chamber, through which spent dung slurry gets collected. (1M)

Working

- ✓ Slurry (animal dung + water) is fed into the digester through the inlet chamber. The slurry, in the digester, is left for about two months for fermentation.
- ✓ Anaerobic micro-organisms are responsible for this action. As a result of anaerobic fermentation, bio-gas is collected in the dome.
- ✓ When sufficient amount of bio-gas is collected in the dome, it exerts a large pressure on the slurry and this in turn forces the spent slurry to the over flow tank through the outlet chamber.

(1M)

Uses of Bio Gas

	1. Bio-gas is used for cooking food and heating water. 2. It is used to run engines. 3. It is also used as an illuminant in villages. 4. It is used for running tube-well and water pump-set engines. 5. It is directly used in gas turbines and fuel cells for producing electricity. (1M)
5.	**Discuss the following case studies on** **(a) Deforestation (2 M)** **(b) Mining (8 M)** **(c) Food resources (3 M)** **(d) Renewable and Non-renewable energy resources (2 M)** BTL4 **Answer : Page : 5.10, 5.31, 5.42, 5.64 - A. Ravikrishnan** **(a)** Deforestation (2 M) (b) Mining (8 M) (c) Food resources (3 M) (d) Renewable and Non-renewable energy resources (2 M)

UNIT - IV SOCIAL ISSUES AND THE ENVIRONMENT	
From Unsustainable to Sustainable Development – Urban Problems Related to Energy – Water Conservation, Rain Water Harvesting, Watershed Management – Resettlement and Rehabilitation of People; its Problems and Concerns, Case Studies – Role of Non-Governmental Organization- Environmental Ethics: Issues and Possible Solutions – Climate Change, Global Warming, Acid Rain, Ozone Layer Depletion, Nuclear Accidents and Holocaust, Case Studies. – Wasteland Reclamation – Consumerism and Waste Products – Environment Production Act– Air (Prevention And Control Of Pollution) Act – Water (Prevention And Control Of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Enforcement Machinery Involved in Environmental Legislation- Central and State Pollution Control Boards- Public Awareness.	
Q. No.	**PART – A**
1	**Define the term sustainable development. (NOV/DEC 2005, NOV/DEC 2007, NOV/DEC 2009, APR/MAY 2011)** BTL1 Sustainable development is defined as, "meeting the needs of the present without compromising the ability of future generations to meet their own needs".
2	**What are the advantages of rain water harvesting? (MAY/JUNE 2008)** BTL1 Reduction in the use of current for pumping water. • Mitigating the effects of droughts and achieving drought proofing. • Increasing the availability of water from well. • Rise in ground water levels. • Minimizing the soil erosion and flood hazards. • Upgrading the social and environmental status. • Future generation is assured of water.
3	**List the objectives of watershed management. (NOV/DEC 2009)** BTL4 • To minimize the risks, of floods, drought and landslides. • To develop rural areas in the region with clear plan for improving the economy of the region. • To manage the watershed for developmental activities like domestic water supply, irrigation, hydropower generation etc., • To generate huge employment opportunities in the backward rain- fed areas to ensure livelihood security. • 5. To promote social forestry and horticultural activity on all suitable areas of land.
4.	**Define the term environmental ethics. (NOV/DEC 2011, NOV/DEC 2013)** BTL1 Environmental ethics refers to the issues, principles and guidelines relating to human interactions with their environment.
5.	**State a few drawbacks of pollution related acts. (NOV/DEC 2008)** BTL1 • The penalties in the act are very small when compared to the damage caused by the big industries due to pollution. • A person cannot directly file a petition in the court.

	• Litigation, related to environment is expensive, since it involves technical Knowledge. • For small unit it is very expensive to install Effluent Treatment – Plant • The position of chairman of the boards is occupied by political appointee. Hence it is difficult to implement the act without political interference.
6.	**What is meant by ISO 14000? (NOV/DEC 2008)** BTL1 ISO 14000 is the environmental management standards which exist to help Organizations minimize how their operations negatively affect the environment and Comply with applicable laws and regulations.
7	**What are the objectives of public awareness?** BTL1 • To create awareness among people of rural and city about ecological imbalances, local environment, technological development and various development plants. • To organize meetings, group discussion on development, tree plantation programmers, exhibitions. • To focus on current environment problems and situations • To train our planners, decision – makers, politicians and administrators. • To eliminate poverty by providing employment that overcome the basic environmental issues. • To learn to live simple and eco-friendly manner
8.	**What are the objectives of environmental impact assessment (EIA)?** BTL1 EIA is defined as a formal process of predicting the environmental consequences of any Development projects. It is used to identify the environmental, social and economic impacts of the Project prior to decision making. Objectives of EIA • To identify the main issues and problem of the parties. • To identify who is the party. • To identify what are the problems of the parties. • To identify why the problems are arise.
9.	**Define urbanization. (NOV/DEC 2010)** BTL1 Urbanization is the movement of human population from rural area to urban area for the want of better education, communication, health and employment.
10	**How can global warming be controlled? (NOV/DEC 2010, APR/MAY 2011)** BTL2 • By reducing the use of fossil fuels. • Utilize renewable resources such as wind, solar and hydropower. • Plant more trees. • Stabilize population growth. • Remove atmospheric CO_2 by utilizing photo synthetic algae.
11	**Mention any four fundamental rights of the individual. (NOV/DEC 2010)** BTL1 • Human right to freedom. • Human right to property. • Human right to religion. • Human right to culture and education. • Human right to equality.

12.	**What is E-Waste? (NOV/DEC 2011)** BTL2 The waste of electronic equipment like computers, printers and mobile phones, Xerox machines, calculators, etc. are e-waste.
13.	**What do we mean by environment refugees? (NOV/DEC 2011)** BTL2 Environmental refugee is a person displaced due to environment causes, especially land loss, and degradation and natural disaster.
14.	**List the objectives of Forest Conservation act. (NOV/DEC 2013)** BTL1 • To protect and conserve the forest • To ensure judicious use of forest
15.	**What are the objectives of water act? (NOV/DEC 2014)** BTL1 • Prevention and control of water pollution. • Maintaining or restoring the wholesomeness of water. • Establishing central and state boards for the prevention and control of water pollution.
16	**Define consumerism and disaster. (NOV/DEC 2015)** BTL2 Consumerism refers to the interrelationship between sellers and buyer. Disaster is a geological process and is defined as an event concentrated in time and space, in which a society or sub-division of a society undergoes severe danger and causes loss of its members and physical property.
17	**What are landslides? (MAY/JUNE 2008, NV/DEC 2014)** BTL2 The movement of earthy materials like coherent rock, mud, soil and debris from higher region to lower region due to gravitational pull is called landslides.
18	**What are the harmful effects of landslides?** BTL2 • Landslides block the roads and diverts the passage • Erosion of soil increases. • Sudden landslides damage the houses, crop yield, live stock etc.
19.	**Define the term Tsunami.** BTL2 A tsunami is a large wave that is generated in a water body when the sea floor is deformed by seismic activity. This activity displaces the overlying water in the ocean.
20	**Give comprehensive definition for air pollution. (NOV/DEC 2010, APR/MAY 2011)** BTL2 The presences of one are more contaminants like dust, smoke, mist and dour in the atmosphere, which are injurious to human beings, plants and animal.
21	**Mention four causes of floods. (NOV/DEC 2010)** BTL2 • Heavy rain, rainfall during cyclone causes flood. • Sudden snow melt also raises the quantity of water in streams and causes flood. • Clearing of forests for agriculture has also increased severity of floods. • Reduction in the carrying capacity of the channel, due to accumulation of Sediments cause floods.
22	**List the objectives of Forest Conservation Act. (NOV/DEC 2013)** BTL1 • Illegal non-forest activity within a forest area can be immediately stopped under this act. • Provides conservation of all types of forests. Non forest activities include clearing of

	forest land for cultivation of any types of crops.
23	**What are the important aspects of sustainable development?** BTL2 • Inter – generational equity It states that we should hand over a safe, healthy and resourceful environment to our future generations. • Intra – generational equity It states that the technological development of rich countries should support the economic growth of the poor countries and help in narrowing the wealth gap and lead to sustainability
24	**Explain the need for water conservation.** BTL2 • Though the resources of water are more, the quality and reliability are not high due to changes in environmental factors. • Better lifestyles require more fresh water. • As the population increases, the requirement of water is also more. • Due to deforestation, the annual rainfall is also decreasing. • Over exploitation of ground water, lead to drought. • Agricultural and industrial activities require more fresh water.
25	**Define the term environmental ethics. (NOV/DEC 2011, NOV/DEC 2013)** BTL2 "Environmental ethics refers to the issues, principles and guidelines relating to human interactions with their environment".
26	**What is meant by environmental audit? (NOV/DEC 2008)** BTL2 Environmental audits are intended to quantify environmental performance and Environmental position. In this way they perform analogous function to financial Audits. It also aims to define what needs to be done to improve on indicators of such Performance and position.
27.	**What is consumerism? List any two objectives of consumerism.** BTL1 The consumption of resources by the people is known as consumerism. Objectives It improves the rights and powers of the buyer It forces the manufacturer to reuse and recycle the product after usage.
28.	**What is Eco-mark?** BTL1 Environmentally friendly products are generally indicated by the symbol called Eco-mark. Eco-mark is a certification mark issued by the Bureau of Indian Standard (BIS) to the environmental friendly products.
PART – B	
1	**What are the salient features of the Air pollution act, Water pollution act and Environment protection Act? Give the reason for why do we prefer environmental protection act as an Umbrella act. (13 M) (MAY/JUNE 2005, NOV/DEC 2005, JAN 2006, NOV/DEC 2006, NOV/JUNE 2007, NOV/DEC 2009, NOV/DEC 2010, MAY/JUNE 2011, NOV/DEC 2013, DEC 2014)** BTL4 **Answer : Refer : 6.34 – 6.38 - A. Ravikrishnan** • Objectives and features of environment protection act (5 M) • Objectives and features of air pollution act (4 M) • Objectives and features of water pollution act (4 M)
2	**Explain in detail the strategies adopted for conservation of water. (6 M) (NOV/DEC**

	2009, APR/MAY 2010, NOV/DEC 2010, APR/MAY 2011, NOV/DEC 2014) BTL2 **Answer : Refer : 6.7 – 6.8 - A. Ravikrishnan** • Reducing evaporation loss (1 M) • Reducing irrigation loss (1 M) • Re-use of water (1 M) • Preventing wastage of water (1 M) • Decreasing run-off losses (1 M) • Avoid discharge of sewage (1 M)
3	**Discuss in detail about Wild life protection act 1972 and Forest conservation act 1980. (13 M) (NOV/DEC 2010, NOV/DEC 2014)** BTL4 **Answer : Refer : 6.38 – 6.40 - A. Ravikrishnan** • Objectives of Wildlife protection act (2 M) • features of wildlife protection act (4 M) • Objectives of Forest conservation act (2 M) • Features of Forest conservation act (5 M)
4	**Explain the following** **(a) Sustainable development (6 M)**BTL2 **(b) Urban problems related to energy. (7 M) (NOV/DEC 2005, NOV/DEC 2006, MAY/JUNE 2007, NOV/DEC 2010, NOV/DEC 2011, MAY/JUNE 2013)** BTL2 **i. Answer : Refer : 6.21 – 6.6 - A. Ravikrishnan** Sustainable development : • World summit (Agenda) (2 M) • Aspects (2 M) • Concept and significance (2 M) **ii. Answer : Refer : 6.21 – 6.6 - A. Ravikrishnan** Urban problems related to energy : • Definition of urbanization (2 M) Urbanization is the movement of human population from rural areas to urban areas for the want of better education, communication, health, employment, etc. • Energy demanding activities (3 M) • Solution for urban energy problem (2 M)
5	**Discuss the phenomenon of global warming and the factors contributing to it. (13 M)** BTL4 • Explanation of phenomenon of global warming (7 M) • Contributing factors (6 M)
6	**Give a note on nuclear accidents and holocausts. (6 +7 M) (MAY/JUNE 2013, NOV/DEC 2013)** BTL4 **Answer : Refer : 6.24 – 6.26 - A. Ravikrishnan** • Nuclear energy and nuclear accidents (2 M) • Types of nuclear accidents (4 M) • Effect of nuclear holocaust (4 M) • Control measures of holocausts (3 M)
7.	**State the 12 principles of green chemistry. (7 M)** BTL1

Answer : Refer : - A. Ravikrishnan

- **Prevention.** It is better to prevent waste than to treat or clean up waste after it is formed.
- **Atom Economy.** Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.
- **Less Hazardous Chemical Synthesis.** Whenever practicable, synthetic methodologies should be designed to use and generate substances that possess little or no toxicity to human health and the environment.
- **Designing Safer Chemicals**. Chemical products should be designed to preserve efficacy of the function while reducing toxicity.
- **Safer Solvents and Auxiliaries**. The use of auxiliary substances (solvents, separation agents, etc.) should be made unnecessary whenever possible and, when used, innocuous.
- **Design for Energy Efficiency.** Energy requirements should be recognized for their environmental and economic impacts and should be minimized. Synthetic methods should be conducted at ambient temperature and pressure
- **Use of Renewable Feed stocks.** A raw material or feedstock should be renewable rather than depleting whenever technically and economically practical.
- **Reduce Derivatives.** Unnecessary derivatization (blocking group, protection/deprotection, temporary modification of physical/chemical processes) should be avoided whenever possible .
- **Catalysis**. Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.
- **Design for Degradation**. Chemical products should be designed so that at the end of their function they do not persist in the environment and instead break down into innocuous degradation products.
- **Real-time Analysis for Pollution Prevention**. Analytical methodologies need to be further developed to allow for real-time in-process monitoring and control prior to the formation of hazardous substances.
- **Inherently Safer Chemistry for Accident Prevention**. Substance and the form of a substance used in a chemical process should be chosen so as to minimize the potential for chemical accidents, including releases, explosions, and fires (7 M)

8.

What is rain water harvesting? What are the purposes survived by it? (7 M) BTL2

Answer : Refer : 6.8 - A. Ravikrishnan

<u>Rain water harvesting :</u> A technique of capturing and storing of rain water for further utilization (1 M)

<u>Objective:</u>

- To meet increasing demands of water
- Raise water table by recharging ground water
- Reduce ground water contamination from salt water intrusion
- To reduce the surface run-off losses
- To reduce storm water and soil erosion
- To increase hydrostatic pressure to stop land subsidence

	• To reduce water crises and water conflicts (1 M) **Roof top rainwater harvesting** • Involves collecting water that falls on roof of house • Rainwater from roof top, road surface, playground diverted to surface tank. Explanation (2 M) • Diagram (2 M) **Advantages of rainwater harvesting** • Increases the well water availability § Raise ground water level • Minimizes soil erosion and flood hazards • Upgrading the environmental and social status • Reduction in the use of current for pupping water • Future generation is assured for water (1 M)
9.	**What is wasteland? Mention its types and sources. Explain the objectives and methods of wasteland reclamation. (7 M)** BTL2 **Answer : Refer : 6.28 - A. Ravikrishnan** The land which is not in use is named as wasteland. Types: 1. Uncultivable wasteland 2. Cultivatable wasteland (1 M) Causes of wasteland (1 M) Objectives of wasteland reclamation (1 M) Methods of wasteland reclamation (4 M)
10.	**List the traditional rights of seller and buyer. Describe the objectives of consumerism and factors affecting consumerism. (7 M)** BTL2 **Answer : Refer : 6.31 - A. Ravikrishnan** Traditionally favourable rights of seller (1 M) Traditional buyer rights (1 M) Objectives of consumerism (3 M) Factors affecting comsumerism (2 M)
11.	**What is biomedical waste? Describe types and the various steps involved in management of biomedical waste. (7 M)** BTL2 **Answer : Refer : 6.41 - A. Ravikrishnan** Waste generated from health care activities. (1 M) Types of biomedical waste (3 M) Three steps involved in management of biomedical waste (3 M)
12.	**Define watershed and watershed management? Explain the concept of watershed management in detail. (13 M)** BTL2 **Answer : Refer : 6.11 - A. Ravikrishnan** Watershed – The land area from which water drains under the influence of gravity into a stream, lake, reservoir or other body of surface water, (1 M) Watershed management – The management of rainfall and resultant runoff is called watershed management. (1 M) Factors affecting watershed management (1 M) Objectives of watershed management (2 M) Watershed management techniques (2 M) Components of integrated watershed management (6 M)

PART–C	
1	**What is an earthquake? Write about its causes, effects and measures to face the earthquake. (15 M) (APR/MAY 2008, NOV/DEC 2008, NOV/DEC 13, NOV/DEC 2014)** BTL4 **Answer : Refer : 6.58 – 5.58 - A. Ravikrishnan** • Definition: An earthquake is a sudden vibration caused on the earth's surface due to the sudden release of tremendous amount of energy stored in the rocks under the earth's crust. (2 M) • Causes (4 M) • Effects (4 M) • Preventive measures (5 M)
2	**Give a note on** **(d) Floods** **(e) Cyclone** **(f) Landslides (15 M)** BTL2 **Answer : Refer : 6.52 – 6.57 - A. Ravikrishnan** • Definition of flood: Whenever the magnitude of water flow exceeds the carrying capacity of the channel within its banks, the excess of water over flows on the surroundings causes floods (1 M) • Causes and effects (2 M) • Preventive measures of floods (2 M) • Definition: Cyclone is a meteorological phenomenon, intense depressions forming over the open oceans and moving towards the land. On reaching the shores, it move into the interior of the land or along the shore lines. (1 M) • Causes and effects (2 M) • Preventive measures of cyclone (2 M) • Definition: The movement of earthy materials like coherent rock, mud, soil and debris from higher region to lower region due to gravitational pull is called landslides. (1 M) • Causes and effects (2 M) • Preventive measures of landslides (2 M)

UNIT V HUMAN POPULATION AND THE ENVIRONMENT	
Population Growth, Variation Among Nations – Population Explosion – Family Welfare Programme – Environment and Human Health – Human Rights – Value Education – HIV / AIDS – Women and Child Welfare – Role of Information Technology in Environment and Human Health – Case Studies.	
Q. No.	**PART-A**
1.	**Define immigration and emigration. (Coim A.U. Dec 2009)**BTL1 **Immigration -** Arrival of individuals from neighbouring population. **Emigration -** Dispersal of individuals from the original population to new areas
2.	**Define population and population density. (Coim A.U. Dec 2009, Chen A.U. Apr 2011)**BTL1 **Population**-Group of Individuals belonging to the same species, which live in a given area at a given time. **Population density**-Number of individuals of the population per unit area (or) unit volume

3.	**Define birth rate and death rate.** BTL1 **Birth rate or Natality**-No. of live birth per 1000 people in a population in a given year **Death rate or Mortality**-No. of deaths per 1000 people in a population in a given year
4.	**Define doubling time with reference in population growth. (Chen A.U. Dec 2008, 2013)**BTL1 Time required for a population to double its size at a constant annual rate. $Doubling\ time = Td = \frac{70}{r}$Where, r -Annual growth rate. If a nation has 2% annual growth; its population will double in the next 35 year.
5.	**What are the reasons behind the increased population growth in the less developed nations compared with developed nations? (Chen AU Dec 2007)**BTL1 • Due to decrease in the death rate and increase in the birth rate • The availability of antibodies, immunization, increased food production, clean water and air decreases the famine-related deaths and infant mortality. • In agricultural based countries, children are required to help parents in the fields.
6.	**Write population equation. (Coim. A.U. Dec 2008)**BTL1 $$Pt + 1 = Pt + (B - D) + \ (I - E)$$ Where Pt and Pt+1 = sizes of population in an area at two different point s in time t and t+1; B-Birth rate I-Immigration; D-Death Rate; E-Emigration.
7.	**List the characteristics of population growth.** BTL4 • Exponential growth • Doubling time • Infant mortality rate • Total fertility rates (TFR) • Replacement level • Male-Female Ratio • Demographic transition
8.	**Mention the various problems of population growth.** BTL4 • Increasing demands for food and natural resources • Inadequate housings and health services • Loss of agricultural lands • Unemployment and socio-political unrest • Environmental pollution
9.	**What is population explosion? (Chen AU Jun 2007, May 2008, TCY A.U. Dec 2008, Dec 2009, Dec2010, Apr 2015)**BTL1 The enormous increase in population due to low death rate and high birth rate.
10.	**What are the effects of population explosion? (Chen A.U. Dec 2009)**BTL1 • Poverty • Environmental degradation • Over exploitation of natural resources • Renewable resources like forests, grass lands are also under threat • Will increase disease, economic inequity and communal war • Leads to development of slums • Lack of basic amenities like water supply and sanitation, education, health, etc

	• Unemployment and low living standard of people
11.	**How the age structure of population can be classified?** BTL4 • Pre-productive population (0-14 years) • Reproductive population (15-44 years) • Post reproductive population (Above 45 years)
12.	**State the reasons of population explosion.** BTL1 • Invention of modern medical facilities; Illiteracy • Decrease in death rate and increase in birth rate • Availability of antibiotics, Food, clean water, air, etc. • Decreases the famine-related deaths and infant mortality • In agricultural based countries- Children are required
13.	**What is family welfare programme?** BTL1 Programme implemented by the government of India. An integral part of overall national policy of growth covering human health, maternity, family welfare, child care and women's right, education, nutrition, health, employment, shelter, safe drinking water
14.	**Define population stabilization ratio.** BTL1 Ratio of crude death rate to crude birth rate.
15.	**What are the objectives of family welfare programme? (TNV A.U. Dec 2009)**BTL1 • Slowing down the population explosion by reducing the fertility • Pressure on the environment due to over exploitation of natural resources is reduced
16.	**List the factors influencing family size.** BTL4 • Reduce infant mortality rate to below 30 per 1000 infant • Achieve 100% registration of births, deaths, marriage and pregnancy • Encourage late marriage, late child-bearing, breast feeding • Enables to improve women's health, education and employment • Prevent and control of communicable disease and AIDS/HIV • Promote vigorously the family norms • Making school education up to age 14 free and compulsory
17.	**What is meant by NIMBY syndrome? (Chen A.U. Dec 2008)**BTL1 NIMBY-**N**ot **I**n **M**y **B**ack **Y**ard. Describes the opposing of residents to the nearby location of something they consider undesirable, even clearly a benefit for many
18.	**List the factors influencing human health.** BTL4 • Nutritional Factors • Biological Factors • Chemical Factors • Psychological Factors
19.	**What is meant by human rights?** BTL1 The fundamental rights which are possessed by all human beings irrespective of their caste, nationality, sex and language. These cannot be taken away by any legislature. Every citizen must enjoy certain rights and also has certain duties towards the country.
20.	**List the features of draft declaration of human rights**. BTL4 • Human rights to freedom

	• Human rights to property • Human rights to freedom of religion • Human rights to culture and education • Human rights to constitutional remedies • Human rights to equality • Human rights against exploitation • Human rights to food and environment • Human rights to good health
21.	**What is education? List its types.** BTL1 **Education-**learning through which knowledge about the particular thing can be acquired **Types of Education** • **Formal Education**-Self related. Will read, write, get jobs and tackle the problems • **Value Education**–Instrument to analyse our behavior and provide proper direction to youth. Teaches distinction between right and wrong, helpful, loving, etc. • **Value-based environmental education**-Provide knowledge on principles of ecology, fundamentals of environment and biodiversity
22.	**Write the importance of value education. (Chen A.U. Dec 2008, 2013)**BTL2 • Improve the integral growth of human being • Create attitudes and improvement towards sustainable lifestyle • Increase awareness about our national history, cultural heritage, constitutional rights, national integration, community development and environment • Create and develop awareness about the values, role and their significance
23.	**What is role playing element of value education?** BTL1 Acting out the true feelings of the actors by taking the role of another person but without the risk of reprisals.
24.	**Mention the types of values imported through value education.** BTL1 • Universal Values or Social Values • Cultural Values • Individual Values • Global Values • Spiritual Values
25.	**Define the term HIV/AIDS.** BTL1 **HIV-H**uman **I**mmunodeficiency **V**irus; **AIDS-A**cquired **I**mmuno **D**eficiency **S**yndrome; a condition in humans in which the immune system begins to fail, leading to life-threatening opportunistic infections.
26.	**What are the factors which do not influence transmission of HIV?** BTL1 Tears, food, air, cough, handshake, mosquito, flies, insect bites, urine, saliva during kissing, sharing of utensils, cloths, toilet, bathroom etc.
27.	**Mention some effects of HIV/AIDS. (Chen A.U. Dec 2008, 2011, 2014)** BTL1 • Large number of death occurs, which affect environment and natural resources • Loss of labour and level of production decreases • Required more water for maintaining hygiene in AIDS affected locality • People affected by HIV, cannot perform work well, due to lack of energy and frequent

	fever and sweating
28.	**What are the major precautions to avoid AIDS? (Chen AU May 2008)**BTL1 • Avoid indiscriminate sex and encourage the use of condoms and also avoid the use of sharing razors needles and syringes • Prevention of blood borne HIV transmission • Aids awareness programmes should be encouraged • Counseling services should be provided • Drug treatment
29.	**State the role of information technology in Environment. (Coim A.U. Dec 2009, Chen AU Jan 2006)**BTL4 • Plays a vital role in the field of environmental education. • Means collection, processing, storage and dissemination of information. • Numbers of software have been developed to study about the environment. • The internet facilities, information through satellites, World Wide Web, and geographical information systems provide us up-to-date information on various aspects of environment and weather.
30.	**What is value education? Give its significance. (NOV/DEC 2013)**BTL4 An instrument used to analyse our behavior and provide proper direction to our youths. Teaches them the distinction between right and wrong, to be compassionate, helpful, loving, generous and tolerant. So that a youth can move towards the sustainable future.
31.	**What do you mean by Doubling Time? (NOV/DEC 2013)** BTL1 Period of time required for a quantity to double in size or value. Generally applied to denote the population growth.
32.	**State the role of Information Technology in health protection.**BTL1 • Health organization turning to package solution of IT for streamlining services oriented work in effective manner. • Health service technology such as finance and accounting, pathology, patient administration • Helps the doctor to monitor the health of the people effectively • Online help of expert doctors can be used for the patient • The outbreak of epidemic diseases can be conveyed easily • Effective function of a hospital • Drugs and its replacement can be administered efficiently • The data regarding birth and death rate, immunization and sanitation programmes can be maintained accurately with the help of computers
33.	**What is environmental impact assessment?** BTL1 Formal process of predicting the environmental consequences of any development projects. Used to identify the environmental, social and economic impacts of the project prior to decision making.
34.	**What is GIS?** BTL1 Graphical Information System (GIS) acts as a technique of superimposing various thematic maps with the use of digital data on a large number of inter-related aspects. Considered to be an effective tool in environmental management.

35.	**List out the benefits of EIA.** BTL4 • Reduce the cost and time • Performance of the project improved • Waste treatment and cleaning expenses are minimized • Usages of resources are decreased • Biodiversity is maintained • Human health is improved (
36.	**Mention the key element of EIA.** BTL1 • **Scoping** – To identify the key issues of the concern in the planning process at early stage, aid site selection and identify any possible alternatives. • **Screening -**To decide whether an EIA is required or not. • **Identifying and evaluating alternatives-**Knowing alternative sites and techniques and their impacts. • **Mitigation measures dealing with uncertainty-**Action taken to prevent adverse effect of a project. • **Environmental statements-**Final stage of EIA process which reports the findings of the EIA.

37.	**What is child welfare? Mention the schemes towards child welfare.** BTL1
	Child Welfare
	• Children occupy 40% of the total population.
	• Out of 21 Million Children born every year in India, 20 Million are estimated to be working as Child Labour in hazardous industries
	Organizations towards Child Welfare
	• UN Conventions on Rights of Child or International Laws
	• Rights of child
	  • …Right to Survival
	  • …Right to Participation
	  • …Right to Development
	  • …Right to Protection
	• Ministry of HRD
	• Centre for Science and Environment (CSE)
	• Environment degradation and child welfare
	So it is essential to keep our environment clean to children for better and healthy life Poverty

38.	**What is women welfare? List the various organization function towards women welfare.** BTL1 Welfare to improve the status of the women by providing opportunities in education, employment and economic independence (1M) **Organizations Towards Women Welfare** • NNWM (National Network for Women and Mining): Fighting for the "Gender Audit" of India's mining companies • UNDW (United Nations Decade for Women): Women welfare related issues on international agenda • CEDAW (Convention on Elimination of all forms of Discrimination against Women)

- NGO's as Mahila Mandals
- Ministry for Women and Child Welfare (1M)

PART – B

1.

(i) Can you recall population characteristics & variations among nations? (7M) BTL1
(ii) What is population explosion and state the views on population growth. (6M)BTL2

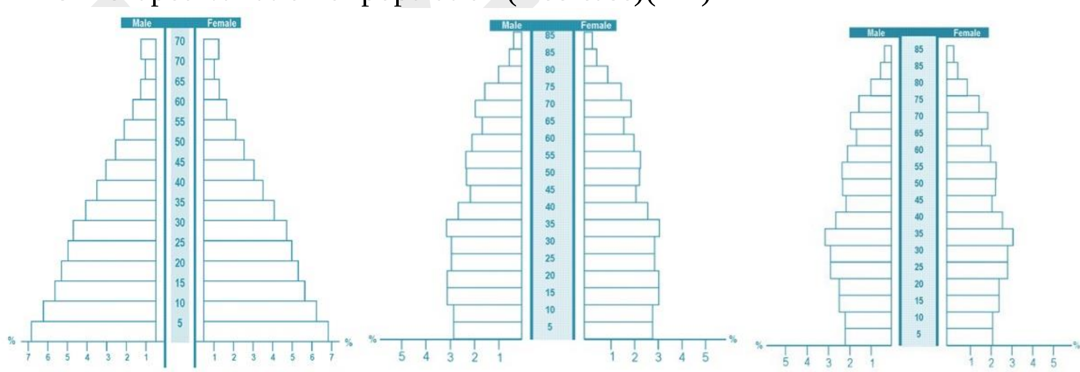
(i) Answer: Page: 7.3 – 7.8-**A. Ravikrishnan**

Characteristics of population growth

- Exponential growth
- Doubling time
- Infant mortality rate
- Total fertility rates
- Replacement level
- Male-Female ratio
- Demographic transition(3M)

Variation of population among nation based on age structure

- Pre-productive population (0-14 years)
- Reproductive population (15-44 years)
- Post Reproductive population (above 45 years)
    - Pyramid shaped variation of population (Increase)
    - Bell shaped variation of population (Stable)
    - Urn shaped variation of population (Decrease)(2M)



- Diagrams (2M)

(ii) Answer: Page: 7.8 – 7.11-**A. Ravikrishnan**

Population explosion–Enormous increase in population due to low death rate and high birth rate is termed as population explosion. (1M)

Causes of population explosion

- Invention of modern medical facilities; Illiteracy
- Decrease in death rate and increase in birth rate
- Availability of antibiotics, Food, clean water, air, etc.
- Decreases the famine-related deaths and infant mortality

	• In agricultural based countries- Children are required(3M) **Effect of Population Explosion** Poverty; Environmental degradation; Unsustainable environment; Over exploitation of natural resources; Renewable resources become under threat; Increase disease, economic inequity and communal war; development of slums; lake of basic amenities; Unemployment.(2M)
2.	
	(i) How would you explain the family welfare programs (8M)BTL2 **(ii) Show family planning in Indian context.(5M)**BTL2 **(i) Answer: Page: 7.11 – 7.14-A. Ravikrishnan.** **Family welfare programme** • An integral part of overall national policy of growth covering human health, maternity, family welfare, child care and women's right, education, nutrition, health, employment, shelter, safe drinking water (1M) **Objectives of family welfare programme** • Slowing down the population explosion by reducing the fertility • Pressure on the environmentis reduced(1M) **Objectives of family planning** • Reduce infant mortality rate to below 30 per 1000 infant • Achieve 100% registration of births, deaths, marriage and pregnancy • Encourage late marriage and late child-bearing. • Encouraging breast feeding • Enables to improve women's health, education and employment • Making family planning available to all women who wanted do • Constrain the spread of AIDS/HIV • Prevent and control of communicable disease • Promote vigorously the family norms • Making school education up to age 14 free and compulsory (3M) **Methods of family planning** • Traditional method • Modern method • Temporary method (3M) **(ii) Answer: Page: 7.14-A. Ravikrishnan.** (BTL2) **Family planning in India** • It was started in the year 1952 • In 1970's Indian government forced family planning campaign all over the country • In 1977, national family programme and ministry of health and family welfareredesigned • In 1978, the government legally raised the minimum age of marriage for men from 18 to 21 and for women 15 to 18 • In 1981, census report showed thatthere was no drop in population. Since then funding for family planning programmes has been increased further • The first country that implemented the family welfare programme at government level

	• Centrally sponsored programme. For this, the states receive 100% assistance from central government • The ministry of health and family welfare have started the operational aims and objectives of family welfare o To promote the adoption of small family size norm, on the basis of voluntary acceptance o To ensure adequate supply of contraceptives to all eligible couples within easy each o Extensive use of public health education for family planning (5M)
3.	
	Discuss the influence of environmental parameters and pollution on human growth. (13M)BTL2 **Answer: Page: 7.14 – 7.17-A. Ravikrishnan** **Factors influencing human health**-A state of complete physical, mental, social and spiritual well-being and not merely the absence of disease or infirmity.“The Ability To Lead A Socially And Economically Productive Life.” • Nutritional factors • Biological factors • Chemical factors • Psychological factors (3M) **Holistic concept of health-**Recognizes the strength of social, economic, political and environmental influences on health **Determinants of health**- Heredity, Health and family welfare services, Environment, Life-styleSocio-economic conditions. Disease result from complex interaction between manand the environment. **Disease**-“Maladjustment of the human organism to the environment”. (2M) **Environmental degradation due to population explosion** • All that which is external to man is the environment • The concept of environment is complex • The external environment or the Macro-environment to be responsible for millions of preventable diseases originating in it (1M) **Environmental hazards** • **Physical:** Air, water, soil, housing, climate, geography, heat, light, noise, debris, radiation, etc. and their health effects • **Biological**: bacteria, viruses, parasites, microbial agents, insects, rodents, animals and plants, etc. and their health effects • **Chemical**: Combustion of fossil fuel liberates SO_2, NO_2, CO_2 ; Industrial effluents; Pesticides; Heavy metals; Chloro fluoro carbons and their health effects • **Psychosocial**: Cultural values, customs, beliefs, habits, attitudes, morals, religion, education, lifestyles, health services, social and political organization and their health effects(7M)
4.	

	(i) Write short notes on human rights. (5M) BTL4 **(ii) Discuss the salient features of draft declaration of Human Rights and environment. (8M)**BTL2 **(i) Answer: Page: 7.17-7.19 A. Ravikrishnan.** **Human rights** • The fundamental rights which are possessed by all human beings irrespective of their caste, nationality, sex and language • These cannot be taken away by any legislature or an government act • Seen as belonging to men and women by their very nature • India is a democratic country • Aim of India is to ensure happiness to all the citizens with equal rights, opportunities and comforts • Every citizen must enjoy certain rights and also has certain duties towards the country • Include civil and political rights, such as the right to life and liberty, freedom of expression, and equality before the law; and social, cultural and economic rights, including the right to participate in culture, the right to food, the right to work, and the right to education. • All human beings are born free and equal in dignity and rights • They are endowed with reason and conscience and should act towards one another in a spirit of brotherhood (5 M) **(ii) Answer: Page:** 7.17-7.19**-A. Ravikrishnan.**BTL2 **Features of draft declaration of human rights** • Human rights to freedom • Human rights to property • Human rights to freedom of religion • Human rights to culture and education • Human rights to constitutional remedies • Human rights to equality • Human rights against exploitation • Human rights to food and environment • Human rights to good health (8M)
5.	
	Summarize the objectives, concepts, types of values and elements of value education? How can the same be achieved? (13M) BTL3 **Answer: Page: 7.20 – 7.24-A. Ravikrishnan** **Education-**learning through which knowledge about the particular thing can be acquired **Types of Education** • Formal Education-Self related • Value Education–Instrument to analyse our behavior and provide proper direction to youth • Value-based environmental education-Provide knowledge on principles of ecology, fundamentals of environment and biodiversity (1M)

Objectives of value education

- To improve the internal growth of human beings.
- To create attitudes and improvement towards sustainable life style.
- To increase awareness on national history, our cultural heritage, constitutional rights, national integration, community development and environment.
- To create and develop awareness about the values and their significance and role.
- To understand about our natural environment in which land and, air and water are interlinked. (2M)

Concepts of value education

- Why and how can we use less resources and energy?
- Why do we need to keep our surrounding clean?
- Why should we use less fertilizers and pesticides?
- Why it is important for us to save water and keep our water sources clean?
- Separate our garbage into degradable and non-degradable types before disposal (2M)

Types of values

- **Universal Values or Social Values**: Expresses the human nature reflected as joy, compassion, tolerance, service, truth, etc
- **Cultural Values:** To reflect true and the false behaviour of human beings in language, aesthetics, education, law, economics, etc
- **Individual Values:** Parents and Teachers shape individual values to a greater extent
- **Global Values:** To reduce disturbance of Harmony leading to ecological imbalance
- **Spiritual Values:**To become more self-disciplined (3M)

Elements of value education–How the objectives can be achieved

- Telling
  Modeling
- Role playing
- Problem solving
- Studying biographies of great man (5M)

6.

Explain the objectives, benefits and key elements of EIA (13M) (TNV AU Dec. 2009) BTL2

Answer: Page:7.32 – 7.34-A. Ravikrishnan

Objectives of EIA

- To identify the main issues and problems of the parties
- To identify who is the party
- To identify what are the problems of the parties
- To identify why are the problems arise(2M)

Benefits of EIA

- Reduce the cost and time
- Performance of the project improved
- Waste treatment and cleaning expenses are minimized
- Usages of resources are decreased
- Biodiversity is maintained

	• Human health is improved (2M) **Key element of EIA** • **Scoping** – To identify the key issues of the concern in the planning process at early stage, aid site selection and identify any possible alternatives. (2M) • **Screening -**To decide whether an EIA is required or not. (2M) • **Identifying and evaluating alternatives-**Knowing alternative sites and techniques and their impacts. (1M) • **Mitigation measures dealing with uncertainty-**Action taken to prevent adverse effect of a project.(2M) • **Environmental statements-**Final stage of EIA process which reports the findings of the EIA. (2M)
7.	
	Explain in details about women welfare and child welfare. (13M) BTL2 **Answer: Page: 7.28 – 7.32-A. Ravikrishnan** **Women welfare** Welfare to improve the status of the women by providing opportunities in education, employment and economic independence(1M) **Need for Women Welfare** • As women suffer Gender Discrimination • Due to physical and mental torture given to them • Violation of Human Rights to Women. • Neglecting of Women in Policy making and decision making (2M) **Objectives of Women Welfare** • To provide Education • To impart Vocational Training • To generate awareness about the environment • To improve employment opportunities • To restore Dignity, Status and Equality (2M) **Objectives National Commission for Women by Government of India** • To examine constitutional and human rights for women. • To review existing legislations. • To sensitize the enforcement and administrative machinery to women's causes (1M) **Organizations Towards Women Welfare** • NNWM (National Network for Women and Mining): Fighting for the "Gender Audit" of India's mining companies • UNDW (United Nations Decade for Women): Women welfare related issues on international agenda • CEDAW (Convention on Elimination of all forms of Discrimination against Women) • NGO's as Mahila Mandals • Ministry for Women and Child Welfare (2M) **Child Welfare** • Children occupy 40% of the total population.

	• Out of 21 Million Children born every year in India, 20 Million are estimated to be working as Child Labour in hazardous industries (1M)
	Reason for Child Labour
	• Poverty
	• Want of Money (1M)
	Organizations towards Child Welfare
	• **UN Conventions on Rights of Child or International Laws**-Formulated a set of International Standards to promote and protect the wellbeing of Children in our society
	• **Rights of child**
	  • …Right to Survival
	  • …Right to Participation
	  • …Right to Development
	  • …Right to Protection
	• **Ministry of HRD**-Concentrates on child's health, education, nutrition, clean and safe drinking water, sanitation and environment
	• **Centre for Science and Environment (CSE)**-Scientific report says that "Children consume more water, food and air than adults and hence more susceptible to environmental contamination
	• **Environment degradation and child welfare**-Children are more affected due to environmental pollution. So it is essential to keep our environment clean to children for better and healthy life Poverty (3M)

8.	
	Write a note on Indian constitution. (13M) BTL1 **Answer: Page: 7.19 – 7.20-A. Ravikrishnan** **Indian constitution; Article 14-30 .** • Article 14: Provides Equality before Law • Article 15: Prohibits Discrimination • Article 16: Provides Equal Opportunity • Article 19: Provides Freedom of Speech and Expression • Article 20: Provides Protection from Conviction • Article 22: Lays down the Rights of a person in Custody • Article 23: Prohibits forms of Forced Labour • Article 24: Prohibits appointment of Child Labour • Article 25: Provides Freedom to Practice any Religion • Article 26: Right to establish Charitable Institutions • Article 27: Prohibits Tax for Promoting Religion • Article 28: Guarantees Secular Character in Education • Article 29: Right to conserve their Language for Minorities • Article 30: Right of Minority to run Educational Institutions • Article 32: Right to Constitutional Remedies for enforcement of Rights by proceeding in Supreme Court (13M)

PART-C	
1.	

	(i) Narrate the role of information technology in environment protection (TNV AU Dec.2008 Dec. 2009, June 2013, Nov. 2011) (8M)BTL4
	(ii) Describe the case studies on role of IT in environment protection. (7M) BTL5
	
	Answer: Page: 7.34 – 7.37-A. Ravikrishnan
	(i) Role of IT in environment
	Software for environment education
	• **Remote Sensing**-Gather information about an object without contact with it
	  • In agriculture
	  • In forestry
	  • In land cover
	  • Water resources Remote sensing(2M)
	• **Data base**
	  • The ministry of environment and forest
	  • National Management Information System (NMIS)
	  • Environment Information System (ENVIS)(1M)
	• **Geographical Information System (GIS) –**Superimposing various thematic maps
	  • Water resources, soil type, forest land
	  • Interpretations of polluted zones, degraded lands
	  • Check unplanned growth and environmental problems (1M)
	• **Satellite data**
	  • Forest cover information
	  • Information on monsoon, ozone layer depletion, smog etc.
	  • Discovery of new reserves of oils, minerals, etc.(1M)
	• **World Wide Web**
	  • Online learning centers
	  • Provides the current and relevant information on principles, queries, and applications of environmental science.
	  • Stores all digital files related to teaching(1M)
	• **General applications**
	• Easily Accessible around The World
	• Disaster Management-Suitable warning system, disaster preparedness
	• Opened up a large number of scientific and technological resources and skills to reduce disaster risk.
	• Internet
	• Aerial sensor technologies to detect and classify objects on earth.
	• To capture, store, manipulate, analyse, manage and present geographical data.
	• Store books, pictures and other data that reduces paper waste that helps us in saving trees.
	• E-bills has significantly increased, which also contribute in saving trees.(2M)

	(ii) Answer: Page: 7.38 – 7.39-A. Ravikrishnan **Case studies on Role of IT in environment** • Study on polluted back waters of Kerala • Ocean study monitor (OCM) to study phytoplanktons • GIS for forest management • National Emission Data System (NEDS) • Environment Information System (ENVIS) (7M)
2.	
	(i) **Explain the role of IT in protection of human health. (10 M) (AU June 2013, Dec. Nov. 2009)(10M)**BTL4 **(ii) Explain the case study on role of IT in human health protection. (5M)**BTL5 **(i) Answer: Page: 7.39–7.40-A. Ravikrishnan** **Role of IT in human protection** • Health service technology- Finance and accounting, pathology, patient administration. • Helps the doctor to monitor the health of the people effectively. • Online help of expert doctors can be used for the patient. • The outbreak of epidemic diseases can be conveyed easily. • Effective function of a hospital. • Drugs and its replacement can be administered efficiently. • The data maintenance- birth and death rate, immunization and sanitation programmes • Spreading awareness about diseases and preventive measures to be taken. • Reduces panic and provides information about prevention and treatment options. • Airports-Screened passengers for high temperature and other symptoms • Robots that emulate or simulate living biological organisms. • Nano-Robots act as delivery systems within the organism • e-Health for healthcare practice. • Gaining momentum in academic research as well as in psychology, clinical work, and mental health counselling. • Statistics about diseases like malaria, fluorosis, AIDS, etc. • DNA databases about population, medical records, fingerprints, etc • Saves lives in critical care and emergency situations. • Bioinformatics for drug discovery and thus contributing to human health. • Provide a great support in maintaining individual fitness.(10M) (ii) **Answer: Page: 7.40–7.41-A. Ravikrishnan** **Case study** Health services on New south wales (3 M) National Institute of Occupational health (2M)
3.	
	Explain HIV/AIDS, its sources, diagnosis, mode of transmission of HIV infection and control and preventive measures.(15M) BTL2 **Answer: Page:** 7.24 – 7.28**-A. Ravikrishnan**

HIV-**H**uman **I**mmunodeficiency **V**irus; **AIDS**-**A**cquired **I**mmuno**D**eficiency **S**yndrome; a condition in humans in which the immune system begins to fail, leading to life-threatening opportunistic infections.(2M)

Sources of HIV infection.

- AIDS has spread from Africa.
- HIV has transferred to human from African monkey or Chimpanzees.
- HIV contaminated polio vaccine, prepared from monkey's kidney.
- Spread through hepatitis-B viral vaccine in Los Angels New York.
- Spread through small pox vaccine programme of Africa. (2 M)

Symptoms or diagnosis of HIV/AIDS

Minor symptoms

- Persistent cough for more than one month
- General skin disease
- Viral infection
- Fungus infection in mouth and throat
- Frequent fever, headache, fatigue

Major symptoms

- Fever for more than one month
- Diarrhea for more than one month
- Cough and TB for more than six months
- Fall of hair from the head
- 10% of body weight get reduced within a short period.(4M)

Mode of transformation of HIV.

- Sexual transmission, presence of STD increases likelihood of transmission.
- Exposure to infected blood or blood products.
- Use of contaminated clotting factors by hemophiliacs.
- Sharing contaminated needles.
- Transplantation of infected tissues or organs.
- Certain body fluids from an HIV-infected person-Blood, Semen, Rectal fluids, vaginal fluids, Breast milk.
- Having unprotected sex with someone who has HIV.
- Receiving blood transfusions, blood products, or organ/tissue transplants that are contaminated with HIV.
- Contact between broken skin, wounds, or mucous membranes and HIV-infected blood or blood-contaminated body fluids.
- Women are more vulnerable to HIV. Transmission of HIV to their new born babies happen easily.
- Women around 18-20 years are at risk, since their cervical tissue is more vulnerable to invading HIV. (5M)

Control and preventive measure

- Education
- Prevention of blood borne HIV transmission
- Primary health care

	• Counselling services • Drug treatment (2M)