JEPPIAAR INSTITUTE OF TECHNOLOGY

"Self-Belief | Self Discipline | Self Respect"

QUESTION BANK

Regulation	:	2017
Year	:	I
Semester	:	01
Batch	:	2019 - 2023

DEPARTMENT OF MECHANICAL 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 be the most sought-after Department in the field of Mechanical Engineering for imparting Technical Education for the upliftment of the society

MISSION

- To provide innovative solutions for industrial problems this helps in societal development.
- To inculcate students for a successful career in engineering and technology.
- To promote excellence in engineering and technology by motivating students for higher studies.

- To motivate self-employment thereby reducing migration to urban areas.
- To maintain ethical values while assimilating diverse culture without compromising with Indian value system.
- To provide excellent infrastructure and motivate lifelong learning.

Program Educational Objectives (PEOs)

PEO1: Have a successful career in Mechanical Engineering and allied industries.

PEO2: Have expertise in the areas of Design, Thermal, Materials and Manufacturing.

PEO3: Contribute towards technological development through academic research and industrial practices.

PEO4: Practice their profession with good communication, leadership, ethics and social responsibility.

PEO5: Graduates will adapt to evolving technologies through life-long learning.

Program Specific Outcomes (PSOs)

PSO 1: Apply the fundamentals of Mathematics, Science and Engineering acquaintance to solve real time problems with scientific principles under mechanical engineering profession.

PSO 2: Develop the ability to synthesize data for application in modeling and analysis software's to enhance the capabilities in simulation and demonstrate leadership qualities in activities related to sustainable development of society.

PSO 3: Understand the impact of Professional Engineering solutions in societal and environmental context, commit to professional ethics 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.

	UNIT 1: Sharing Information Related To Oneself/Family& Friends
	Reading- short comprehension passages, practice in skimming-scanning and predicting - Writing- completing sentences- - developing hints. Listening- short texts- short formal and informal conversations. Speaking - introducing oneself - exchanging personal information- Language development- Wh- Questions- asking and answering-yes or no questions- parts of speech. Vocabulary development-- prefixes- suffixes- articles.- count/ uncount nouns.
	PART*A
1.	Frame WH questions for the following sentences. (BTL-3) 1. I am going to Chennai tomorrow. When are you going to Chennai? 2. He comes from Ooty Where does he come from? 3. I didn't go to college yesterday as I was not feeling well? Why didn't you come yesterday? 4. It rains occasionally in our village When does rain in your village 5. The cost of my watch is 1000 rupees. How much does your watch cost? 6. Sixty students visited the Company. How many students visited the company? 7. Spain won the FIFA World Cup in the finals in 2010. Which country has won the World Cup in the finals? 8. Brazil shall host the 2014 World Cup in June-July. When will the World cup be hosted? 9. I washed my motor cycle last week When did you wash your Motor cycle? 10. She came to Coimbatore to study. Why did she come to Coimbatore? 11. They study (English) every Tuesday morning. What do they study every Tuesday morning? 12. Romi goes to school (by bus). How does Romi go to school? 13. The teacher explains the lesson (in front of the class). Where does the teacher explain the lesson? 14. My brother) does his homework carefully. Who does his homework carefully? 15. My daughter washes her hair (twice a week). How often does your daughter wash her hair? 16.N.John loves eating (pizza). What does John love eating? 17 Olga sings a song (beautifully). How does Olga sing a song? 18.P.Shanti gets up (at five). What time does Shanti get up? 19Q.Harry doesn't go to school (because he is sick). Why doesn't Harry go to school?

20.R. (Mother) cooks rice in the kitchen.
Who cooks rice in the kitchen?
21. Tommy rides his bike (very fast).
How does Tommy ride his bike?
22Thalia (has breakfast) before going to school
What does Thalia do before going to school?
23. I give (Mario) a birthday present.
Whom do you give a birthday present to -or- Who do you give a birthday present to?
24. Mario celebrates (his birthday) in September.
What does Mario celebrate in September?
25. The students listen to (the teacher's explanation
What do the students listen to?
26. I like (the white T-shirt), not the red one.
Which T-shirt do you like?
27. Julia has (two) brothers.
How many brothers does Julia have?
28. The little boys play (hide and seek).
What do the little boys play?
29. Sammy closes the windows (because it's going to rain).
Why does Sammy close the windows?
30.Baskar works with HP and Dell
Where does Baskar work?
31. Am Planning to relocate to Canada. (HS8151, Jan, 2017-18)
When are you planning to relocate?
32.The School reopens on 21st (HS8151, Jan, 2017-18)
When the school does reopens?
33. This is my friend's calculator. (HS8151, Jan, 2017-18)
Whose calculator is this?
34. Tanuj was late and so he could not attend the meeting. (HS8151, Jan, 2019)
When did Tanuj come?
35. My mother was coming to Chennai.
Where is your mother coming to?
36. I am Planning to relocate to Canada. (HS8151 Jan-2018)
Where are you relocating?
37. Complete the dialogue framing suitable Question: HS8151 Jan-2019
Ravi: Sir, Do you have Wheat Flour?
Shop keeper: Yes, We Have wheat Flour. Which Brand do you want?
Ravi: I want ABC brand
38. Complete any ONE of the following dialogues adding EIGHT exchanges:(HS8151 2019) (16)

a. Dialogue between Suresh and a shop owner. Suresh has gone to buy a video game.

Shop Owner : Hi, how can I help you?

Suresh : I'm looking for a video game.

	Shop Owner : ______________________? Suresh : ________________________. (Write English more exchanges)
2	**Yes or No Type Question:** **(**BTL-3) **1. Does he come from Singapore?** Yes, he comes from Singapore No, he comes from Dubai. **2. Have you completed your Project?** Yes, I have completed my project. No, I have not completed my project. **3. Is there any NRI student in our class?** Yes, there are five NRI students in our class No. there is no any NRI student in our class. **4. Have they gone to the swimming class?** Yes, They have gone to swimming class. No, They have gone to the music class **5. Are you willing to go there?** Yes, I am willing to go there No, I am not willing to go there **6. Are they hungry?** Yes, They are hungry No they aren't Hungry **7. Has he finished his homework?** Yes, He has finished his Home work No, He has not finished his home work **8. Have you got the Train Tickets?** Yes, I have got the tickets No I haven't got the tickets **9. Are you hungry?** Yes, I am very hungry. No I'm not hungry **10. Do you know your Chemistry master's name?** Yes, I know him very well No, I haven't met him **11. Have you seen my glasses?** Yes, I Have taken it. No, I haven't seen him. **12. Do you know the latest movie by Charles?** Yes, I have seen the movie No, I haven't seen the movie **13. Is there a cup of tea?** Yes, there is a cup of Tea No there is no tea left. **14. Does he know the information?**

Yes, he is aware of the information.
No, He doesn't know any information.

15. Will he come to the party?
Yes he will come to the party
No, He will not come to the party.

16. Is he prepared for the interview?
Yes, He is prepared for the interview
No, He isn't prepared for the interview.

17. Does the driver know the destination?
Yes, He knows the place/ Destination
No. He does not know the destination.

18. Can he work in the Computer?
Yes, He can work with the computer.
No, He can't work with the computers.

19. Will he know how to fill the form?
Yes, He knows to fill the form.
No he does not know how to fill the form.

20. Are you ready for the function?
Yes I'm ready for the function

3. **Parts of Speech:** (BTL-3)

Fill in the blanks with appropriate forms of words.

Sr. No	**Verb**	**Noun**	**Adjective**
1	Comfort	**Comfort**	Comfortable
2	Compel	Compulsion	C**ompulsive**
3	**Conclude**	conclusion	Conclusive
4	Continue	Continuation	**Continual**
5	**Believe**	belief	Believable
6	**Compare**	Comparison	Comparative
7	Enjoy	**enjoyment**	Enjoyable
8	Create	**creation**	Creative
9	**Attend**	Attention	Attentive
10	Collect	Collection	**Collective**
11	Accept	**Acceptance**	Acceptable
12	Act	Action	**Active**
13	Beautify	**Beauty**	Beautiful
14	**Communicate**	Communication	Communicative

15	Derive	Derivation	**Derivative**
16	Electrify	Electrification	**Electric**
17	Inform	**Information**	Informative
18	Conduct	Conduction	**Conductive** (Pg. 37,)
19	Correct	**Correction**	Corrective
20	Apply	**Application**	Applicable
21	Attract	Attraction	**Attractive**
22	Solve	Solution	**Solvable**
23	Accommodate	Accommodation	**Accommodative**
24	**Collaborate**	Collaboration	Collaborative

4 **Fill in the blanks with appropriate forms of words** . (BTL-3)

1. **Noun:** Environment
   Person Concerned: Environmentalist
   Adjective: Environmental
2. **Noun:** Science
   Person Concerned: Scientist
   Adjective: Scientific
   Noun: Account
   Person Concerned: Accountant
   Adjective: Accountable
3. **Noun:** Conversation
   Person Concerned: Conversationalist
   Adjective: Conversational
4. **Noun:** Machine
   Person Concerned: Mechanic
   Adjective: Mechanical

1. **Complete the sentence using the adjective with the correct degree (HS8151 jan2019)**

a. The Marina Beach is one of the **<u>Finest</u>** (Fine) and the second **<u>Longest</u>** (Long) beach in the world. Many people are attracted by its refreshing (refreshing) air. The morning walker find the air **more refreshing** than in the evening.

5 **Fill in the blanks with the appropriate forms of the underlined words:** (BTL-3)

1. They **<u>observed</u>** the readings and made entries in the ***<u>Observation</u>*** note book.
2. The release of CO2 in to the atmosphere leads to the ***<u>production</u>*** of greenhouse gases.
3. The industries ***<u>produce</u>*** plenty of such gases.
4. The Principal recommended the student for a scholarship and gave a *Recommendation* letter.
5. My uncle was **<u>promoted</u>** as the chief engineer and this P*romotion* came after he completed 15

	years. 6. The windmills in our district **generate** 100 megawatt power and the *Generation* of power will improve in August. 7. The **application** of nano-technology is seen in all disciplines. Doctors *apply* it in medical inplants. 8. Due to the good rains, the crops are ready for **harvest** .The *Harvested* grains can be sold for a good price
	Prefixes and Suffixes **Form words using the following prefixes and suffixes.** (BTL-1) 1. **Multi**tasking 2. **Proto**cal 3. **supe**rvision 4. Port**able** 5. Geo**graphy** 6. Tan**gle** 7. comfort**less** 8. **le**gible 9. **Un** comfort 10. **Un** important 11. **Ir-**relevant 12. **Up**loaded 13. **In-**depth 14. **Mis**fortune 15. **Mis**pronunciation 16. **Mis-**communication 17. **Un**identitify 18. **In**definite 19. **Bi**lingual 20. **Dis** approve 21. **Dis**obedience 22. **In**discipline 23. **Im**possible 24. **In**accurate **25.** **Dis** embark
7.	**Give the antonyms of the following words using negative Prefixes given in brackets.** (BTL-1) ***(dis, in,un,re, ir)*** 1. Unite – **Re** unite 2. Appropriate – **In** appropriate 3. Prove – **Un** prove 4. Popular – **Un** popular 5. Decent **– In**decent 6. Resistible**- Ir**resistible 7. Interesting – **Un**interesting 8. Comfort – **Dis/Un** comfort 9. Accurate - **In**accurate 10. Familiar - **Un**familiar 11. Efficient – **In**efficient

	12. Significant – **In**significant 13. Add suitable Prefixes to the underlined words to form Antonyms (HS8151- jan2019) a. The manager is **In**sensitive to the condition of the workers. The workers are very **Un** satisfied with the company management. b. The new officer is very **ir** responsible. He works **il** logically.
9	**Countable and Uncountable Nouns** (BTL-3) **Decide whether these nouns are countable or uncountable.** 1. The **children** are playing in the garden. 2. I don't like **milk.** 3. I prefer **tea**. 4. **Scientists** say that the environment is threatened by pollution. 5. My mother uses **butter** to prepare cakes. 6. There are a lot of **windows** in our classroom. 7. We need some **glue** to fix this vase. 8. The **waiters** in this restaurant are very professional. 9. My father drinks two big **glasses** of water every morning. 10. The **bread** my mother prepares is delicious. 11. It will **cost** about £2 million to repair the damage to the factory that was caused by the fire. 12. Every week our French teacher gives us a list of vocabulary to learn. 13. I was filled with joy ✔ when he told me the whole story. English is a difficult language. 14. The city faces worsening social and economic problems. It is sometimes difficult to persuade farmers to wear the proper protective clothing. 15. She's doing the housework every morning. 16. He did not have many possessions. 17. Have you heard the news about Tina and Tom? They're getting divorced. 18. Please report any accidents to a member of staff.
8.	**Fill in the blanks with the appropriate articles, *a, an,* or *the,* or leave the Space blank if no article is needed**. (BTL-3) 1. I want ***an*** apple from that basket. 2. ***The*** church on the corner is progressive. 3. Miss Lin likes **the** table. 4. Can I borrow **the** pencil from your pile of pencils and pens? 5. One of **the** students said, "the professor is late today." 6. Eliza plays volleyball at the national indoor stadium 7. I bought an umbrella to go out in the rain. 8. My daughter is learning to play **the** violin at her school. 9. Please give me **the** cake which is on the counter. 10. I lived on t**he** Main Street when I first came to town. 11. Albany is the capital of **the** New York State. 12. My husband's come with **a** hand full of rice. 13. **An** apple a day keeps the doctor away. 14. **The** ink in my pen is red. 15. Our neighbors have **a** cat and **a** dog. 16. Ms Parrot, <u>**the**</u> most famous lady detective of <u>**the**</u> twenty-first century, was born in <u>**the**</u> United Kingdom in <u>**the**</u> 1960s. Since then, she has been to many countries, including Portugal, Singapore and

Australia, and has lived in **the** northern hemisphere and **the** southern hemisphere, as well as on **the** equator. She has never been to **the** Philippines or **the** United States, but she speaks English, French and Portuguese. Like Sherlock Holmes, **the** famous detective, she plays **the** violin, and sometimes practises up to five times **a** day. She is also **the** only person in **the** world to have performed Tchaikovsky's 1812 overture in one breath on **the** recorder.

17. She has been **a** detective for thirty years and claims that although many people think that being **a** detective is **a** piece of cake, detectives generally work very hard and it's not all fun and games. **A** detective is someone who solves mysteries, and **the** people who contact Ms Parrot have some very unusual problems. Little information is available about some of **the** cases she has solved, but quite **a** few of her most famous cases have attracted worldwide attention and she has been offered up to **a** thousand dollars **an** hour to help solve mysteries such as **the** case of **an** Australian owl in **a** uniform. **The** bird laid **an** egg in **a** European nest in less than **an** hour after its arrival. What **a** strange problem! With great modesty, she has either declined such **a** fee or donated **the** money to **the** poor, or to **the** Grammar Survival Fund, believing that **the** detective should use their skills for **the** common good.

18. The Parliament ______ (has/have) its speaker. ***(has)***

19. Every body _______(appreciate/ appreciates) Mr. Rahul Gandhi's speech. ***(appreciates)***

20. Computer classroom and lab ______ (was/ were) closed. ***(were)***

21. The news ________ (are/is) not true. ***(is)***

22. Only a few people in this world _____ (leave) their footprints on the sands of history, and these men of honor never _____ (die). One such grand personality _____ (be) the greatest innovator of all times Mr.Alexander Grahm Bell, who _____ (invent) the first practical telephone. His other major inventions are hydrofoils and metal detector

(Ans : had left, dies, is , invented) **(AU, Nov/Dec, 2014)**

23. Stephen Hawking is one of the most brilliant theoretical physicists. He ____ (be) also a popular writer. His first book, "A Brief History of Time" ____ (publish) in 1988 and ____ (become) an international best seller. In it, he ____ (explain) about the birth and death of the universe to the lay person.

Ans : is, was published, became, had explained **(AU, Model QP 2015)**

9. **Read the Passage and answer the question that follows it. (16M)** (BTL -2)

Considering the enormous number of things which could turn a space mission into a fatal disaster, it is remarkable that there have been so few accidents. 1967 was a bad year; in January, the Americans lost three astronauts in a fire which occurred during tests on the ground and, in April, the Russians lost astronaut komarov landing after sixteen successful Earth orbits. The accident was due to a parachute failure. Neither of these tragedies was quite what the world had expected. It was feared that one day astronauts would be strande4d in space, alive but with no possibility of returning to Earth. This very nearly happened in 1970 during the flight of Apollo 13.

The life-support and other systems of spacecraft are interlinked. This means that if one system fails it is likely to cause other systems to fail too. Designers have tried to avoid disasters by duplicating, and in some cases triplicating, important pieces of equipment; for example , Apollo has no less than three fuel cells. Even so, a breakdown in the service module of Apollo 13 was nearly fatal. On 13 April one of the low temperature oxygen tanks in the service module suddenly broke open; the explosion probably damaged the other oxygen tank close beside it. The exact reason for the explosion may never be known. The important point to note is that the oxygen from these tanks is not only used by the crew but also feeds the fuel cells and fuel cells produce electrical power and water. So, one failure immediately caused a major power failure affecting nearly every system in the command module and produced a shortage of oxygen and water for life-support.

The safe return of the astronauts was due to their ingenuity and powers of improvisation. They managed to adapt their equipment. They were able to use it for different purposes from those for which it had been originally intended.

Intelligence and the ability to use limited resources for self-preservation have always been admired by writers of adventure book. The shipwrecked sailor who converts bits of wreckage into a raft and an explorer who makes a bow and arrow from branches and bootlaces are considered heroes because they survive by their own wits. Many people thought that the advanced technology of space flight ruled out all opportunities for makeshift repairs, but Apollo 13 proved them wrong. Luckily, at the time of the accident the lunar module was still joined to the command and service modules and the lunar module had most of the things urgently needed by the disabled modules. The spacecraft was not on a free return trajectory, one which would bring it round the moon back to Earth, and rocket power was needed to bring it into such a trajectory. Without a proper power supply, the rocket of the services module could not be fired; the rocket of the lunar module had to be used instead. Inside this module there was a supply of oxygen, water and power, and a guidance System. Though it was designed for a crew of two for only about thirty hours, and intended for landing on the moon, this vehicle became the lifeboat of Apollo 13.

Life for the three crew members was difficult but bearable. A lunar module cannot reenter the Earth's atmosphere without burning up, so the crew had to return to the command module, jettison their lifeboat and the service module, and turn themselves into the right position for re-entry, hoping that their heat-shield had not been damaged by the explosion of the oxygen tank. Re-entry and recovery were totally successful.

(a) **Write a response which best reflects the meaning of the text**:

i. 1967 was

1. A good year for the Russians and Americans.
2. A good year for the Americans but not for the Russians.
3. A bad year for the Americans and the Russians.
4. A bad year for the Americans but not for the Russians.

ii. Why was the breakdown of the oxygen supply so important?

1. Because it could cause an explosion.
2. Because they could not fire their rocket without it.

3. Because they never found out the reason for it.
4. Because it affected all the systems in the module.

iii. The astronauts survived because

1. The command module was not very badly damaged.
2. The lunar module was intended as a lifeboat.
3. They managed to improvise.
4. They had read a lot of adventure stories

iv. How did the astronauts get back into the atmosphere from space?

1. By using a Parachute.
2. By going back into the command module.
3. By staying in the service module
4. By burning the lunar module

(b) **State whether the following statements are true or false:**

1. The Americans lost an astronaut when his parachute did not open.
2. People expected that someday astronauts would be left in space.
3. Makeshift repairs are impossible in space.
4. The spacecraft was on a trajectory which would have brought in back to earth.
5. Life for the astronauts in Apollo 13 was unbearable.
6. The heat-shield of the command module had been damaged by the explosion.

(c) Choose the definition which best reflects the meaning of the word as it is used in the text:

i. **Fatal**

1. Causing injury
2. Causing death
3. Causing illness
4. Causing failure

ii. Stranded

1. **Delayed**
2. Isolated
3. Injured
4. Killed

iii. Jettison

1. Get off
2. Trun over
3. Throw away
4. Break down

iv. Makeshift

1. Expensive
2. Elaborate
3. Technical
4. Improvised

v. Wits

1. Endurance
2. Experience
3. Intelligence
4. Connections

v. **Ruled out**

1. Ruined
2. Excluded
3. .Improved
4. Justified

II. Completing Sentences (BTL-2)

Match the ideas given below with the options provided and complete the sentence.

a. The behavior of earth quake is the evidence to show that

i. The outer layer is not semi-solid.
ii. The interior of the earth is not solid.
iii. The interior layer consists of compressed rock
iv. Earth quakes can be controlled.

b. Complete the sentence by matching the ideas given below with the options provided.

The Progress in the field of Chemistry has helped in

i. The development of many types of industries.
ii. The progress of space research
iii. The innovations in the communication field.
iv. The increase of computers.

c. **Use the appropriate option and complete the sentence. India and Russia build BrahMos missiles on----------**

i. Working separately
ii. Working abroad
iii. Collaboration
iv. Working in native country

*(**Scheme of Marks**: 16 questions- objective type- 16M)*

Read the passage and answer the questions that follow:

1. Man has won his dominant position on this planet by his command of technology. Other animals have to take nature as they find her ; they must fit into the environment that she provides as best they can. Man alone changes the shape of this world. He moves things about; he alters them in a constant

effort to create an environment more hospitable than that, which nature has thurst him into. Technology is the sum total of all different techniques by which man changes his environment.

Technology is characteristic of all human societies, and it exits even among leas developed tribes and communities. Even the Eskimo uses a number of techniques to make life more comfortable for him. He makes clothes: he builds an igloo and a boat: he uses needles and knives: he gets food by means of fishing lines and harpoons. All these are techniques for changing his wild habitat into an environment that suits him better.

More advanced civilizations have more complex technologies, but the basic pattern is always the same. There must be means to get food; so the hunter invents the spear , or the bow and arrow, or the boomerang; and the farmer invents the hoe or the plough. There must be means to move things about, so the community domesticates the ox or the horse and invents the boat or the wheel. There must be means to ward off the weather, so the community makes clothes and huts and invents the tools that are needed to make them. These and other tools need to be strong and durable, so civilizations gradually move on from stone to bronze, from bronze to iron, and so on. And when we think of our present age as the age of light metals, we see ourselves in the tradition of progress that began with stone, bronze, and iron.

Our own technological progress, then, has been a natural continuation of earlier trends. When today we breed new stains of corn, we are following the same aims as the first farmers. And when we send a rocket above the atmosphere, we are following the line begun by the invention of the wheel.

However, there is one respect in which our technology is markedly different. We have transformed the simple tools of the past into complex machines. For example, man has used such a tool as the hammer since long before historical records began. But it was only in historical times that he discovered that the hammer could be made into a trip hammer that is, could be made to deliver its blow again and again automatically, When a tool is made to repeat the same mechanical action, it becomes a machine. Modern civilization is built on the use of machines in this way. However clever they may appear, all machines at bottom are as the water wheel they do nothing but save us from carrying out ourselves a fixed and repeated sequence of actions.

(i)**Answer in a sentence or two:**

1) What is technology?

2) What is the common feature between the technologies developed by advanced and less advanced civilizations?

3) In what respect is the modern technology different from that of the past?

4) What are the techniques used by the Eskimoes to better their life?

(ii) Say whether the following statement s are true or false:

	1) Technology is typical of only a few societies. 2) Humans have used simple tools since time immemorial. 3) Other animals can modify their environment. 4) Eskimoes represents less developed society. **(iii) Complete the following appropriately:** 1) Human beings have achieved a powerful position on earth because of their _________. 2) The spear or the bow and arrow are ____________. 3) In this passage, the present age is referred to as the ___________. 4) A tool becomes a machine ________. **(iv) Give the meanings of the following words:** 1) Hospitable- 2) Dominant- 3) Durable- 4) Breed
	2. What is so common among highly successful people and organizations? It is their vision, the power to look beyond the present and to visualize the possibilities of the future. It is not only their vision, but their determination to transform their dreams into realities that have made them great. Thinking ahead is the **privilege** given to man alone. Man learns from the past experience, analyses the present and plans for the future. Management is defined as the art of getting things done through and with the people. Therefore, to be successful, a manager needs to do a lot of planning not only for himself but also for his people. Planning is an important management function. **The planning process takes into account the following factors:** 1. PEOPLE: who are going to carry out the plan? How many people do we need? What are the kinds of people required and how to involve them? 2. PRODUCTS: What are the products necessary for achieving the goal? 3. DEADLINE: What is the time-grace needed for achieving the gold? Planning also takes into account the strengths, which are to be made use of an weaknesses which are to be avoided during the execution of any task. It considers how to capitalize on the available opportunities and how to **safeguard** against competitive developments and the changing scenario.

Planning is of different kinds depending on the planner and his objectives. For example, companies have 'Corporate Visions which stem from individual vision. To achieve these, they make short-term and long-term plans. A long term plan is derived from a long range vision of the organization's destiny.

It is involved in setting broad objectives and the procedures for achieving them. This is essential for the survival and future growth of any business. Senior Managers are involved in long-term planning, thinking of new products and services, and of new ways of obtaining resources. Short- term plans are drawn up to realize more immediate goals and take care of the step by step activities needed for achieving the over-all objectives of a long- term.

It is necessary that planning should be realistic. While planning, one must accept the reality and set objectives which can be **accomplished.** Whenever one develops a plan, it is important to devise back up actions and alternative plans, just in case something goes wrong. Flexibility is vital to any good business plan. After planning, clear communication to all concerned is the key to success. Then **implementation** within a time frame must follow Planning and monitoring must go together, because, planning cannot be really effective without regular monitoring and good control.

The prime advantage with planning is that it leads to systematic and methodical work. It ensures proper coordination; helps proper control and provides an overall picture of the operations. It brings about optimum input utilization, minimizes wastage and helps periodic evaluation and replanning it necessary. Due to lack of planning many projects have failed. So success in life requires both merely thinking big , but also planning in advance.

(i)Choose the response which best reflects the meaning of the text.

1. The vision of highly successful people has enabled them to

a) see far beyond and foretell what might happen in time to come

b) predict the future events that might affect humanity in one way or the other

c) send warning signals to the people regarding the future

d) dream about the happily life, they will lead in the future

2. Planning is

a) thinking ahead

b) examining the past

c) the art of achieving one's objective

d) devising a method following which the objective can be achieved

3. Good planning is

a) realistic having set objectives

b) fixed not permitting any change

c) supported by back-up actions

d) a failure when a mistake occurs in implementation

4. Successful planning

a) helps management settle amicably labour unrest.

b) takes to task those who waste raw material

c) punishes those who are not systematic in their work

d) ensures maximum input utilization, continuous monitoring and periodic evaluation.

ii) Decide whether the following statements are 'true' or 'false' :

1. The future growth of any business depends only on the procurement of resources by senior managers.
2. The success of planning depends on how well it is implemented with regular monitoring, within the time limit, securing the support of all concerned.
3. Short-term plans help not only to realize immediate goals, but also to monitor the step- by- step activities in achieving the over- all objectives of a long term plan.
4. Success in life depends on thinking big alone.

iii) Choose the most accurate definitions of the terms taken from the text:

1. Privilege

(a) Special right or advantage

(b) Special choice

(c) Special prize

(d) Special respect

2. Safeguard

(a) to improve or better something

	(b) to violate something (c) to protect or guard something (d) to despise something 3. to accomplish (a) to master something (b) to complete successfully something (c) to help another to do something illegal (d) to fail to achieve something 4. Implementation (a) Division of labour (b) A tool or instrument (c) Involvement (d)Carrying out effectively.
	3. It is everyone who agrees a difficult task that the child performs when he learns to speak, and the fact that he does so, in so short a period of time challenges explanation. Language learning begins with listening. Individual children vary greatly in the amount of listening they do before they start speaking and late starters are often long listeners. Most children will obey spoken instructions some time before they can speak, though the word ‘obey’ is hardly accurate as a description of the eager and delighted cooperation usually shown by the child. Before they can speak, many children will also ask questions by gesture and by making questioning noises. Any attempt to trace the development from the noises babies make to their first spoken words leads to considerable difficulties. It is agreed that they enjoy making noises and that during the first few months one or two noises sort themselves out as particularly indicative of delight, distress, sociability and so on. But since these cannot be said to show the baby’s intention to communicate, they can hardly be regarded as early forms of language. It is agreed, too, that from about three months they play with sounds for enjoyment and that by six months they are able to add new sounds to their repertoire. This self-imitation leads to deliberate imitation of sounds made or words spoken to them by other people. The problem then arises as to the point at which one can say that these imitations can be considered as speech.

It is a problem we need not get our teeth into. The meaning of word depends on what a particular person means by it in a particular situation; and it is clear that what a child means by a word will change as he gains more experience of the world. Thus the use, at say seven months of 'mama' as a greeting for his mother cannot be dismissed as a meaningless sound simply because he also uses it at other times for his father, his dog, or anything else he likes.

Playful and apparently meaningless imitation of what other people say continuous after the child has begun to speak to itself. I doubt, however, whether anything is gained when parents cash in on this ability in an attempt to teach new sounds.

I. Choose the response which best reflects the meaning of the text:-

1. Children who start speaking late

a) May have problems with their hearing.

b) Probably do not hear enough language spoken around them.

c) Usually pay close attention to what they hear.

d) Often takes a long time in learning to listen properly.

1. **A baby's first noises are**

a) a reflection of his models and feelings.

b) an early form of language.

c) a sign that he means to tell you something.

d) an imitation of the speech of adults.

1. **The problem of deciding at what point a baby's imitations can be considered as speech**

a) is important because words have different meanings for different people.

b) is not especially important because the change over takes place gradually.

c) is one that can never be properly understood because the meanings of words change with age.

d) is one that should be completely ignored because children's use of words is often meaningless.

1. **The writer implies that**

	a) Parents can never hope to teach their children new sounds. b) Children no longer imitate people they begin to speak. c) Children who are good at imitating learn new sounds more quickly. d) Even after they learn to speak, children still enjoy imitating. **II. Write whether the following statements are 'True' or 'False':-** a) Before they begin to speak most children do about the same amount of listening. b) Children can ask questions by making noises. c) Children first imitate adults, and then themselves. d) Children's first words are usually meaningless because they can apply to many different things. **III. Choose the most accurate definition of the terms taken from the text:** 1) **Vary** a) Worry b) differ c) develop d) change 2) **Sort themselves out** a) Become evident b) are learnt c) are discovered d) take the place of others 3) **It is agreed** a) it has been proved b) it is generally accepted c) it is obvious d) it is most likely 4) **Cash in on** (d) a) Ignore b) exploit c) discourage d) praise
	Read the following passage and answer the questions given below (HS8151, JAN 2019) Noise from aircraft, traffic and commercial and development is drowning out the natural quiet of many wilderness area and parks, according to a new analysis of noise pollution in U.S. protected lands made public in Science. The sounds of people on the move or at work are "pervasive" in public lands set aside for recreation, resource conservation and respite from the din of daily life, said scientists of Colorado State University and the U.S. National Park Service who analyzed noise levels at 492 federal state and local parks. They calculated that the sounds people make- from the racket of ringing phones and the rumble of road traffic, to the clatter of mining, drilling and logging- have raised the levels above natural background noise in two-thirds of U.S. protected areas, with adverse consequences for wildlife and for the 200 mission or so people who seek the tranquil hush of park lands every year. " The din of modern life extends into protected areas", said acoustic biologist Megan McKenna at the Natural Sounds and Night Skies Division of the U.S. National Park Service in Fort Collions, Colo., Who joined in the project. The study arises from a growing appreciation of the effect of excess noise on human health and wildlife behavior. To quantify the human contribution to park noise, the researchers led by Colorado State University conservation biologist Rachel Buxton created a

computerized national soundscape that approximated the level of noise during an average summer day. They collated and analyzed millions of hours of park-land sound recordings. They fed the acoustic data into a computer algorithm that combined it with dozens of landscape variables to calculated how much extra noise people added. Overall, they found that, depending on the locale, human activity boosted noise levels up to 10 decibels above natural levels.

For comparison, sounds in cities often often exceeds 65 decibels- about the level of a running air conditioner. In natural settings, sounds rarely exceed 40 decibels- about the noise level of a babbling brook. The quietest parks have a background noise levels of less than 20 decibels. Road traffic and aircraft were the biggest sources of park noise, Dr. Buxton said. In an independent study of air traffic in national parks in 2010, researcher at Colorado State found that overflights of Grand Canyon National Park had grown to about 55,000 a year, with more the 100 helicopters in the air over the canyon on the busiest days. Sound levels in spots reached as high as 76 decibels, they said.

The impact of noise on wildlife conservation biologists. Noise pollution can deafen fish, scare off animals, and muffle the sound of mating calls among wild birds, hindering their ability to hunt for food or to warn each other about predators. “They can no longer these calls,” said avian behavioral ecologist Christopher Templeton at Pacific University in Oregon, who studies the effect of noise on birds in the U.S. and Europe. Other birds sing louder to be heard or flee the noisy area entirely.

Psychologists are discovering that natural sounds-from the wind rustling the trees to the warble of songbirds- have benefits for humans, and can lower stress, elevate mood, boost cognitive abilities and perhaps enhance healing Jonas Braasch, a musicologist at the Rensselaer Polytechnic Institute, found that office workers listening to the burble of a flowing mountain stream while taking tests not only performed better, but also reported feeling more positive about their surroundings, compared with those who listened to normal office noise or a background recording of white noise. “They were more patient and avoided more errors,” he said. “Nature sounds can have a restorative effect on our cognitive abilities.”

Listening to nature also may help people recover more quickly from stress or trauma, according to a 2015 study by Pennsylvania State University psychologists. They tested how people reacted to a disturbing video of surgery. Those who listened to a recording of natural sounds recovered their good mood more quickly than those who listened to a tape of the same natural noises with human-made sounds, such as voices and cars; added to it.

(a) Choose the correct answer for the following questions: (10 * 1=10)

(i) Where did scientists at Colorado State University and the U.S. National Park Services analyze noise levels for a study?

(1) In cities across the U.S.
(2) In rural areas across the U.S.
(3) In Federal, state, and local parks
(4) In areas by the oceans.

(ii) The levels of noise in many protected areas has been raised above the level of background noise. What is one cause of this increased noise the text describes?

(1) Some animals have become louder.
(2) There are aircraft and road traffic nearby.

(3) Background noise has dropped.
(4) The number of thunderstorms has increased.

(iii) Noise pollution can be harmful to wildlife in protected areas. What evidence from the text supports this conclusion?

(1) The number of flights over the Grand Canyon has increased, with sound levels in sports reaching as high as 76 decibels.
(2) The noises humans make has raised the noise levels in two -thirds of protected areas in the U.S.
(3) Natural sounds like birds warbling and the wind rustling in the trees can have benefits for humans.
(4) Noise pollution can muffle the sounds of calls among wild birds, hindering their ability to hunt for food.

(iv) How might the noise the humans make be affecting humans?

(1) It may be negatively affecting our moods.
(2) It may be Improving our cognitive abilities.
(3) It may be causing people trauma.
(4) It may be causing increased traffic.

(v) What is the main idea of this article?

(1) Natural sounds have benefits for humans, and can lower stress, elevate mood, and boost cognitive abilities.
(2) Noise pollution from humans is invading protected natural areas, with negative effects on wildlife and people there.
(3) Noise pollution can have negative effects on wildlife, like deafening fish, scaring off animals, and muffling the calls birds make.
(4) While sounds in cities often exceeds 65 decibels, sounds in natural settings are usually not higher than 40 decibels.

(vi) Please read these sentences from the text.

"The din of modern life extends into protected area,' said acoustic biologist Megan McKenna(.)" Based on this sentence, what does the word din mean?

(1) Stress
(2) Nature
(3) Quiet hush
(4) Loud noise

(vii) Choose the answer that best completes the sentence.

Psychologists are discovering that natural sounds have benefits for humans, ___________ lowering stress, elevating mood, and boosting cognitive abilities.

(1) Therefore
(2) Such as
(3) However
(4) Consequently

(viii) Which of the following words means 'sound'?

(1) Acoustic

(2) Song
(3) Muffle
(4) Stream

(ix) One who studies the mind of a person is called a ______________.

(1) Musicologist
(2) Psychologist
(3) Ecologist
(4) Scientist

(x) Which of the following statements is incorrect according to the passage?

(1) Listening to nature helps people recover more quickly from stress.
(2) People make sounds from the racket of ringing phones that irritate us.
(3) The warble of songbirds – have benefits for humans, it enhances healing.
(4) The noise that man makes affects only the humans and not the animals and birds.

(b) Answer the following questions in one or two sentences:

(i) What kinds of human noises are extending into protected areas?

(ii) Why might the increase of noise in the natural areas be a problems, according to scientists studying wildlife? Support your answer with at least two details from the text.

(iii) If humans took steps to reduce the amount of noise pollution in natural areas, what could some possible effect be? Support your answer with evidence from the text.

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1. Developing Hints(16M) (BTL-2)

Develop the following hints given here and write a paragraph on Nuclear Energy. Nuclear energy—alternative source of energy—a boon—less quantity of mineral oil and coal—burning coal for power generation—environmental hazard like acid rain—generation of hydroelectric power—destruction of forests. Nuclear energy from nucleus of atom--fission or fusion--almost 350 nuclear reactors in the world. Power from fusion—to operate industries –to provide electricity –food preservation—useful in medicinal field.

b. Develop the hints and draw a comparison between calculators and computers. Calculators—cheaper—battery—solar power—slower—limited memory— computer—expensive—needs electricity—faster—unlimited memory.

Scheme of Marks :
Content : (4M)
Presentation: (4M)
Grammar: (2M)
Vocabulary: (2M)
Sentence Pattern: (4M)

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UNIT II GENERAL READING AND FREE WRITING

Reading - comprehension-pre-reading-post reading- comprehension questions (multiple choice questions and /or short questions/ open-ended questions)-inductive reading- short narratives and descriptions from newspapers including dialogues and conversations (also used as short Listening texts)- register- Writing – paragraph writing- topic sentence- main ideas- free writing, short narrative descriptions using some suggested vocabulary and structures –Listening telephonic conversations. Speaking – sharing information of a personal kind—greeting – taking leave- Language development – prepositions, conjunctions Vocabulary development guessing meanings of words in context.

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Conjunctions (BTL-1)

Fill in the blanks with appropriate conjunctions.

1. Receptionists must be able to relay information ______ pass messages accurately.
(A) Or
(B) And
(C) But
(D) Because

2. I did not go to the show ______ I had already seen it.
(A) Until
(B) Because
(C) So
(D) But

3. Mary is a member of the Historical Society ______ the Literary Society.
(A) As
(B) Or
(C) And
(D) But

4. Read over your answers ______ correct all mistakes before you pass them up.
(A) Or
(B) And
(C) Because
(D) While

5. Keep the food covered ______ the flies will contaminate it.
(A) Or
(C) And
(D) Until
(E) Though

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	6. ______ he is thin, he is strong. (A) But (B) As **(C) Though** (D) Because 7. Susie ______ phoned ______ wrote after she left home. (A) either, or **(B) neither, nor** (C) while, and (D) though, or 8. She had an unpleasant experience ______ she was in Thailand. (A) But (B) And (C) Because **(D) While** 9. The committee rejected the proposal ______ they did not think it was practical. (A) Or (B) But (C) Though **(D) Because** 10. John welcomed his guests ______ offered them drinks. **(A) And** (B) While (C) Until (D) As
3.	**Preposition Supply suitable Preposition in the blanks provided.** (BTL-3)
	Machine civilization is that own standard of life One of the important benefits **of** civilization has improved. There is much more variety **in** our lives. We have a wide choice of everything any wrist watches to flash lights. Food from any part of the world can be obtained **in** the season of the year.
	Supply suitable Preposition in the blanks provided. What time are you leaving? I am leaving **in** the afternoon. May be **at-** 3 p.m. I am coming back **on** Sunday evening. I'll take the 8a.m. train **on** Sunday. I'll be here **by** 9 p.m.
	b. **Fill in the blanks in following passage with suitable prepositions.**
	1. Very fast trains are safe compared _______ most other forms _____ motorized transport. For example, the TGV, which commenced operation ____ 1981 travels ____ 10 million passenger kilometers each year.***(Ans: to, of, in, at)***
	2. The research study highlights the importance ____ the fossil record ____ understanding long-term ecological responses ____ changes ____ time. ***(Ans: of, in, to, over)*** **(AU May/June 2013)**
	3. Experiments have been carried out------ volunteers to see what happen when all sensations are stopped. This can be done ----- several ways. One method is----- put a man ----- a completely isolated room.***(Ans: by, in, to, in)***

	4. The Gobar gas plant is a simple apparatus used ____ turning animal wastes ____ biogas plus nitrogen fertilize. "Gobar" comes ____ the Hindi word ____ cow.***(Ans: for, into,from, for)*** **(AU May/June 2012)**
	5. A Snowflake originates ____ countless water molecules that initially come together ____ small groups as a result ____ a weak force _____ oxygen and hydrogen atoms. ***(Ans: from, in, of, of)***
	6. You can see the entire information ____ the screen which gives the details the arrival and departure ____ trains. ***(Ans: of, of)***
	7. What is the matter ____ your car? Haven't you sent it ____ servicing? ***(Ans: with, for)***
	8. The thorium reserves can be used ____ fast breeder reactors. A very small quantity ____ nuclear fuel produces energy that can otherwise be produced ____ vast quantities ____ conventional fuels like coal. ***(Ans: in, of, in, as)*** **(AU May/June 2011)**
	9. Children have been playing ____ toys ____ ages. Toys are said ____ be made ____ 2000 B.C.A toy is not simply an object ___ amusement, it can be educative also. ***(Ans: with, for, to, in, of)***
	10. Is necessity the mother ____ invention? Well, not always. Determined to find a cheap sustainable fuel, ____ Engineer, Chitra Thiyagarajan who developed a unit that converts plastic waste ____ a fuel similar to diesel. ***(Ans: of, by, into)***
	11. **S**teve jobs founded Apple Computers _______ Steve Woznaik_____ 1976. It soared. It starts _________ as a garage venture _____ a giant Technology. (. ***(HS8151, Jan, 2017-18)***
	12.A nuclear reactor is a device ______ producing nuclear energy **(for)**
	13. The committee has agreed _____ the main issues **(on)**
	14. Coal is used _______ make coal tar **(to)**
	15.The young man got _____ the running train**(to)**
	16. I always go to college ______ train (**by**)
	17. He spoke to his chairman _______ phone (**on**)
	18. The boys watched the cricket match ______ the television **(at)**
	19.He always drives his car ________ the speed of 60km/hour **(at)**
	20. The president congratulated the cricket team ______ their success **(on)**
	21.We have been waiting here ____ eight in the morning **(of)**
	22. The ore is then transported _______ the mills **(to)**
	23. The traffic moved _____ a snail's pace. We were detained _____ two hours**(at, for)**
	24. the application must reach the office _______ 15th April **(by/on)**
	25. I am not very good _______ repairing things**(at)**

	Guess the meaning of the words in italics. **(**BTL-1**)** **1.** Our baseball team's pitchers has a few ***eccentric*** habits, such as throwing exactly thirteen warm-up pitches and never wearing socks. **1.** normal 2. **strange 3.** messy
	2.After the heavy rains the stream became ***murky***; in fact, the water was so cloudy you couldn't see the bottom. **1.** cloudy 2. **bottomless 3.** clear
	3.The ***debris*** on the stadium floor included numerous paper cups, ticket stubs, and cigarette butts. **1.** products 2. papers 3. **trash**
	4. The coach takes every opportunity to ***censure*** his players, yet he ignores every opportunity to praise them. 1. approve of 2. **criticize 3.** choose
	5. The newlyweds agreed to be very ***frugal*** in their shopping because they wanted to save enough money to buy a house. 1. **economical 2.** wasteful 3. interested
	6. Although Alex usually looks ***unkempt,*** 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.	**Reading Comprehension (16M)** (BTL3)
	1. Objective/ Multiple type: 1 per question 2. True or False: 1m/ Question 3. Short note: 2m if any

Unit III GRAMMAR AND LANGUAGE DEVELOPMENT Reading- short texts and longer passages (close reading) Writing- understanding text structure- use of reference words and discourse markers-coherence-jumbled sentences Listening – listening to longer texts and filling up the table- product description- narratives from different sources. Speaking- asking about routine actions and expressing opinions. Language development- degrees of comparison- pronouns- direct vs indirect questions- Vocabulary development – single word substitutes- adverbs.

Sr. No	**PART* A**
1	**Degrees of Comparison (2M)** (BTL-3) **Fill in the correct forms of the words in brackets. (comparative or superlative)** 1. My house is (big) ***Bigger*** than yours. 2. This flower is (beautiful) ***More Beautiful*** than the other one. 3. This is the (interesting) ***More Interesting*** book I have ever read. 4. Non-smokers usually live (long) ***Longer*** than smokers. 5. Which is the (dangerous) ***more dangerous*** animal in the world? 6. My house is (big) ***bigger*** than yours. 7. This flower is (beautiful) ***More Beautiful*** than the other one. 8. This is the (interesting) ***Most Interesting*** book I have ever read. 9. He was the (clever) ***cleverest*** thief of all. 10. Who is the (rich) ***richest*** woman on earth? 11. Diesel is ***heavier*** (heavy) than petrol. 12. Nylon is ***harder*** (hard) than rubber. 13. Platinum is ***more expensive*** (expensive) than gold. 14. Hyderabad is the ***largest*** (large) city in South India.\ 15. The Arabian Nights is ***morepopular*** (popular) than any other story book. 16. Mount Everest is the ***highest*** (high) peak of the Himalayas. 17. Mumbai is one of the ***richest*** (rich) towns in India. 18. England is ***richer*** (rich) than most other countries. 19. Shakuntala is the ***best*** (good) drama in Sanskrit. 20. Silver is ***Less valuable*** (valuable) than gold

2.	**Pronouns** (BTL-3) **Fill in the blanks with suitable pronouns.** 1. John and Peter are brothers. I know **them** very well and my father likes …very much. 2. This book has many interesting pictures and stories. I like ***it*** very much. 3. The woman gave sweets to the children, but **he** did not thank **her** 4. The teacher said, 'John, you're a naughty boy. **You** don't obey ***me*** 5. The boys were late so the teacher scolded ***Them*** 6. We have a good teacher, ***she*** advised ***us*** to work harder. 7. My father told my mother, "I want **you** to take these jewels and put **it** in a box. When **you** have done that, come and see ***me*** and ***you ll*** tell me why you don't want me to keep it in that box". 8. My brother needs a servant whom **he** can trust completely. 9. He is Dr Hussain **his** .paintings are world famous. 10.Sachin and **I** went to the railway station. 11. Hers It me That These This Those yours yourself **12.** I'm in bed, because I'm ill. Looking through the window is my only fun. Look-________ are my friends playing football in the playground. 13. That isn't Diana's house._________ is next door. 14. Hello. My name's Frank. What's _______ ? 15. ________ is certainly not hot tea, I can touch it. 16. I've got a problem. Can you help _______? 17. _______ is my father's picture on the wall. It's dirty, but I can't clean it, because it's too high. 18. My office isn't big. _______'s quite small. 19. You can do it by_____ 20. _________ books are very interesting. Could I borrow them?
3.	**Direct and Indirect Questions** (BTL-3) **1.** **Direct:** Where is Market Street? **Indirect:** Could you tell me where Market Street is? 2. **Direct** What time does the bank open? **Indirect:** Do you know what time the bank opens? 3. **Direct:** Why did you move to Europe? **Indirect:** I was wondering why you moved to Europe..

	4. **Direct:** How has he managed to get in shape so quickly? **Indirect:** Do you have any idea how he's managed to get in shape so quickly? 5. **Direct:** How much does this motorcycle cost? **Indirect:** I'd like to know how much this motorcycle costs. 6. **Direct:** Can you finish the project by tomorrow? **Indirect:** Would it be possible for you to finish the project by tomorrow? 7. **Direct:** Can we change the meeting to Thursday? **Indirect:** Is there any chance we could change the meeting to Thursday?
	Change this direct speech into reported speech: 1. "He works in a bank" She said ____ 2. "We went out last night" She told me____ 3. "I'm coming!" She said ____ 4. "I was waiting for the bus when he arrived" She told me ____ 5. " I'd never been there before" She said ____ 6. "I didn't go to the party" She told me ____ 7. "Lucy'll come later" She said ____ 8. "He hasn't eaten breakfast" She told me ____ 9. "I can help you tomorrow" She said ____ 10. "You should go to bed early" She told me ____ 11. "I don't like chocolate" She told me ____ 12. "I won't see you tomorrow" She said ____ 13. "She's living in Paris for a few months" She said ____ 14. "I visited my parents at the weekend" She told me ____ 15. "She hasn't eaten sushi before" She said ____ 16. "I hadn't travelled by underground before I came to London" She said ____ 17. "They would help if they could" She said ____

18. “I’ll do the washing-up later”
She told me ____
19. “He could read when he was three”
She said ____
20. “I was sleeping when Julie called”
She said ____

Reported statements: Answers

1. She said (that) he worked in a bank.
2. She told me (that) they went (had gone) out last night (the night before).
3. She said (that) she was coming.
4. She told me (that) she was waiting for the bus whenhe arrived.
5. She said (that) she hadnever been there before.
6. She told me (that) she didn't go (hadn't gone) to the party.
7. She said (that) Lucy wouldcome later.
8. She told me (that) he hadn't eaten breakfast.
9. She said (that) she could help me tomorrow.
10. She told me (that) I should go to bed early.
11. She told me (that) she didn't like chocolate.
12. She said (that) she wouldn't see me tomorrow.
13. She said (that) she is living in Paris for a few months.
14. She told me (that) she visited (had visited) her parents at the weekend.
15. She said (that) she hadn't eaten sushi before.
16. She said (that) she hadn't travelled by underground before she came to London.
17. She said (that) they would help if they could.
18. She told me (that) she would do the washingup later.
19. She said (that) he could read when he was three.
20. She said (that) she had been sleeping when Julie called.

Reported Questions

Change these direct questions into reported speech

1. “Where is he?”
She asked me ____
2. “What are you doing?”
She asked me ____
3. “Why did you go out last night?”
She asked me ____
4.“Who was that beautiful woman?”
She asked me ____
5. “How is your mother?”
She asked me ____
6. “What are you going to do at the weekend?”
She asked me ____
7. “Where will you live after graduation?”
She asked me____
8. “What were you doing when I saw you?”
She asked me ____
9. “How was the journey?”
She asked me ____

10. “How often do you go to the cinema?”
She asked me ____
11. “Do you live in London?”
She asked me ____
12. “Did he arrive on time?”
She asked me ____
13. “Have you been to Paris?”
She asked me ____
14. “Can you help me?”
She asked me ____
15. “Are you working tonight?”
She asked me ____
16. “Will you come later?”
She asked me ____
17. “Do you like coffee?”
She asked me ____
18. “Is this the road to the station?”
She asked me ____
19. “Did you do your homework?”
She asked me ____
20. “Have you studied reported speech before?”
She asked me ____

Reported Questions – Answers:

1. She asked me where hewas.
2. She asked me what I was doing.
3. She asked me why I went (had gone) out last night.
4. She asked me who that beautiful woman was.
5. She asked me how my mother was.
6. She asked me what I was going to do at the weekend.
7. She asked me where I would live after graduation.
8. She asked me what I had been doing when she saw (had seen) me.
9. She asked me how the journey was (had been).
10. She asked me how often I went to the cinema.
11. She asked me if I lived in London.
12. She asked me if he arrived (had arrived) on time.
13. She asked me if I had been to Paris.
14. She asked me if I could help her.
15. She asked me if I was working tonight (that night).
16. She asked me if I would come later.
17. She asked me if I liked coffee.
18. She asked me if this was the road to the station.
19. She asked me if I did (had done) my homework.
20. She asked me if I had studied

Turn the following sentences into indirect speech.

1. John said, ‘I am very busy now.’
2. He said, ‘The horse has been fed.’
3. ‘I know her name and address,’ said John.

	4. 'German is easy to learn,' she said. 5. He said, 'I am writing letters.' 6. 'It is too late to go out,' Alice said. 7. He said to me, 'I don't believe you.' 8. He says, 'I am glad to be here this evening.' 9. He said to me, 'What are you doing?' 10. 'Where is the post office?' asked the stranger. 11. He said, 'Will you listen to me?' 12. John said to Peter, 'Go away.' 13. She said to me, 'Please wait here till I return.' 14. 'Call the witness,' said the judge. 15. The speaker said, 'Be quiet and listen to my words.' **Answers** 1. John said that he was very busy then. 2. He said that the horse had been fed. 3. John said that he knew/knows her name and address. (Note that the tenses may not change if the statement is still relevant or if it is a universal truth.) 4. She said that German is/was easy to learn. 5. He said that he was writing letters. 6. Alice said that it was too late to go out. 7. He told me that he didn't believe me. OR He said he didn't believe me. 8. He says that he is glad to be here this evening. (When the reporting verb is in the present tense, adverbs of time and place do not normally change in indirect speech.) 9. He asked me what I was doing. 10. The stranger asked where the post office is/was. 11. He asked me if I would listen to him. 12. John ordered Peter to go away. 13. She asked me to wait there till she returned. 14. The judge commanded them to call the first witness. 15. He urged them to be quiet and listen to them **Rewrite the following direct question to indirect question : (HS8151, Jan2019)** 1. "**Where is the Railway station? Could you tell me?"** Ans. Could you please tell me where the Railway station **2. "How is the movie? Can someone tell me?"** Ans: Can someone tell me how the movie is?
4.	**Adverbs** (BTL-3) **Fill in the blanks with suitable Adverbs** 1. We visit the zoo _Monthly. 2. They often play tennis with their friends. 3. As there is a heavy traffic ,I drive my car **weekly** 4. He met Gandhiji ***hardly*** in his life time once. 5. My brother has ***a lot*** of books, paperbacks. 6. He has **definitely** completed his course.

	7. He rode the bike **fast** to avoid being late to the examination. 8. I ***strongly*** think it would be the Prime Minister, do you? 9. We never do it, because it ***always*** goes wrong. 10. ***Astonishingly*** she is alone in her house. 11. Pathan bowled him out ***surprisingly***. 12. He ***hardly*** listens to the radio. 13. After knowing about the theft, Raju called the police **swiftly.** 14. Some little time ago I heard her voice from the operation theater. 15. They played hockey ***seriously*** to win in the finals. 16. Balu **hardly** lived here. 17. He played well, but unfortunately he lost it to his friend . 18. I did not ***completely*** give my new address to my father. **19.** The accident happened ***suddenly*** **20.** ***Surprisingly*** he attends the office after a long time.
5.	**Single word substitutes** (BTL-1) ***(2017- 18 Odd Sem Question Paper)*** 1.A name adopted by a writer- pen writer 2. Of unknown authorship- anonymous 3. Taking one's own life –Autobiography 4. A person concerned with practical results - Pragmatic 5. Animals living on land and in water- amphibians 6. A person who is made to bear the blame due to others- scape goat 7.A person who derives pleasure by inflicting pain on others- Sadist 8. A wishful longing for something one has known in the past- Nostalgia 9. A person who believes in God- theist 10. A person who does not believe in God - atheist 11. One who copies the writing of others- plagiarist 12. Journey to a holy place - Pilgrimage 13. One knowing everything - Omniscient 14. One who is present everywhere - Omnipresent 15. Printed notice of somebody's death – Obituary

1. Substitute the single word from the list for the underlined words in the sentence: (HS8151, Jan 2019)

a. The weather was bad and unpleasant **(Horrible)**

b. The girl was frightened and unable to move **(Petrified)**

c. India has a rich history and Tradition **(Heritage)**

d. The flame was started by a short circuited. **(ignited)**

PART* B

Jumbled Sentences (16M) (BTL-2)

1. Rearrange the following jumbled sentences into a coherent paragraph.

(i) Secondly, we can heat the steel above a certain temperature, and then allow it to cool at different rates. 4

(ii) We can alter the characteristics of steel in various ways. 2

(iii) Annealing has a second advantage. 7

(iv) In the process known as annealing, we heat the steel above the critical temperature and permit it to cool very slowly. 1

(v) This causes the metal to become softer than before and much easier to machine. 6

(vi) At this critical temperature, changes begin to take place on the molecular structures of the metal. 5

(vii) It helps to relieve any internal stresses, which exist in the metal. 8

(viii) In the first place, steel which contains very little carbon, will be milder than steel which contains a higher percentage of carbon. 3

Scheme of Marks :

Arrangements of sentence: 16M

2. **Rearrange the following jumbled sentences into a coherent paragraph**.

(i) Engineering is the use of scientific principles to achieve a planned result.

(ii) The distinctions between science, engineering and technology are not always clear.

(iii) Generally, science is the reasoned investigation or study of nature aimed at discovering enduring relationships among elements of the world.

(iv) In this sense, scientists and engineers may both be considered technologists, but scientists less so.

(v) This knowledge then may be used by engineers to create artifacts, such as semiconductors, computers and other forms of advanced technology.

(vi) However, technology broadly involves the uses and application of knowledge both formally and informally, to achieve some practical result.

(vii) It generally employs formal techniques, i.e., some set of established rules of procedure such as the scientific method.

(viii) For example, science might study the flow of electrons in electrical conductors.

3. Rearrange the following jumbled sentences into a coherent paragraph

(i) The dissolved cellulose is formed into threads by a technical process.

(ii) This fibre is, in fact, a reconstituted natural fibre.

(iii) After that, they are dried on a heated roller.

(iv) The cellulose is obtained from shredded wood pulp.

(v) Finally, they are wound on to a bobbin.

(vi) It is made by dissolving cellulose in a solution of sodium hydroxide.

(vii) The threads are drawn from the setting bath of dilute sulphuric acid. Then, they are wound on reel and washed.

(viii) Rayon is a man-made fibre.

4. Rearrange the following jumbled sentences into a coherent paragraph.

(i) But the answers are very hard to find, since several words appear equally appropriate.

(ii) The third type of cross word puzzle is a straight forward exercise in which words matching the definitions given in the clues have to be found.

(iii) There are several types of cross word puzzles.

(iv) There are no catches or tricks.

(v) The first is the prize competition in which the person who finds the correct answers gets a big prize.

(vi) The clue gives only hints about the word and it tests your comprehension and general knowledge.

(vii) This type is useful in the study of vocabulary.

(viii) The second type of crossword puzzle is one in which there is only one possible answer to every clue.

5. Rearrange the following jumbled sentences into a coherent paragraph.

(i) In the 1984 Olympics held in Los Angles in U.S.A. many women athletes took part.

(ii) The festival of Olympics games was held in 1896.

(iii) It was a great disappointment both to her parents and to the country as a whole.

(iv) In 1984, Olympic games, our Indian heroine P.T. Usha, in 100 & 200 meters races narrowly missed the bronze medal.

(v) The first time, the woman athletes took part in the Olympics was in 1922 and their number has steadily increased over the years.

(vi) In that 1984 Olympic games, Indian team of men and women participated in several events such as long jump, shot put, weight lifting, 100, 200, 400 and 600 mts. dashes.

(vii) Since then Olympic games are held, once in four years in different parts of the world.

6.Rearrange the sentence in the correct order (HS8151, JAN 2019)

(i) In 1923, a team of paleontologists from the American Museum of Natural

(ii) History made a surprising discovery in Mongolia's Gobi Desert.

(iii)The embryo turned out to be a baby Citipati (sit-uh-PAH-TEE), a kind of dinosaur.

(iv)Seventy years later, in 1993, another team from the Museum found very similar fossil eggs in the same desert.

(v) Their discovery was three large rocks that turned out to be fossilized dinosaur eggs.

(vi)It was brooding, or sitting on the nest, the same way birds do. With it's to protect the eggs.

(vii) Paleontologists realized that these dinosaurs nested like birds arms spread living today.

(viii) Later, the team discovered an adult Citipati over a nest.

7. Rearrange the sentences in the right order

(i) When an orange is ripe, the picker clips it off the tree.

(ii) In the plant, oranges are placed on a machine with moving rollers.

(iii)People who work as fruit pickers move through groves filled with orange trees.

(iv)How does an orange get from the tree to your refrigerator?

(v) Special brushes was the fruit as it rolls along and then each orange is dried.

(vi)All picked orange are the carefully moved to a packing plant.

(vii) Finally, each orange is given a sticker and placed in a box. Full boxes are shipped I In cool trucks to stores.

(viii) Another machine lines up the oranges in boxes which are checked by a computer.

	UNIT IV **READING AND LANGUAGE DEVELOPMENT**
	(12) Reading- comprehension-reading longer texts- reading different types of texts- magazines Writing- letter writing, informal or personal letters-e-mails-conventions of personal email- Listening- listening to dialogues or conversations and completing exercises based on them. Speaking- speaking about oneself- speaking about one's friend- Language development- Tenses- simple present-simple past- present continuous and past continuous- Vocabulary development- synonyms-antonyms- phrasal verbs
	PART* A
1	**Simple Present, Simple Past, Present Continuous, Past Continuous** (BTL-3) **Fill in the blanks with suitable tense forms of verbs given in brackets**. 1. Weather is created by the heat of the sun. When the sun **shines_____ (**shine) on the earth, the air close to the surface **Heats up_**(heat up).The higher it **_Goes______(**go), the cooler it **Becomes(**become). 2. Now, I **am writing** (write) the English examination. 3. Optical mice supporters claimed (claim) that optical rendering **works** (work) better than mechanical mice **requires** (require) no maintenance and last_ (last) longer due to fewer moving parts. 4. The film director **met** (meet) the child star two years ago. 5. My grand parents **have been living** (live) in the same house since 1995. 6. My aunt **arrived** (arrive) last Sunday. 7. Water **boils** (boil) at 100 degree Celsius. 8. In 1950 and 1970, most of America's energy **had come** (come) from coal, oil and natural gas. But in their twenty year period, the amount **Produced** (produce) Falls from coal (fall) from 38% to 18.5% , while oil **was rising** (rise) from 36% to 44%. 9. Then a strange blight **crept** (creep) over the area and everything began changed (change). some evil spell settled (settle) on the community: mysterious maladies **were**

	sweeping (sweep) the flock of chickens. 10. Nuclear fuels give out dangerous and very penetrate (penetrate) radiation. During fission even more radiation is produced (produce). This **radiation** (radiate) is harmful even in small quantities . It **attacks** (attack) living tissues. 11. Fill in the Blanks with the correct tense form of the verb given in the bracket: **(HS8151, Jan2019)** a. Natural Disaster **occurs** (occur)in many parts of the world. Hurricanes have **affected** (affect) the US in the recent decades. b. In the year 2004, A great Tsunami with the magnitude of 9.1 **Struck** (strike) the Island of Sumatra. Many people **lost** (loose)their lives and property.
1	**Synonyms and Antonyms** (BTL-1) **1. Match the words in column "A" with their meanings in column "B":** a) Cramped — i) Take people into service on contract b) Stagnant — ii) Variety; having differences c) Recruit — iii) Confined within narrow limits d) Diversity — iv) Not moving or changing v) A condition caused by magical powers ***Ans: a-iii, b-iv, c-i, d-ii)***
	***(**a) Mandatory — i) Make certain b) Ascertain — ii) Compulsory c) Infrastructure — iii)Feasibility d) Viability — iv) Building (Ans: a-ii, b-i, c-iv, d-iii)
	a) Benevolent — i)Save b) Regulations — ii)Clear c) Lucid — iii)System d) Redeem — iv)Kind ***(Ans: a-iv, b-iii, c-ii, d-i)***
	a) Affluent — i)Deadly, danger b) Uranium — ii)Bring goods from foreign country c) Fatal — iii)Abundant: rich d) Import — iv)Metallic element ***(Ans: a-iii, b-iv, c-i, d-ii)***
	a) Amalgamation — i)Giving out rays b) Chip — ii)Man-made program c) Radiation — iii)Bring together d) Depletion — iv)Getting completely exhausted v)Device composed of silicon (***Ans: a-iii, b-v, c-i, d-iv)*** a) Appropriate — i) allowing light to pass b) Translucent — ii) a place water is collected and stored c) Feedback — iii) repercussion d) Catchment — iv) suitable v) response

	(Ans: a-iv, b-i, c-v, d-ii)	**(AU May/June 2013)**
	a)Perpetual b) Layout c) Deforestation d) Appropriate ***(Ans: a-ii, b-i, c-iv, d-iii)***	i) the make-up of a page ii) never ends or changes iii) suitable iv) clearing of forests v) planting trees **(AU May/June 2012)**
	a) Breeder b) Harness c) Portable d) Stagnant ***(Ans: a-iv, b-iii, c-v, d-ii)***	i) energy ii) not moving iii) connect iv) producer v) can be moved around **(AU May/June 2011)**
	a) Dynamism b) Enhance c) Breeder d) Empathy	- producer -3 - sympathy -4 - heighten - getting rid of - strength -1
	a) Amalgamation b) Chip c) Radiation d) Depletion	- giving out rays -3 - bringing together -1 - getting completely exhausted -4 - device composed of silicon -2
	a) Contamination b) Fission c) Aggravate d) Abuse	- intensify -3 - misuse -4 - division of the atom -2 - pollution -1
	a)Amalgamate b)Adulteration c)Amplify d)Eminent	Notorious(4) Decrease (3) Purification(2) Isolate (1)
	1. Astute 2. Feasible 3.Aloof 4 Adhere	Gregarious (3) Detach (4) Foolish (1) Impracticable(2)
3.	**Phrasal Verbs** **Make sentences of your own with the phrasal verbs given.** 1. believe in 2. blow up 3. break down 4. call back 5. call off 6. call on 7. check in 8. cheer up 9. eat out	(BTL-4)

	10. fall out 11. get up 12. grow up 13. fall down 14. find out 15. look into 16. turn down 17. get over 18. back off 19. break down 20. look up **Replace the highlighted word in the sentence with one of the phrasal verbs given below to convey the same meaning.** 1. You will suffer if you drink. a) break off b) break down c) break up d) break away **Answer:(B)break down** 2. He is inviting trouble if he quarrel with the house owner. a) ask for b) ask after c) ask against d) ask on **Answer:(A) ask for** 3. She is depending on the bank loan for her higher study. a) banking on b) banking away c) banking off d) banking up **Answer:(A)banking on** 4. I was surprised when I won the lottery. a) taken of b) taken away c) taken on d) taken aback **Answer:(D)taken aback** 5. Please tolerate the pain. a) bear up b) bear down c) bear off d) bear out **Answer:(A) bear up** 6. Modern researches prove that yoga cures diseases. a) bear up b) bear off c) bear out d) bear down **Answer:(C) bear out** 7. A few under trials escaped from prison last night. a) break up b) broke up c) break down d) broke away **Answer:(B) broke up** 8. Our parents have raised us to be good citizens a) brought out b) brought up c) brought by d) brought down **Answer:(A)brought out** 9. Many people pray to god for help rather than to thank him. a) Call at b) call upon c) call about d) call on **Answer :(B) Call upon**

10. We must obey his orders.
a) Carry on b) carry off c) carry out d) carry down **Answer :(C) Carry out**

2).Complete the sentences with the correct form of one of the phrasal verbs from the box

BREAK UP – CALL OFF - COME OUT - COME UP WITH – FIND OUT – GET ON – GO UP - LIE DOWN – LOOK AFTER - LOOK FOR - LOOK UP – SEE OFF – SET UP – TAKE AFTER - TURN UP - WAKE UP -

1. Simon ____________________ a story about catching an enormous fish, and almost everyone believed him.
ANSWER: CAME UP WITH
2. I'm self-employed now. I'm going to ____________________ my own office.
ANSWER: SET UP
3. My friend has been thinking about it all morning, but she simply can't ____________________ a solution to the problem.
ANSWER: COME UP WITH
4. He ____________________ when the alarm clock rang.
ANSWER: WOKE UP
5. I'll ____________________ his number in the phone book.
ANSWER: LOOK UP
6. The novel 1948 first ____________________ in 1948.
ANSWER: CAME OUT
7. Jack ____________________ that his wife was having an affair.
ANSWER: FOUND OUT
8. I'll _____________ you _____________ at the airport when you travel to London.
ANSWER: SEE, OFF
9. We have ____________________ the meeting until we can find someone who can write a protocol.
ANSWER: CALLED OFF
10. They ____________________ last month, after being together for over ten years.
ANSWER: BROKE UP
11. Prices have ____________________ in the supermarket, so everything is much more expensive than a year ago.
ANSWER: GONE UP
12. Yesterday, John ____________________ that he had passed his test.
ANSWER: FOUND OUT
13. I'd like you to ____________________ all the words you don't know.
ANSWER: LOOK UP
14. Could you ____________________ the radio. I can't hear anything,
ANSWER: TURN UP

	15. She ____________________ well with her father. He was such an amazing guy. **ANSWER: GOT ON** 16. Shirley ____________________ her mother. She's got the same blue eyes. **ANSWER: TAKES AFTER** 17. When she ____________________ saw that she was going to be late for work, so she forgot to brush her teeth. **ANSWER: WOKE UP** 18. I'm surprised that you ____________________ with your sister because you are very different **ANSWER: GET ON** 19. The police are trying to ____________________ where the robbers hid the money. **ANSWER: FIND OUT** 20. Why don't you ____________________ on the sofa a bit until you feel better. **ANSWER: LIE DOWN** 21. Keep ____________________ the keys. They have to be somewhere. **ANSWER: LOOKING FOR** 22. The third game of the series was ____________________ because it was raining. **ANSWER: CALLED OFF** 23. The temperature ____________________ a few degrees as soon as the sun came out. **ANSWER: WENT UP** 24. Don't worry about it. I'll ____________________ a meeting between Jake and you when I get to the office. **ANSWER: SET UP** 25. I must get someone to ____________________ my dog when I go on holiday. **ANSWER: LOOK AFTER** 3) Complete the following sentences using suitable phrases: **passed away, do without, look forward to, called off, made up, carried away, break out, run out, put up with, keep up.** **1.** Don't smoke in the forest. Fires _________ easily at this time of the year. **ANSWER: Break out** **2.** **I** ________ seeing my friends again. **ANSWER: Look forward to** **3.** I'm afraid; we have________ of apple juice. Will an orange juice do? **ANSWER: Run to** **4.** Your website has helped me a lot to________ the good work. **ANSWER: Keep up** **5.** A friend of mine has________ her wedding. **ANSWER: called off** **6.** His mother can't ________ his terrible behavior anymore. **ANSWER: put up with**

7. As an excuse for being late, she__________ a whole story.

ANSWER: made up

8. I got__________ by his enthusiasm.

ANSWER: carried away

9. I just cannot _____________ my mobile. I always keep it with me.

ANSWER: do without

10. She was very sad because her father__________ last week.

ANSWER: passed away

Frame Sentences:

.1. Sachin rand up to his mother. (AU, May/June 2014)

Ans : Rang up - to make a telephone call

2. He takes after his father. (AU, May/June 2014)

Ans : Take after - to be similar to an older person

3. The thief broke into the house last night. (AU, May/June 2014)

Ans : Broke into - break to get access to something or somewhere

4. The chief guest gave away the prizes to the winners. (AU, May/June 2014)

Ans : Gave away - to give as a gift

(B).Frame sentences using the given phrasal verbs:

1.Get over (AU, April/May 2015)

Ans : My friend has requested me to get over to his place as soon as possible.

2. Back off (AU, April/May 2015)

Ans : Our relative suddenly backed off from the preplanned trip.

3. Break down (AU, April/May 2015)

Ans : Hearing about the demise of Dr.APJ Abdul Kalam, many youngsters broke down in tears.

4. Look up (AU, April/May 2015)

Ans : The student looked up the dictionary for correct spelling.

PART *B

5 **. Informal Letters** (BTL-5)

1. Write a letter to your friend inviting him to your college cultural festival.

2. Write a letter to your father describing a recent cricket match in which your side won.

3. Write a letter to your mother sharing your Hostel life experience.

4. You are enrolled in the college N.S.S /YRC team. As part of the programme, you had done social service activities. Share your experience with your friend who is studying in another college. Write a letter about the activities.

5. As students from a professional college, you are aware of the importance of reading to improve your knowledge. Write a letter to your father requesting him to send some money to buy some books. State what type of books you have to buy.

6. You are enrolled in the college Youth Red Cross team. As part of the programme, a Blood Donation Camp was organized and many young boys and girls came forward to donate blood. Write a letter to your friend about this incident and say how it was an enriching experience.

7. A book exhibition is organized in your town/city, you are planning to visit the exhibition and buy a dictionary and some story books to read. Write a letter to your father about the books you are planning to buy, their usefulness and request him to send adequate money for the same.

8. Write a letter to your father about the Literary club inauguration in your college stating that how it is useful for improving your own personality (HS8151, JAN, 2019).

9. Write a letter to your friend about the cultural event that took place in your college campus (HS8151, JAN2019)

Scheme of Marks :

Format – 6**M**

Key Words – 4**M**

Presentation- 2**M**

Content - 4**M**

6 **E-Mail Writing** (BTL-3**)**

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

	UNIT V EXTENDED WRITING
	Reading- longer texts- close reading –Writing- brainstorming -writing short essays – developing an outline- identifying main and subordinate ideas- dialogue writing-Listening – listening to talks-conversations- Speaking – participating in conversations- short group conversations-Language development-modal verbs- present/ past perfect tense - Vocabulary development-collocations- fixed and semi-fixed expressions
	PART*A
1.	Modal Verbs (BTL-4) **Fill in the blanks with modal verbs.** 1. I can't give you my car, so you _____ buy a new one. (may) 2. They _____ be in a hurry, because they have got more than enough time. (would) 3. You ______ stop at the red light. (should) 4. Tomorrow is Sunday. You _____ get up very early. (must) 5. Mrs. Parks can't see very well. She _______ wear glasses. (must) 6. You _______ return them. They are too small for you. (should) 7. I ________ borrow some money to buy a car. (could) 8. You ______ stop smoking. It is very harmful. (should) 9. Mr. Dickson is going to travel abroad, so he ______ learn English in 4 months. (must) 10. All the students ---------obey the school rules. (should)
2	**II Present Perfect and Past Perfect** (BTL-3) **Fill in the blanks with suitable tense forms of verbs given in brackets.** 1. I …………………. (Finish) the job. 2. ………………… you ……………….. (Eat) your lunch? 3. She ………………….. (Not return) yet. 4. I ………………… (never see) such a mess. 5. ………………….. he ………………….. (bring) his violin? 6. …………………… you ever …………………. (be) to Australia? 7. I ………………… (read) all the plays of Shakespeare. 8. My parents ……………………. (never hurt) me.

	9. He ……………………. always ……………… (want) to be a soldier. 10. She ………………….. (never apologize) to anybody. 11. The patient ……………………. (die) before the doctor …………………… (arrive). 12. As the fire …………………. (break) out, people ………………….. (hurry) out of their houses. 13. I …………………… (meet) him yesterday. 14. I ……………………… (recognize) him immediately as I ………………….. him before. (see) 15. . I wish I ………………….. (stay) with my friend during his last days. 16. . If he ……………………. (apply) in time, he would have got the job. 17. By the time the firemen …………………. (arrive), the fire ………………….. (destroy) many huts. 18. Long before the chief guest ………………… (arrive), the invitees …………………….. (assemble). 19. I wish I ……………………. (send) my application in time. 20. I ………………………(not speak) to him, as I ………………………. (not introduce) to him.
3.	**Collocation and Fixed and Semi-fixed Expressions** (BTL-3) 1. 1. My grandfather was a …………………. smoker, so few people were surprised when he died of oral cancer. a) serial b) **heavy** c) big 2. 2. She was a / an ……………………. wife who loved her husband more than anything else in the whole universe. a) **devoted** b) sincere c) intelligent 3. 3. It is a golden ……………………….. If you miss it, you will regret it. a) chance b) **opportunity** c) offer

	4. She seemed quite interested in buying that house, but at the last moment, she changed her ………………….. a) **mind** b) thoughts c) offer 5. Although I was …………………. annoyed by her attitude, I said nothing. d) moderately e) lightly f) **slightly** **6.Choose the word that collocates with the given word and complete the sentences: (HS8151, JAN, 2019)** There was **Heavy** (heavy/ high)rain in Ooty yesterday We **went** (went/ Walked) for a trekking. He was **wearing** (wearing/ using) sunglasses and **carrying** (wearing/ carrying) an Umbrella
	1. He didn't know anything about business, so starting his own business was _______. a) a leap into the cloud **b) a leap in the dark** c) a leap into the whole 2. I hate the way he criticizes everybody. It really rattles __________ a) my back **b) my bones** c) my cage 3. When her business crashed, she had to pick up ______ and start again. a) the fragments **b) the pieces** c) the stones 4. I used to go to church under false ____. I never wanted to go but my mother made me. a) agreements b) feelings **c) pretences** 5. One minute they were just talking and then all hell broke ______ and everybody started screaming and shouting. a) free **b) loose** c) over 6. He never cheats or tricks anybody when he plays. He always goes by the ______. **a) book** b) instructions c) principles 7. Don't tell Mary your plans or she'll tell everybody. She is always ______ her mouth off. **a) shooting** b) speaking c) talking

8. Tom might be able to help with your problem. He has friends in high ______ who might be able to change the decision.
a) jobs
b) places
c) spots

9. 3 of the following nouns follow the verb 'catch' very naturally. Which verb and noun combination does NOT go together?
a) catch a fish
b) catch a bus
c) catch a cold
d) catch a new word in English
10. "Excuse me, would you mind __________ a photo of me and my girlfriend?"
a) making
b) taking
c) catching
d) doing
11. 3 of the following nouns follow the verb 'have' very naturally. Which verb and noun combination does NOT go together?
a) have a meeting
b) have a baby
c) have a cup of coffee
d) have business with someone

12. "Could you _________ me a favour? Would you mind answering the phone for a minute – I need to pop out to the post office."
a) do
b) make
c) take
d) all of the above answers
13. Which of the following verbs do NOT fit into this sentence: "The Health Authority has _____________ its decision and will now allow the fertility treatment to go ahead."
a) altered
b) changed
c) moved
d) reversed
14. 3 of the following nouns follow the verb 'make' very naturally. Which verb and noun combination does not go together?
a) make your bed in the morning
b) make progress
c) make a noise
d) make the weekly shopping
1. I really <u>missed</u> my family when I stayed in Canada on my own last year.
2. When I went into the children's room, the boys were both fast asleep, but Oliver was <u>wide</u> awake, reading the Little Prince story.
3. I <u>wasted</u> my time on that course; it was terrible.
4. I'm sure he is <u>well</u> aware of the problem.

	5. It's vitally important that we finish this work by the end of the week. 6. We are terribly sorry we are late, but we missed the bus and had to wait ages for another one. 7. We carried the carton of books up to the fourth floor, and it was very hard work. 8 She told everyone the same joke, and nobody laughed. 9. I think they want to get married and start a family. 10. My mum doesn't drink strong coffee at night because it keeps her awake 11. Everyone said the party was a great success. 12. If this heavy rain continues, I don't think we'll go to the beach.
4	**Fill in the blanks with the appropriate forms of the underlined words:** (BTL-3) They **observed** the readings and made entries in the ***Observation*** note book. The release of CO_2 in to the atmosphere leads to the ***production*** of greenhouse gases. The industries ***produce*** plenty of such gases. The Principal recommended the student for a scholarship and gave a *Recommendation* letter. My uncle was **promoted** as the chief engineer and this P*romotion* came after he completed 15 years. The windmills in our district **generate** 100 megawatt power and the *Generation* of power will improve in August. The **application** of nano-technology is seen in all disciplines. Doctors *apply* it in medical inplants. Due to the good rains, the crops are ready for **harvest** .The *Harvested* grains can be sold for a good price
	PART *B

	Essay Writing (BTL-3) **Format :** **Content: 8** **Presentation: 4** **Grammar/ Spellings:4** 1. Write in about 200 words the reasons for environmental degradation and list three ways by which our environment can be conserved? 2. Write in about 200 words the necessity for training in modern organizations? 3. English can very well be a universal medium of communication. Justify the statement in about 200 words. 4. With more and more vehicles on the road, it is becoming very risky for all vehicles that ply on the roads safely. Write in about 200 words, the measures that must be adopted in order to bring safety on the roads. 5. Write in about 200 words an essay on Technology: Boon or Bane? 6. Write an essay on Space Tourism? 7. Write an essay on reducing child labour through Technology? 8. Write a paragraph about an initiative taken in your institution that helped protect your immediate environment? 9. What are the practices followed by your grandparents to preserve their surroundings, which are now forgotten? Write an essay in 200 words on why and how these practices should be revived? 10. Discuss in two paragraphs of 200 words each on how tourist destinations have been adversely affected by tourism and about what can be done to restore them? 11. Describe an interesting place you had visited. The essay should include the name of the Place, how you reached there what interesting things you saw and enjoyed etc. **(HS8151, 2019)** 12. Write an essay using the following hints. Develop into a narrative essay Give a suitable **(HS8151, 2019)**
6.	**II. Dialogue Writing** (BTL-5) **Format :** **Content : 8m** **Dialogue formation: 4m** **Presentation/ Grammar/ Spellings :4** 2. Write a dialogue between two students who have joined college recently. 3. Write a conversation between a salesperson and customer in a mobile phone shop. Aravind had been shortlisted for an interview by a multi-national company in Chennai. 4. What are the questions likely to be asked by the Placement officer and how would he respond to them. Make a minimum of eight exchanges. (16 sentences) (The first one is done for you).

`

	Placement Officer: Hello Aravind, can you tell us why have you applied to this company? Aravind: It had been my dream to work in a multi-national company like yours.
	5. Share your thoughts with Akash about pollution in the water bodies and ways to keep them clean. Write at least eight exchanges. The first exchange is given for you to start the dialogue. You : Hello Akash! How are you? Akash : I am fine. How are you? You : I am fine too. Hey, did you read today's Hindu ? In fact almost all papers have carried news on city's polluted water bodies. I am really worried.
	6. Your younger brother likes only junk food. So you decide to have a chat and make him understand the ill effects. Write at least eight exchanges. The first exchange is given for you to start the dialogue. You : Sanjay, have you noticed that you're putting on weight ? He : Yeah... You : Have you thought about it ?

MA8151 ENGINEERING MATHEMATICS – I L T P C

4 0 0 4

OBJECTIVES:

- The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus.
- The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions.
- This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

UNIT I DIFFERENTIAL CALCULUS 12

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules - Maxima and Minima of functions of one variable.

UNIT II FUNCTIONS OF SEVERAL VARIABLES 12

Partial differentiation – Homogeneous functions and Euler‘s theorem – Total derivative – Change of variables Jacobians – Partial differentiation of implicit functions – Taylor‘s series for functions of two variables – Maxima and minima of functions of two variables – Lagrange‘s method of undetermined multipliers.

UNIT III INTEGRAL CALCULUS 12

Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

UNIT IV MULTIPLE INTEGRALS 12

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of ids – Change of variables in double and triple integrals.

UNIT V DIFFERENTIAL EQUATIONS 12

Higher order linear differential equations with constant coefficients - Method of variation of parameters – Homogenous equation of Euler‘s and Legendre‘s type – System of simultaneous linear differential equations with constant coefficients - Method of undetermined coefficients.

TOTAL: 60 PERIODS

OUTCOMES :

After completing this course, students should demonstrate competency in the following skills:

- Use both the limit definition and rules of differentiation to differentiate functions.
- Apply differentiation to solve maxima and minima problems.
- Evaluate integrals both by using Riemann sums and Fundamental Theorem of Calculus.
- Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates,

in addition to change of order and change of variables.

- Apply various techniques in solving differential equations.

TEXT BOOKS :

1. Grewal B.S., ―Higher Engineering Mathematics ‖, Khanna Publishers, New Delhi, 43rd Ed., 2014.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015. [For Units I & III - Sections 1.1, 2.2, 2.3, 2.5, 2.7(Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1(Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

REFERENCES :

1. Anton, H, Bivens, I and Davis, S, "Calculus", Wiley, 10th Edition, 2016.
2. Jain R.K. and Iyengar S.R.K., ―Advanced Engineering Mathematics‖, Narosa Publications, New Delhi, 3rd Edition, 2007.
3. M.B.K. Moorthy, Engineering Mathematics – I, 2017.
4. Dr.A. Singaravelu, Engineering Mathematics – I, 2017.

UNIT I - DIFFERENTIAL CALCULUS

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules - Maxima and Minima of functions of one variable.

PART * A

Q.No.	Questions
1.	**Find the domain of the following functions** $f\left(x\right)=\sqrt{3-x}-\sqrt{2+x}$ **(Dec 2018)** BTL1 $f\left(x\right)=\sqrt{3-x}-\sqrt{2+x}=0$ $3-x=2+x$ $x=1/2$ $Domain:\left(-\infty,1/2\right)U\left(1/2,\infty\right)$
2.	**Find the domain and range of the following functions** $\boldsymbol{y=\ x^2+4x+5}$ **(May2018)** BTL1 $(x+2)^2+9$ $(x+2)^2+9$ for all x The range is $(-\infty, 9)$ Domain is $(-2, \infty)$
3.	**Evaluate Find the domain of the function** $y=\ \sqrt{x^2+yx-6}$ **(May 2018,2019)** BTL1 $x^2+5x-6\ \geq 0$ $(x-1)(x+6)\ \geq 0$ $x=1,-6$ Domain is $(-\infty,-6)\ U\ (-1,\infty)$
4.	**Evaluate** $\boldsymbol{\lim_{x\to 8}\frac{\sqrt{x}-2\sqrt{2}}{x-8}}$ **(May 2018)** BTL5 $\lim_{x\to 8}\frac{\sqrt{x}-2\sqrt{2}}{x-8}=\frac{2\sqrt{2}-2\sqrt{2}}{8-0}=0/0$ (By L' Hospital rule) (Diff Numerate & Denominator) $\lim_{x\to\propto}\frac{\frac{1}{2\sqrt{x}}}{1}=\frac{1}{2\sqrt{8}}=\frac{1}{2x2\sqrt{2}}=\frac{1}{4\sqrt{2}}$
5.	**Evaluate** $\boldsymbol{\lim_{x\to 0}\frac{\sqrt{1+x}-\sqrt{1-x}}{x}}$ BTL5 $=\lim_{x\to 0}\frac{\sqrt{1+x}-\sqrt{1-x}}{x}=\frac{0}{0}$ $=\lim_{x\to 0}\frac{\sqrt{1+x}-\sqrt{1-x}}{x}\ x\ \frac{\sqrt{1+x}+\sqrt{1-x}}{\sqrt{1+x}-\sqrt{1-x}}$ $=\lim_{x\to 0}\frac{(1+x)-(1-x)}{x\sqrt{1+x}+\sqrt{1-x}}$ $=\lim_{x\to 0}\frac{2x}{x\sqrt{1+x}+\sqrt{1-x}}$ $=\lim_{x\to 0}\frac{2}{\sqrt{1+x}+\sqrt{1-x}}$ $=\frac{2}{1+1}=\frac{2}{2}=1$
6.	**Evaluate** $\boldsymbol{\lim_{x\to\propto} x^n e^{-x}}$ BTL5

	$\lim\limits_{x\to\propto} \frac{x^n}{e^x} = \frac{\propto}{\propto}$ (By L Hospital rule) Diff denominator and numerator in times $\lim\limits_{x\to\propto} \frac{x^n}{e^x} \quad = \quad \lim\limits_{x\to\propto} \frac{h!}{e^x} = 0$
7.	**Evaluate** $\lim\limits_{x\to 2} \frac{x^3-8}{x-2} = \frac{0}{0}$ **(May 2018)** BTL5 (By L Hospital Rule) $\lim\limits_{x\to 2} \frac{3x^2}{1} = \mathop{\text{lt}}\limits_{x\to 2} \frac{3(2M)^2}{1} = 12$
8.	**Evaluate** $\lim\limits_{x\to 0} \frac{sin5\theta}{\theta}$ BTL5 (By L Hospital Rule) $\lim\limits_{x\to 0} \frac{cos5\theta}{1} 5 = \lim\limits_{x\to 0} 5.1 = 5$
9.	**Find** $\frac{dy}{dx}$ **if** $y = 3x^5 + 7$ **(May 2018)** BTL5 $y = 3x^5 + 7$ Differentiate w.r.to x , $d\ (x^n) = hx^{n-1}$ $\frac{dy}{dx} = \frac{d}{dx}(3x^5) + \frac{d}{dx}(7)$ $= 3x^5\ x^{5-1} + 0$ $= 15x^4$
10.	**Find** $\frac{dy}{dx}$ **if** $y = x^{\frac{3}{2}} + logx + 2\sqrt{x}$ **(May 2018)** BTL5 $y = x^{\frac{3}{2}} + logx + 2\sqrt{x}$ Differentiate w.r.to x $\frac{dy}{dx} = \frac{d}{dx}\left(x^{\frac{3}{2}}\right) + \frac{d}{dx}(logx) + \frac{d}{dx}(\sqrt{x})$ $= \frac{3}{2} x^{\frac{3}{2}} + \frac{1}{x} + 2 - \frac{1}{2\sqrt{x}}$ $= \frac{3}{2} x^{\frac{1}{2}} + \frac{1}{x} + \frac{1}{\sqrt{x}}$
11.	**Find** $\frac{dy}{dx}$ **if** $y = \frac{3x^3 + 7x^2 + 5}{x}$ BTL5 $y = \frac{3x^3 + 7x^2 + 5}{x}$ $y = \frac{3x^3}{x} + \frac{7x^2}{x} + \frac{5}{x}$ y $= 3x^3 + 7x^2 + 5$ Differentiate w.r.to x $\frac{dy}{dx} = 3\frac{d}{dx}(x^2) + 7\frac{d}{dx}(x) + 5\frac{d}{dx}(\frac{1}{x})$ $= 3(2x) + 7(1) + 5\left(-\frac{1}{x^2}\right)$ $= 6x + 7 - \frac{5}{x^2}$
12.	**Find** $\frac{dy}{dx}$ **if** $y = x^2 e^{-3x}$ **(May 2018)** BTL5 Product Rule $y = x^2 e^{-3x}$ $\quad d(uv) = uv' + vu'$ Differentiate w.r. to x $\frac{dy}{dx} = x^2 \frac{d}{dx}(e^{-3x}) + e^{-3x}\frac{d}{dx}(x^2) + \frac{d}{dx}(x^2)$

$$= x^2\, e^{-3x}(-3) + e^{-3x}\ 2x$$
$$= -3x^2\, e^{-3x} + 2x\, e^{-3x}$$
$$= xe^{-3x}\,(-3x+2)$$

13. **Find $\frac{dy}{dx}$ if $y = x^3 \log x$** BTL5

$$y = x^3$$

Differentiate w.r.to x

$$\frac{dy}{dx} = x^3 \frac{d}{dx}(logx) + logx\ \frac{d}{dx}(x^3)$$
$$= x^3 \left(\frac{1}{x}\right) + \log x - 3x^2$$
$$= x^2 + logx\ \ 3x^2$$
$$= x^2\,(1 + 3\,logx)$$

14. **Find $\frac{dy}{dx}$ if $y = 5e^{-3x} + \frac{1}{\sqrt{x}} + 3$** BTL5

$$y = 5e^{-3x} + \frac{1}{\sqrt{x}} + 3 \qquad \sqrt{x} = x^{\frac{1}{2}}$$
$$\frac{1}{\sqrt{x}} = \frac{1}{x^{\frac{1}{2}}} = x^{\frac{-1}{2}}$$

Differentiate w.r. to x

$$\frac{dy}{dx} = 5\frac{d}{dx}(e^{-3x}) + \frac{d}{dx}\left(x^{\frac{-1}{2}}\right) + \frac{d}{dx}(3)$$
$$= 5\left(e^{-3x}(-3)\right) + (-\frac{1}{2}x^{\frac{-3}{2}} + 0$$
$$= -15e^{-3x} - \frac{1}{2x^{\frac{3}{2}}}$$

15. **If $y = \log(2x^2+3)$ find $\frac{dy}{dx}$** BTL1

Given $y = \log(2x^2+3)$ -- (1M)

Put $t = 2x^2 + 3$

$$\frac{dt}{dx} = 4x$$

From (1M) $y = \log t$

$$\frac{dy}{dt} = \frac{1}{t}$$
$$\therefore \frac{dy}{dx} = \frac{dy}{dt}.\frac{dt}{dx}$$
$$= \frac{1}{t}.4x$$
$$= \frac{1}{2x^2+3}\ 4x = \frac{4x}{2x^2+3}$$

16. **Find $\frac{dy}{dx}$ from $x^2 + y^2 = a^2$** BTL1

$$x^2 + y^2 = a^2$$

Differentiating w.r. to X

$$2x + 2y\frac{dy}{dx} = 0$$
$$2y\frac{dy}{dx} = -2x$$
$$\frac{dy}{dx} = -\frac{2x}{2y}$$
$$\frac{dy}{dx} = -\frac{x}{y}$$

17. **Find $\frac{dy}{dx}$ if $y = \sec(tanx)$** BTL1

	$y = \sec(tanx)$ Put $t = tanx$ $dy = \sec t$ $\frac{dt}{dx} = sec^2x$ $\frac{dy}{dt} = sect\ tant$ $\frac{dy}{dx} = \frac{dy}{dt}.\frac{dt}{dx}$ $\frac{dy}{dx} = sect\ tant\ sec^2x$
18.	**Find $\frac{dy}{dx}$ if $y = \log(logx)$** BTL1 $y = \log(logx)$ Put $t = logx$ $y = logt$ $\frac{dt}{dx} = \frac{1}{x}$ $\frac{dy}{dt} = \frac{1}{t}$ $\frac{dy}{dx} = \frac{dy}{dt}.\frac{dt}{dx}$ $= \frac{1}{t}.\frac{1}{x}$ $= \frac{1}{logx}.\frac{1}{x}$
19.	**Find $\frac{dy}{dx}$ if $xy = c^2$** BTL1 $xy = c^2$ Differentiating w.r. to X $x.\frac{dy}{dx} + y.1 = 0$ $\frac{dy}{dx} = -\frac{y}{x}$
20.	**Find $\frac{dy}{dx}$ if $\sqrt{x} + \sqrt{y} = \sqrt{a}$** BTL1 $\sqrt{x} + \sqrt{y} = \sqrt{a}$ Differentiating w.r. to X $\frac{1}{2\sqrt{x}} + \frac{1}{2\sqrt{y}}\frac{dy}{dx} = 0$ $\frac{1}{2\sqrt{y}}\frac{dy}{dx} = \frac{1}{2\sqrt{x}}$ $\frac{dy}{dx} = \frac{\sqrt{y}}{2\sqrt{x}}$
21.	**Find $\frac{dy}{dx}$ if $x = at^2, y = 2at$** BTL1 $\frac{dy}{dx} = \frac{dy}{dt} / \frac{dx}{dt}$ $x = at^2$ $y = 2at$ $= \frac{2a}{2at}$ $\frac{dx}{dt} = 2at$ $\frac{dy}{dt} = 2a$
22.	**Find $\frac{dy}{dx}$ if $x = a\,(cos\theta + \theta sin\theta), y = a\,(sin\theta - \theta cos\theta)$** BTL1 $x = a\,(cos\theta + \theta sin\theta)$ $\frac{dx}{d\theta} = a\,(-sin\theta + \theta cos\theta + sin\theta - 1)$

<table>
<tr><td></td><td>$\frac{dx}{d\theta} = a\,\theta\,cos\theta$
$y = a\,(\,sin\theta + \,\theta cDs\theta)$
$\frac{dy}{d\theta} = a\,(cos\theta - (\,\theta - sin\theta + cos\theta - 1)$
$\frac{dy}{d\theta} = a\,\theta\,sin\theta$
$\frac{dy}{dx} = \frac{dy}{d\theta} / \frac{dx}{d\theta} = \frac{a\,\theta\,sin\theta}{a\,\theta\,cos\theta} = tan\theta$</td></tr>
<tr><td>23.</td><td>Find $\boldsymbol{\frac{dy}{dx}}$ if $\boldsymbol{x = ct,\ y = \frac{c}{t}}$ BTL1

$\frac{dy}{dx} = \frac{dy}{dt} / \frac{dx}{dt}$ $x = ct\ y = \frac{c}{t}$
$= \frac{-c}{t^2}\ x\,\frac{1}{c}$ $\frac{dx}{dt} = c\ \frac{dy}{dt} = \frac{-c}{t^2}$
$= \frac{1}{t^2}$</td></tr>
<tr><td>24.</td><td>Find $\boldsymbol{\frac{d^2y}{dx^2}}$ if $\boldsymbol{x^4 + y^4 = 16}$ BTL1

Differentiation w.r.to x
$4x^3 + 4y^3\frac{dy}{dx} = 0$
$\frac{dy}{dx} = \frac{-x^3}{y^3}$
$\frac{d^2y}{dx^2} = \left[\frac{(y^3 - 3x^2 - x^3 3y^2\frac{dy}{dx}}{(y^3)^2}\right]$
$= -\left[\frac{3x^2y^3 - x^3 3y^2\left(-\frac{x^3}{y^3}\right)}{y^6}\right]$
$\frac{d^2y}{dx^2} = -\left[\frac{3x^2y^3 + \frac{3x^6}{y}}{y^6}\right]$</td></tr>
<tr><td>25.</td><td>Find the equation of the tangent to the circle $\boldsymbol{x^2 + y^2 = 25}$.
Differentiating w.r.to x
$2x + 2y\,\frac{dy}{dx} = 0$
$\frac{dy}{dx} = -\frac{x}{y}$
$\frac{dy}{dx}\,(3,4) = -\frac{3}{4} = m_1$
Equation of tangent,
$y - y_1 = m\,(x - x_1)$
$y - 4 = -\frac{3}{4}\,(x - 3)$
$4y - 16 = -3x + 9$
$3x + 4y = 25$</td></tr>
</table>

26. **Evaluate** $\lim_{t\to 1}\frac{t^4-1}{t^3-1}$ **(Dec 2018)** BTL1

By L-H rule,

$$\lim_{t\to 1}\frac{t^4-1}{t^3-1}=\frac{4}{3}$$

PART * B

1 **Evaluate i)** $\lim_{x\to\frac{\pi}{2}}(\sec x-\tan x)$ **ii)** $\mathrm{lt}_{x\to\frac{\pi}{2}}\frac{\tan x-125}{\sec x+125}$ **(4+4M) (NOV/DEC-2017)** BTL5

Answer : Page. 1.23 - M.B.K. Moorthy

i) $\lim_{x\to\frac{\pi}{2}}(\sec x-\tan x)=\infty-\infty$ (2M)

$$\lim_{x\to\frac{\pi}{2}}\left[\frac{1}{\cos x}-\frac{\sin x}{\cos x}\right]$$

$$\lim_{x\to\frac{\pi}{2}}\left[\frac{1-\sin x}{\cos x}\right]$$

$$\lim_{x\to\frac{\pi}{2}}\left[\frac{1-\sin x}{\cos x}x\frac{1+\sin x}{1+\sin x}\right]$$

$$\lim_{x\to\frac{\pi}{2}}\left[\frac{1-\sin^2 x}{\cos x\,(1+\sin x)}\right]$$

$$\lim_{x\to\frac{\pi}{2}}\left[\frac{\cos^2 x}{\cos x\,(1+\sin x)}\right]$$

$= \frac{0}{1+1}$ (2M)

$= 0$

ii) $\mathrm{lt}_{x\to\frac{\pi}{2}}\frac{\tan x-125}{\sec x+125}=\frac{\infty}{\infty}$ (2M)

(By L Hospital Rule)

$$\mathrm{lt}_{x\to\frac{\pi}{2}}\frac{\sec^2 x}{\sec x\tan x}=\mathrm{lt}_{x\to\frac{\pi}{2}}\frac{\sec x}{\tan x}$$

$$\mathrm{lt}_{x\to\frac{\pi}{2}}\frac{1}{\cos x}\,x\,\frac{\cos x}{\sin x}$$

$\mathrm{lt}_{x\to\frac{\pi}{2}}\frac{1}{\sin x}=\frac{1}{1}=1$ (2M)

2. **Find** $\frac{dy}{dx}$ **if i)** $y=e^x\,\mathbf{tam}\,x$ **ii)** $y=x^2\sin x\log x$ **(4+4M) (NOV/DEC-2017)** BTL1

Answer : Page. 1.97 -M.B.K.Moorthy

i) $y=e^x\tan x$ (2M)

Differentiate w.r.to x

$\frac{dy}{dx} = e^x\frac{d}{dx}(\tan x)+\tan x\frac{d}{dx}(e^x)$

$= e^x\sec^2 x+\tan x\, e^x$

$= e^x(\sec^2 x+\tan x)$ (2M)

ii)

		$y = x^2 sinx\ logx$ $\quad d\ (uvw) = u'vw + uv'w + uvw'$ Differentiate w.r.to x (2M) $\frac{dy}{dx} = \frac{d}{dx}\ x^2 sinx.logx + x^2 \frac{d}{dx}\ (sinx) \log x + x^2\ sinx \frac{d}{dx}(logx)$ $= 2x\ sinx\ logx + x^2 cosx\ logx + x^2 sinx \frac{1}{x}$ (2M)
3		**Evaluate i)** $\mathbf{lt}_{x\to\frac{\pi}{2}} \frac{x^{\frac{3}{2}} - 5^{\frac{3}{2}}}{x^{\frac{1}{2}} - 5^{\frac{1}{2}}}$ ***ii)*** $\mathbf{Lim}_{x\to\infty} \frac{1-e^x}{1+2e^x}$ **(4+4M) (NOV/DEC-2017,2018)** BTL5 **Answer : Page. 1.44 -M.B.K. Moorthy** i) $\underset{x\to\frac{\pi}{2}}{\text{lt}} \frac{x^{\frac{3}{2}} - 5^{\frac{3}{2}}}{x^{\frac{1}{2}} - 5^{\frac{1}{2}}} = 0$ (2M) (By L Hospital rule) $\underset{x\to 5}{\text{lt}} \frac{\frac{3}{2} - x^{\frac{1}{2}}}{\frac{1}{2} x^{\frac{-1}{2}}} = \underset{x\to 5}{\text{lt}} \frac{3}{2}\ x \frac{2}{1}\ x^{\frac{1}{2}}\ x^{\frac{1}{2}}$ $= \underset{x\to 5}{\text{lt}}\ 3\ (x^1)$ $= \underset{x\to 5}{\text{lt}}\ 15$ $= 15$ (2M) ii) $\underset{x\to\infty}{\text{Lim}} \frac{1-e^x}{1+2e^x} = \underset{x\to\infty}{\text{lt}} \frac{e^x\left[\frac{1}{ex}-1\right]}{e^x\left[\frac{1}{ex}+2\right]}$ (2M) $= \frac{\underset{x\to\infty}{\text{Lim}} \frac{1}{ex} - \underset{x\to\infty}{\text{lt}} -1}{\underset{x\to\infty}{\text{Lim}} \frac{1}{ex} - \underset{x\to\infty}{\text{lt}}\ 2}$ $= \frac{0-1}{0+2} = -\frac{1}{2}$ (2M)
4		**Find** $\frac{d^2y}{dx^2}$ **if** $\boldsymbol{i)}\ \boldsymbol{x^4 + y^4 = 16}\ \ \boldsymbol{ii)}\ \boldsymbol{x^3 + y^3 + 3axy = a}$ **(4+4M) (NOV/DEC-2017)** BTL1 **Answer : Page. 1.117 -M.B.K. Moorthy** i) $x^4 + y^4 = 16$ (2M) Differentiate w.r.to X $4x^3 + 4y^3\ \frac{dy}{dx} = 0$ $4y^3\ \frac{dy}{dx} = -4x^3$ $\frac{dy}{dx} = \frac{-4x^3}{4y^3}$ $\frac{d^2y}{dx^2} = -\left[\frac{y^3(3x^2) - x^3 3y^2 \frac{dy}{dx}}{(y^3)^2}\right]$ $= -\left[\frac{3x^2y^3 - x^3 3y^2\left(-\frac{x^3}{y^3}\right)}{y^6}\right]$ $\frac{d^2y}{dx^2} = -\left[\frac{3x^2y^3 + \frac{3x^6}{y}}{y^6}\right]$ (2M)

	ii) $x^3 + y^3 + 3axy = a$ Differentiate w.r.to X (2M) $3x^2 + 3y^2\frac{dy}{dx} + 3ax\frac{dy}{dx} + 3ay = 0$ $\frac{dy}{dx}(3y^2 + 3ax) = -3ay - 3x^2$ $\frac{dy}{dx} = -\frac{3(ay+x^2)}{3(y^2+ax)}$ $\frac{dy}{dx} = -\frac{(ay+x^2)}{(y^2+ax)}$ (2M)
5	**Find $\frac{dy}{dx}$ if $i)\ y = x(x^2+1)(x^2-3)\ ii)\ y = \frac{x^n}{logx}$ (4+4M) (NOV/DEC-2017)** BTL1 **Answer : Page. 1.107 -M.B.K. Moorthy** i) $y = y = x(x^2+1)(x^2-3)$ (2M) Differentiate w.r.to x $\frac{dy}{dx} = \frac{d}{dx}(x)(x^2+1)(x^2-3) + x\frac{d}{dx}(x^2+1)(x^2-3)$ $+ x(x^2+1)\frac{d}{dx}(x^2-3)$ $= x(x^2+1)(x^2-3) + x(2x)x(x^2-3)$ $+ x(x^2+1)(2x)$ (2M) ii) $y = \frac{x^n}{logx}$ (2M) Differentiate w.r.to x $\frac{dy}{dx} = \frac{logx\frac{d}{dx}(x^n) - x^n\frac{d}{dx}(logx)}{(logx)^2}$ $= \frac{logx\ hx^{n-1} - x^n\frac{1}{x}}{(logx)^2}$ $= \frac{nx^{n-1}logx - x^{n-1}}{(logx)^2}$ $= \frac{x^{n-1}(nlogx-1)}{(logx)^2}$ (2M)
6	**Find $\frac{dy}{dx}$ if $i)\ y = \log[\log(logx)]$ ii) $y = \sin(\cos(tanx))$ (4+4M) (NOV/DEC-2017)** BTL1 **Answer : Page. 1.136--M.B.K. Moorthy** i) $y = \log[\log(logx)]$ Put $t = \log(logx)$ $y = \log t$ $\frac{dt}{dx} = \frac{1}{logx}\frac{1}{x}$ (2M) $\frac{dy}{dt} = \frac{1}{t}$ $\frac{dy}{dx} = \frac{dy}{dt}.\frac{dt}{dx}$ $= \frac{1}{t}.\frac{1}{logx}.\frac{1}{x}$ $= \frac{1}{\log(logx)}.\frac{1}{logx}.\frac{1}{x}$ (2M) ii) $y = \sin(\cos(tanx))$ Put $t = \cos(tanx)$ $y = sint$ $\frac{dt}{dx} = -\sin(tanx).sec^2x$ $\frac{dy}{dt} = cost$ (2M)

$$\frac{dy}{dx} = \frac{dy}{dt}.\frac{dt}{dx}$$
$$= cost. -\sin(tanx)\ sec^2x$$
$$= -\cos(\cos(tanx))\sin(tanx)sec^2x \quad \text{(2M)}$$

7 **Find $\frac{dy}{dx}$ if $i)\ y = \sin(e^x + 2)$ $ii)\ y = \sin(e^x\ logx)$ (4+4M) (NOV/DEC-2017)** BTL1

Answer : Page. 1.136 -M.B.K. Moorthy

i) $y = \sin(e^x + 2)$ Put $t = e^x + 2$ (2M)

$y = sint$ $\quad \frac{dt}{dx} = e^x$

$\frac{dy}{dt} = cost$

$\frac{dy}{dx} = \frac{dy}{dt}.\frac{dt}{dx}$

$= cost.\, e^x$

$= \cos(\ e^x + 2)$

ii) $y = \sin(e^x\ logx)$ Put $t = e^x logx$ (2M)

$y = sint$ $\quad \frac{dt}{dx} = e^x\frac{1}{x} +\ log - e^x$

$\frac{dy}{dt} = cost$ (2M)

$\frac{dy}{dx} = \frac{dy}{dt}.\frac{dt}{dx}$

$= cost.\frac{e^x}{x} +\ e^x\ logx$

$= e^x\left[\frac{\cos(e^x logx)}{x} +\ logx\right]$ (2M)

8 **Find $\frac{dy}{dx}$ $is\ \ y = \log\frac{(1-sinx)}{1+sinx}$ (8M) (NOV/DEC-2017)** BTL1

Answer : Page. 1.137-M.B.K. Moorthy

$y = \log\frac{(1-sinx)}{1+sinx}$ Put $t = \frac{1-sinx}{1+sinx}$ (2M)

$y = logt$ $\quad \frac{dt}{dx} = \frac{(1+sinx)(-cosx)- 1-sinx)\ (cosx)}{(1+sinx)^2}$

$\frac{dy}{dt} = \frac{1}{t}$ $\quad = \frac{-2cosx}{(1+sinx)^2}$

$\frac{dy}{dx} = \frac{dy}{dt}.\frac{dt}{dx}$ (2M)

$= \frac{1}{t}.\frac{-2cosx}{(1+sinx)^2}$

$= \frac{-2cosx}{1-sin^2x}$

$= \frac{-2cosx}{cos^2x}$

$= -2\sec x$ (4)

9 **Find $\frac{dy}{dx}$ if i) $y = \frac{3x^3- 7x+ 3}{2x^2+4x+ 2}$ ii) $y = \frac{5sinx}{5+2\ cosx}$ (4+4M) (NOV/DEC-2017)** BTL1

Answer : Page. 1.103 -M.B.K. Moorthy

i) $y = \frac{3x^2- 7x+ 3}{2x^2+4x+ 2}$ (2M)

Differentiate w.r.to x

$$\frac{dy}{dx} = \frac{(2x^2+4x+ 2)\frac{d}{dx}(3x^2- 7x+ 3)-(3x^2- 7x+ 3)\frac{d}{dx}(2x^2+4x+ 2)}{(2x^2+4x+ 2)^2}$$

$$= \frac{(2x^2+4x+ 2)\ (6x-7)-(3x^2- 7x+ 3)\ (4x+4)}{(2x^2+4x+ 2)^2} \quad \text{(2M)}$$

ii) $y = \frac{5sinx}{5+2\,cosx}$

Differentiate w.r.to x (2M)

D(y) = $\frac{(5+2\,cosx)\,(5cosx) - (5sinx)\,(-2sinx)}{(5+2\,cosx)^2}$

$= \frac{25\,cosx + 10\,cos^2x + 10sin^2x}{(5+2\,cosx)^2}$ (2M)

10

Find $\frac{dy}{dx}$ if $i)\ y = (sinx)^x$ $ii) x^y = y^x$ (4+4M) (NOV/DEC-2017) BTL1

Answer : Page. 1.75 -M.B.K. Moorthy

i) $y = (sinx)^x$

Taking log on both sides (2M)

$logy = log(sinx)^x$

logy $= x\,log(sinx)$

Differentiate w.r.to x

$\frac{1}{y}\frac{dy}{dx} = x\frac{cosx}{sinx} + logsinx$

$\frac{dy}{dx} = y\ x\ cotx + logsinx$ (2M)

$\frac{dy}{dx} = (sinx)^x\ x\cot x + \log sinx$

ii) $x^y = y^x$

Taking log on both sides (2M)

$ylogx = xlogy$

Differtiate w.r.to X

$y.\frac{1}{x} + logx.\frac{dy}{dx} = x.\frac{1}{y}\frac{dy}{dx} + logy$

$\frac{dy}{dx}\left(logx - \frac{x}{y}\right) = logy - \frac{y}{x}$

$\frac{dy}{dx} = \frac{\left(logy - \frac{y}{x}\right)}{\left(logx - \frac{x}{y}\right)}$ (2M)

11

1. If $y = e^x sinx$ prove that $y_2 - 2y_1 + 2y = 0$

2. If $y = ae^{2x} + be^x$ P.T. $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = 0$ (4+4M) (NOV/DEC-2017) BTL1

Answer : Page. 1.77 -M.B.K. Moorthy

i) $y = e^x sinx$

$\frac{dy}{dx} = e^x\frac{d}{dx}(sinx) + sinx\frac{d}{dx}(e^x)$ (2M)

$y_1 = e^x\,(cosx + sinx)$

$\frac{d^2y}{dx^2} = e^x\frac{d}{dx}\,(cosx + sinx) + (cosx + sinx)\frac{d}{dx}\,(e^x)$

$= e^x\,(-sinx + cosx + cosx + sinx)$ (2M)

$= e^x\,2\,cosx$

$\therefore \frac{1}{2} - 2y_1 + 2y = 2e^x cosx - 2e^x cosx - 2e^x sinx + 2e^x sinx$

$\frac{1}{2} - 2y_1 + 2y = 0$

ii) $y = ae^{2x} + be^x$

Differentiate w.r.to x

$\frac{dy}{dx} = 2ae^{2x} + be^x$

$3\frac{dy}{dx} = 6ae^{2x} + 3be^x$ (2M)

	Differentiate w.r.to x $\frac{d^2y}{dx^2} \quad = \quad 4ae^{2x} + be^{x}$ $\therefore \frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y \quad = \quad 4ae^{2x} + be^{x} - 6ae^{2x} - 3be^{x} + 2ae^{2x} + 2be^{x}$ $= \quad 0$ (2M) $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = \quad 0$
12	**Find the tangent line to the equation $x^3 + y^3 = 6xy$ at the point (3, 3) and at what point the tangent line horizontal in the first quadrant. (8M) (NOV/DEC-2017)** BTL1 **Answer : Page. 1.117 -M.B.K. Moorthy** $x^3 + y^3 = 6xy$ (1M) Differentiate w.r.to x (2M) $3x^2 + 3y^2\frac{dy}{dx} \quad = \quad 6\left(x\frac{dy}{dx}\ x\ y.1\right)$ $3x^2 + 3y^2\frac{dy}{dx} - 6x\frac{dy}{dx} \quad = \quad 6y$ $\frac{dy}{dx}(3y^2 - 6x) \quad = \quad 6y - 3x^2$ $\frac{dy}{dx} \quad = \quad \frac{6y-3x^2}{3y^2-6x} = \quad \frac{2y-x^2}{y^2-2x}$ (3M) $\frac{dy}{dx} \quad = \quad \frac{2y-x^2}{y^2-2x}$ $\frac{dy}{dx}$ at (3, 3) $\quad = \quad \frac{2(3)-3^2}{3^2-2(3)} = -\frac{3}{3} = -1$ $m \quad = \quad$ -1 Equation of tangent $\quad y - y_1 \quad = \quad m\,(x - x_1)$ (3,3) $y - 3 \quad = \quad m\,(x-3)$ $y - 3 \quad = \quad -x + 3$ $x + y = 6$ The tangent line in horizontal if $y' = 0$ $\frac{dy}{dx} = 0$ i.e $\frac{2y-x^2}{y^2-2x} = 0$ $= \quad 2y - x^2 = 0$ $= \quad 2y = x^2$ $y \quad = \quad \frac{1}{2}x^2$ $x^3 + (\frac{1}{2}\ x^2)^{3} \quad = \quad 6\ x\ x\ x\frac{1}{2}\ x^2$ $x^3 + \frac{1}{8}\ x^{6} \quad = \quad 3\ x^3$ $8x^3 + x^{6} \quad = \quad 24\ x^3 - 8\ x^3$ $x^{6}\ (x^3 - 16) \quad = \quad 0$ $x^3 = 0 \qquad x^3 - 16 = 0$ $x^3 \quad = \quad 16$ $x \quad = \quad 2^{\frac{4}{3}}$ $y \quad = \quad \frac{1}{2}x^2$ $y \quad = \quad 2^{\frac{5}{3}}$ $\therefore A\ \left(2^{\frac{4}{3}}, 2^{\frac{5}{3}}\right)$ the tune has horizontal tangent

13

Find the equation of tangent line to the cure at the given point $y\ sin2x = x\ cos2y$ at $\left(\frac{\pi}{2}, \frac{\pi}{4}\right)$ (8M) (NOV/DEC-2017) BTL1

Answer : Page. 1.119 -M.B.K. MOORTHY

$y\ sin2x = x\ cos2y$

Differentiate w.r.to x (2M)

$y\ cos2x.2 + sin2x\frac{dy}{dx} = x\,(-sin2y\,)\frac{dy}{dx} + 1.cos2y$

$2y\ cos^2x + sin^2 x\frac{dy}{dx}. +2x6in^2 y\frac{dy}{dx} = cos^2y$

$\frac{dy}{dx}\ (sin^2 x + 2xsin^2 y) = cos^2y - 2ycos^2x$

$\frac{dy}{dx} = \frac{cos^2y-2ycos^2x}{1sin^2 x-2xsin^2 y}$ (2M)

$m = \frac{dy}{dx}\left(\frac{\pi}{2}, \frac{\pi}{4}\right) = \frac{cos^2 x\frac{\pi}{4} - 2x\frac{\langle}{4}cos^2 x\frac{\pi}{2}}{sin^2 x\frac{\pi}{2} + 2\,x\frac{\pi}{2}\ sin^2 x\frac{\pi}{4}}$

$= -\frac{\frac{\pi}{2}(-)}{\pi\ (1M)} = \frac{\frac{\pi}{2}}{\pi} = \frac{1}{2}$ (2M)

$y - y_1 = m\,(x - x_1)$ (2M)

$y - \frac{\pi}{4} = -\frac{1}{2}\,(x - \frac{\pi}{2})$

$2y - \frac{\pi}{2} = x - \frac{\pi}{2}$

$x - 2y = 0$

14

Verify Rolle's theorem $f(x) = x^{\frac{1}{2}} - \frac{1}{3}x$ in $(0, 9)$ (8M) (NOV/DEC-2017) BTL5

Answer : Page. 1.162 -M.B.K. MOORTHY

$f(x) = x^{\frac{1}{2}} - \frac{x}{3}$ (2M)

$f(0) = 0$

$f(9) = 0$

By Rolle's theorem, (2M)

$f'(x) = \frac{1}{2\sqrt{x}} - \frac{1}{3}$

$f'(x) = \frac{1}{2\sqrt{x}} - \frac{1}{3} = 0$

$\frac{1}{2\sqrt{x}} = \frac{1}{3}$ C $\in (0,9)$ (2M)

$\sqrt{C} = \frac{3}{2}$ $\frac{9}{4} \in (0, 9)$

C $= \frac{9}{4}$ (2M)

15

Find the maximum and minimum values of $f(x) = x^3 - 6x^2 + 5$ on (-3, 5) (8M) (NOV/DEC-2017) BTL5

Answer : Page. 1.150 -M.B.K. MOORTHY

$f(x)$ is continuous on (-3, 5) closed interval (2M)

$\therefore$ The $f'(x) = 0$

$3x^2 - 12x = 0$

$3x\,(x - 4) = 0$

$3x = 0$ $x - 4$

$x = 0$ & $x = 4$ are critical numbers. (2M)

$f\ (0) = (0^2 - 1)^3 = -1$

$f\ (1) = (1^2 - 1)^3 = 0$

	$f(-1) = ((-1)^2 - 1)^3 = 0$ $f(2M) = (2^2 - 1)^3 = 3^3 = 27$ (2M) largest and smallest value of $f(x)$ is = 7 and -1 $f(x)$ = -1 is the absolute minimum $f(2M)$ = 27 is the absolute maximum (2M)
16	**Find the derivative of** $f(x)=\cos^{-1}\left(\frac{b+a\cos x}{a+b\cos x}\right)$ **. (8M) (DEC-2018)** BTL3 **Answer : Page. Nil** $\cos\left(f(x)\right)=\left(\frac{b+a\cos x}{a+b\cos x}\right)$ **(2M)** $d\left(\frac{u}{v}\right)=\frac{vdu-udv}{v^2}$ **(2M)** $f'(x)=\left(\frac{a^2\sin x-b^2\sin x}{(a+b\cos x)^2}\right)\csc\left(\frac{b+a\cos x}{a+b\cos x}\right)$ **(4M)**
17	**Find y' for** $\cos(xy)=1+\sin y$ **(4M) (DEC-2018)** BTL3 **Answer : Page. Nil** $d(uv)=udv+vdu$ **(2M)** $y'=\frac{1-y\sin(xy)}{x\sin(xy)-\cos y}$ **(2M)**

	UNIT-II FUNCTIONS OF SEVERAL VARIABLES
	Partial differentiation – Homogeneous functions and Euler‘s theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor‘s series for functions of two variables – Maxima and minima of functions of two variables – Lagrange‘s method of undetermined multipliers.
	PART - A
1.	**If** $x^y+y^x=1$ **find** $\frac{dy}{dx}$ **(DEC 2018)** BTL1. Let $f(x,y)=x^y+y^x-1$

	$\frac{dy}{dx} = -\left(\frac{\frac{\partial f}{\partial x}}{\frac{\partial f}{\partial y}}\right) = \frac{yx^{y-1} + y^x \log y}{x^y \log x + xy^{x-1}}$
2.	**If** $x^2 + y^2 = 1$ **find** $\frac{dy}{dx}$ **(NOV/DEC-2007)** BTL1 Let $f(\mathrm{x}, \mathrm{y}) = x^2 + y^2 - 1$ $\frac{dy}{dx} = -\left(\frac{\frac{\partial f}{\partial x}}{\frac{\partial f}{\partial y}}\right) = \frac{2x}{2y} = \frac{x}{y}$
3.	**If** $y\sin x = x\cos y$ **find** $\frac{dy}{dx}$ **(APR/MAY-2009)** BTL1 Let $f(\mathrm{x}, \mathrm{y}) = y\sin x - x\cos y$ $\frac{dy}{dx} = -\left(\frac{\frac{\partial f}{\partial x}}{\frac{\partial f}{\partial y}}\right) = -\left(\frac{y\cos x - \cos y}{\sin x + x\sin y}\right)$
4.	**If** $u = x^2 y$ **and** $x^2 + xy + y^2 = 1$ **, then find** $\frac{du}{dx}$**. (APR/MAY-2004)** BTL1 Given that $u = x^2 y$ Diff p.w .r .to 'x'&'y' $\therefore \frac{\partial u}{\partial x} = 2xy \quad \& \quad \frac{\partial u}{\partial y} = x^2$ Also Given that $x^2 + xy + y^2 = 1$ Diff .w .r .to 'x' $2x + \left[x\frac{dy}{dx} + y\right] + 2y\frac{dy}{dx} = 0$ $2x + (x + 2y)\frac{dy}{dx} + y = 0$ $(x + 2y)\frac{dy}{dx} = -y - 2x$ $\frac{dy}{dx} = \frac{-(y + 2x)}{(x + 2y)}$ $\therefore \frac{du}{dx} = \frac{\partial u}{\partial x} + \frac{\partial u}{\partial y}\frac{dy}{dx} = 2xy + x^2\left(\frac{y + 2x}{x + 2y}\right)$

5.	**If** $u=(x-y)(y-z)(z-x)$ **show that** $\frac{\partial u}{\partial x}+\frac{\partial u}{\partial y}+\frac{\partial u}{\partial z}=0$ **(APR/MAY-2010) (NOV/DEC-2009)** BTL2 Given $u=(x-y)(y-z)(z-x)$ $\frac{\partial u}{\partial x}=(y-z)\left[(x-y)(-1)+(z-x)(1)\right]=-(x-y)(y-z)+(y-z)(z-x)$ $\frac{\partial u}{\partial y}=(z-x)\left[(x-y)(1)+(y-z)(-1)\right]=(x-y)(z-x)-(y-z)(z-x)$ $\frac{\partial u}{\partial z}=(x-y)\left[(y-z)(1)+(z-x)(-1)\right]=(x-y)(y-z)-(x-y)(z-x)$ $\therefore \frac{\partial u}{\partial x}+\frac{\partial u}{\partial y}+\frac{\partial u}{\partial z}=0$
6.	**If** $Z=f(y-z,z-x,x-y)$ **then find** $\frac{\partial Z}{\partial x}+\frac{\partial Z}{\partial y}+\frac{\partial Z}{\partial z}$. **(NOV/DEC-2013,2014,2016)** BTL2 let $u=y-z,\ v=z-x,\ w=x-y$ $\Rightarrow Z=f(u,v,w)$ $\frac{\partial Z}{\partial x}=\frac{\partial f}{\partial u}\frac{\partial u}{\partial x}+\frac{\partial f}{\partial v}\frac{\partial v}{\partial x}+\frac{\partial f}{\partial w}\frac{\partial w}{\partial x}=\frac{\partial f}{\partial u}(0)+\frac{\partial f}{\partial v}(-1)+\frac{\partial f}{\partial w}(1)=-\frac{\partial f}{\partial v}+\frac{\partial f}{\partial w}$ ....(1) Similarly $\frac{\partial Z}{\partial y}=\frac{\partial f}{\partial u}-\frac{\partial f}{\partial w}$ ....(2) $\frac{\partial Z}{\partial z}=-\frac{\partial f}{\partial u}+\frac{\partial f}{\partial v}$................(3) Adding $(1)+(2)+(3)$ $\frac{\partial Z}{\partial x}+\frac{\partial Z}{\partial y}+\frac{\partial Z}{\partial z}=-\frac{\partial f}{\partial v}+\frac{\partial f}{\partial w}+\frac{\partial f}{\partial u}-\frac{\partial f}{\partial w}-\frac{\partial f}{\partial u}+\frac{\partial f}{\partial v}=0$
7.	**If** $u=x^y$ **then show that** $\frac{\partial^2 u}{\partial x\partial y}=\frac{\partial^2 u}{\partial y\partial x}$. **(NOV/DEC-2012)** BTL4. Given $u=x^y=e^{y\log x}$ $[\because a^x=e^{x\log a}]$ $\frac{\partial u}{\partial y}=e^{y\log x}\log x$ $\frac{\partial^2 u}{\partial x\partial y}=\frac{\partial}{\partial x}\left(\frac{\partial u}{\partial x}\right)=e^{y\log x}\frac{1}{x}+e^{y\log x}\frac{y}{x}\log x$ $\frac{\partial^2 u}{\partial x\partial y}=\frac{x^y}{x}+x^y\frac{y}{x}\log x=\frac{x^y}{x}\left[1+y\log x\right]=x^{y-1}\left[1+y\log x\right]$........................(1) $\frac{\partial u}{\partial x}=e^{y\log x}\frac{y}{x}$

	$\frac{\partial^2 u}{\partial y\partial x} = \frac{\partial}{\partial y}\left(\frac{\partial u}{\partial x}\right) = e^{y\log x}\frac{1}{x} + \frac{y}{x}e^{y\log x}\log x = \frac{e^{y\log x}}{x}[1+y\log x]$ $= \frac{x^y}{x}[1+y\log x] = x^{y-1}[1+y\log x]$..................................(2) From (1) and (2) we get $\frac{\partial^2 u}{\partial x\partial y} = \frac{\partial^2 u}{\partial y\partial x}$
8.	**Find** $\frac{du}{dt}$ **when** $u = \sin\left(\frac{x}{y}\right),\ x = e^t,\quad y = t^2$ **(APR/MAY-2015 R-08)** BTL3 $\frac{du}{dt} = \frac{\partial u}{\partial x}\frac{dx}{dt} + \frac{\partial u}{\partial y}\frac{dy}{dt} = \frac{1}{y}\cos\left(\frac{x}{y}\right)e^t + \left(-\frac{x}{y^2}\right)\cos\left(\frac{x}{y}\right)(2t)$ $= \frac{1}{y}e^t\cos\left(\frac{x}{y}\right) - 2t\left(\frac{x}{y^2}\right)\cos\left(\frac{x}{y}\right) \qquad = \frac{1}{y}\cos\left(\frac{x}{y}\right)\left[e^t - \frac{2xt}{y}\right] = \frac{1}{t^2}\cos\left(\frac{e^t}{t^2}\right)\left[e^t - \frac{2e^t t}{t^2}\right]$
9.	**Find** $\frac{du}{dt}$ **when** $u = x^2+y^2,\ x = at^2,\quad y = 2at$ **(APR/MAY-2006)(NOV/DEC-2011)** BTL1 $\frac{du}{dt} = \frac{\partial u}{\partial x}\frac{dx}{dt} + \frac{\partial u}{\partial y}\frac{dy}{dt} \qquad = 2x(2at) + 2y(2a) = 4(a^2t^3) + 8a^2t \qquad [\because x = at^2,\quad y = 2at]$ $= 4a^2t(t^2+2)$
10	**Find** $\frac{du}{dt}$ **when** $u = \left(\frac{x}{y}\right),\ x = e^t,\quad y = \log t$ **(NOV/DEC-2014-R-08)** BTL3 $\frac{du}{dt} = \frac{\partial u}{\partial x}\frac{dx}{dt} + \frac{\partial u}{\partial y}\frac{dy}{dt} = \frac{1}{y}e^t + \left(-\frac{x}{y^2}\right)\left(\frac{1}{t}\right)$ $= \frac{1}{\log t}e^t + \left(-\frac{e^t}{(\log t)^2}\right)\left(\frac{1}{t}\right) = \left(\frac{e^t}{\log t}\right)\left(1 - \left(\frac{1}{t\log t}\right)\right)$
11	**If** $x = r\cos\theta\ , y = r\sin\theta$ **evaluate** $\frac{\partial(x,y)}{\partial(r,\theta)}$ and $\frac{\partial(r,\theta)}{\partial(x,y)}$ **(NOV/DEC-2016, 2017-R-17)** BTL2 $\frac{\partial(x,y)}{\partial(r,\theta)} = \begin{vmatrix} \frac{\partial x}{\partial r} & \frac{\partial x}{\partial \theta} \\ \frac{\partial y}{\partial r} & \frac{\partial y}{\partial \theta} \end{vmatrix} = \begin{vmatrix} \cos\theta & -r\sin\theta \\ \sin\theta & r\cos\theta \end{vmatrix} = r(\cos^2\theta + \sin^2\theta) = r$ $\therefore \frac{\partial(r,\theta)}{\partial(x,y)} = \frac{1}{r} \qquad [\because \left(\frac{\partial(r,\theta)}{\partial(x,y)}\right)\left(\frac{\partial(x,y)}{\partial(r,\theta)}\right) = 1]$

12	**If** $x = uv \;, y = \frac{u}{v}$ **evaluate** $\frac{\partial(\mathrm{x,y})}{\partial(u,v)}$ **(NOV/DEC-2017-R-17)** BTL2 $\frac{\partial(x,y)}{\partial(u,v)} = \begin{vmatrix} \frac{\partial x}{\partial u} & \frac{\partial x}{\partial v} \\ \frac{\partial y}{\partial u} & \frac{\partial y}{\partial v} \end{vmatrix} = \begin{vmatrix} v & u \\ \frac{1}{v} & \frac{-u}{v^2} \end{vmatrix} = \frac{-u}{v} - \frac{u}{v} = \frac{-2u}{v}$
13	**If** $u = \frac{y^2}{x}, v = \frac{x^2}{y}$ **find** $\frac{\partial(u,v)}{\partial(x,y)}$ **(NOV/DEC-2010)** BTL2 $\frac{\partial(u,v)}{\partial(x,y)} = \begin{vmatrix} \frac{\partial u}{\partial x} & \frac{\partial u}{\partial y} \\ \frac{\partial v}{\partial x} & \frac{\partial v}{\partial y} \end{vmatrix} = \begin{vmatrix} \frac{-y^2}{x^2} & \frac{2y}{x} \\ \frac{2x}{y} & \frac{-x^2}{y^2} \end{vmatrix} = 1 - 4 = -3$.
14	**If** $u = \frac{y^2}{2x}, v = \frac{x^2 + y^2}{2x}$ **find** $\frac{\partial(u,v)}{\partial(x,y)}$ **(NOV/DEC-2012)** BTL2 $\frac{\partial(u,v)}{\partial(x,y)} = \begin{vmatrix} \frac{\partial u}{\partial x} & \frac{\partial u}{\partial y} \\ \frac{\partial v}{\partial x} & \frac{\partial v}{\partial y} \end{vmatrix} = \begin{vmatrix} \frac{-y^2}{2x^2} & \frac{y}{x} \\ \frac{x^2 - y^2}{2x^2} & \frac{y}{x} \end{vmatrix} = \frac{-y^3}{2x^3} - \frac{y(x^2 - y^2)}{2x^3} = \frac{-y}{2x}$.
15	**If** $u = 2xy,\ v = x^2 - y^2$ **and** and $x = r\cos\theta \;, y = r\sin\theta$ **evaluate** $\frac{\partial(u,v)}{\partial(\mathrm{r},\theta)}$ BTL2 $\frac{\partial(u,v)}{\partial(x,y)} = \begin{vmatrix} \frac{\partial u}{\partial x} & \frac{\partial u}{\partial y} \\ \frac{\partial v}{\partial x} & \frac{\partial v}{\partial y} \end{vmatrix} = \begin{vmatrix} 2y & 2x \\ 2x & -2y \end{vmatrix} = -4(x^2 + y^2) = -4r^2$. $\frac{\partial(x,y)}{\partial(r,\theta)} = \begin{vmatrix} \frac{\partial x}{\partial r} & \frac{\partial x}{\partial \theta} \\ \frac{\partial y}{\partial r} & \frac{\partial y}{\partial \theta} \end{vmatrix} = \begin{vmatrix} \cos\theta & -r\sin\theta \\ \sin\theta & r\cos\theta \end{vmatrix} = r(\cos^2\theta + \sin^2\theta) = r$ $\Rightarrow \frac{\partial(u,v)}{\partial(\mathrm{r},\theta)} = \left(\frac{\partial(u,v)}{\partial(x,y)}\right)\left(\frac{\partial(x,y)}{\partial(r,\theta)}\right) = -4r^3$
16	**If** $x = u(1+v) \;, y = v(1+u)$ **evaluate** $\frac{\partial(\mathrm{x,y})}{\partial(u,v)}$ **(APR/MAY-2005)** BTL5

	$\frac{\partial(x,y)}{\partial(u,v)} = \begin{vmatrix} \frac{\partial x}{\partial u} & \frac{\partial x}{\partial v} \\ \frac{\partial y}{\partial u} & \frac{\partial y}{\partial v} \end{vmatrix} = \begin{vmatrix} 1+v & u \\ v & 1+u \end{vmatrix}$ $= (1+u)(1+v) - uv = 1+u+v+uv-uv = 1+u+v$
17	**State Euler's theorem(APR/MAY-2001)** BTL1 If u is a homogeneous function of degree n in x and y, then $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = nu$
18	**If** $u = \tan^{-1}\frac{x^3+y^3}{x-y}$ **prove that** $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = \sin 2u.$ **(APR/MAY-2017)** BTL3 Let $u = \tan^{-1}\left(\frac{x^3+y^3}{x-y}\right)$ $f(x,y) = \tan u = \frac{x^3+y^3}{x-y} \quad \Rightarrow \quad f(u) = \tan u,\ f'(u) = \sec^2 x$ $\therefore\ f(tx, \mathrm{t}\,y) = \frac{(tx)^3+(ty)^3}{tx-ty} = \frac{t^3(x^3+y^3)}{t(x-y)} = t^2 f(x,y)$ $\therefore$ f is a homogeneous function of degree 2 in $'x'$ and $'y'$ $\therefore$ By Euler's theorem $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = n\frac{f(u)}{f'(u)}$ $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = 2\frac{\tan u}{\sec^2 u} = 2\frac{\sin u}{\cos u}\cos^2 u = 2\sin u\cos u$ $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = 2\frac{\tan u}{\sec^2 u} = \sin 2u$
19	**If** $u = \frac{x}{y} + \frac{y}{z} + \frac{z}{x}$ **then find** $\mathrm{x}\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} + z\frac{\partial u}{\partial z}.$ **(NOV/DEC-2014-R-13)** BTL3 Given $u(x,y) = \frac{x}{y} + \frac{y}{z} + \frac{z}{x}$ $f(tx, \mathrm{t}\,y) = \frac{tx}{ty} + \frac{ty}{tz} + \frac{tz}{tx} = \frac{x}{y} + \frac{y}{z} + \frac{z}{x} = t^0 f(x,y)$ $\therefore$ u is a homogeneous function of degree 0 in $'x'$ and $'y'$ $\therefore$ By Euler's theorem $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} + z\frac{\partial u}{\partial z} = nu = n(0) = 0$
20	**If** $u = (x-y)f\left(\frac{y}{x}\right)$ **then find** $\mathrm{x}^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2}.$ **(NOV/DEC-2010)** BTL3

	Given $u(x,y)=(x-y)f\left(\frac{y}{x}\right)$ $f(tx,ty)=(tx-ty)f\left(\frac{ty}{tx}\right)=t^1 f(x,y)$ $\therefore$ u is a homogeneous function of degree 1 in $'x'$ and $'y'$ $\therefore$ By Euler's theorem $x^2\frac{\partial^2 u}{\partial x^2}+2xy\frac{\partial^2 u}{\partial x\partial y}+y^2\frac{\partial^2 u}{\partial y^2}=n(n-1)u=0.u=0$
21	**Find the Taylor series expansion of x^y at $(1,1)$ up to 1st degree. (APR/MAY-2009)** BTL1 Function — Value at $(1,1)$ $f(x,y)=x^y$ — $f=1$ $f_x=yx^{y-1}$ — $f_x=1$ $f_y=x^y\log y$ — $f_y=0$ By Taylor theorem, $f(x,y)=f(a,b)+\frac{1}{1!}\left[hf_x(a,b)+kf_y(a,b)\right]+\ldots$ where $h=x-a$ & $k=y-b$ $f(x,y)=1+(x-1)+\cdots$
22	**Find the Taylor series expansion of $e^x siny$ at $(-1,\frac{\pi}{4})$. (NOV/DEC-2013)** BTL1 Function — Value at $\left(-1,\frac{\pi}{4}\right)$ $f(x,y)=e^x\sin y$ — $f=\frac{1}{e}\frac{1}{\sqrt{2}}$ $f_x=e^x\sin y$ — $f_x=\frac{1}{e}\frac{1}{\sqrt{2}}$ $f_y=e^x\cos y$ — $f_y=\frac{1}{e}\frac{1}{\sqrt{2}}$ By Taylor theorem, $f(x,y)=f(a,b)+\frac{1}{1!}\left[hf_x(a,b)+kf_y(a,b)\right]+\ldots$ where $h=x-a$ & $k=y-b$ $f(x,y)=\frac{1}{e}\frac{1}{\sqrt{2}}\left[x+2+(y-\frac{\pi}{4})\right]+\cdots$
23	**Write the sufficient condition for $f(x,y)$ to have a maximum value at (a,b). (APR/MAY-2012)** BTL2 If $f_x(a,b)=0,\ f_y(a,b)=0,$ and $f_{xx}(a,b)=A,\ f_{xy}(a,b)=B,\ f_{yy}(a,b)=c,$ then

(i) If $f(a,b)$ is maximum value if $AC-B^2>0$ and $A<0(or B<0)$

(ii) If $f(a,b)$ is maximum value if $AC-B^2>0$ and $A>0(or B>0)$

(iii) If $f(a,b)$ is saddle if $AC-B^2<0$.

(iv) If $AC-B^2=0$ then the test is inconclusive.

24. **Find the stationary points of** $f(x,y)=x^3+y^3-3x-12y+20$ **(NOV/DEC-2010)** BTL1

Given $f(x,y)=x^3+y^3-3x-12y+20.$

$f_x(x,y)=3x^2-3;\ f_y(x,y)=3y^2-12;$

$A=f_{xx}(x,y)=6x; B=f_{xy}(x,y)=0; C=f_{yy}(x,y)=6y$.

$Let\ \ f_x=0\Rightarrow 3x^2-3=0\Rightarrow x^2-1=0$

$\therefore x=\pm 1$

$and\ Let\ \ f_y=0\Rightarrow 3y^2-12=0\Rightarrow y^2-4=0$

$\therefore y=\pm 2$

$\therefore$ The stationary points are $(1,2),(1,-2),(-1,2),(-1,-2)$

25. **Find the stationary points of** $f(x,y)=x^2-xy+y^2-2x+y.$ **(APR/MAY-2010,2012)** BTL1

Given $f(x,y)=x^2-xy+y^2-2x+y.$ $f_x(x,y)=2x-y-2$; $f_y(x,y)=-x+2y+1$

$A=f_{xx}(x,y)=2\ ; B=f_{xy}(x,y)=-1\ ; C=f_{yy}(x,y)=2$.

Let $f_x=0\Rightarrow 2x-y-2=0$...........................(1)

and Let $f_y=0\Rightarrow -x+2y+1=0$..................(2)

From (1) & (2) we get $x=1$ & $y=0$ $\therefore$ The stationary point is $(1,0)$

PART * B

1. **If** $u=\sin^{-1}\left(\dfrac{x+y}{\sqrt{x}+\sqrt{y}}\right)$ **then prove that** $x\dfrac{\partial u}{\partial x}+y\dfrac{\partial u}{\partial y}=\dfrac{1}{2}tanu$ **and**

$$x^2u_{xx}+2xyu_{xy}+y^2u_{yy}=-\frac{sinucos2u}{4\cos^3 u}$$ **(8M) (APR/MAY-2014 R-08)** BTL3

Answer : Page.2.23 -G.Balaji

- f is a homogeneous function of degree $\left(\dfrac{1}{2}\right)$ in $'x'$ and $'y'$ (1M)
- Proving $x\dfrac{\partial u}{\partial x}+y\dfrac{\partial u}{\partial y}=\dfrac{1}{2}tanu$ (2M)

	• $xu_{xx}+yu_{xy}=\left(\frac{1}{2}\sec^2 u-1\right)u_x$ (2M) • $xu_{xy}+yu_{yy}=\left(\frac{1}{2}\sec^2 u-1\right)u_y$ (2M) • Proving $x^2u_{xx}+2xyu_{xy}+y^2u_{yy}=-\frac{sinucos2u}{4\cos^3 u}$ (1M)
2.	**If** $F=f\left(x,y\right)$ **is a function of x and y and if** $x=e^u sinv, y=e^u cosv$ **, prove that** $\frac{\partial^2 F}{\partial x^2}+\frac{\partial^2 F}{\partial y^2}=e^{-2u}[\frac{\partial^2 F}{\partial u^2}+\frac{\partial^2 F}{\partial v^2}]$ **. (8M) (NOV/DEC-2013)** BTL1 **Answer : Page.2.33 -G.Balaji** • $\frac{\partial^2 F}{\partial u^2}=x^2\frac{\partial^2 F}{\partial x^2}+x\frac{\partial F}{\partial x}+xy\frac{\partial^2 F}{\partial y\partial x}+y^2\frac{\partial^2 F}{\partial y^2}+y\frac{\partial F}{\partial y}$ (3M) • $\frac{\partial^2 F}{\partial v^2}=y^2\frac{\partial^2 F}{\partial x^2}-x\frac{\partial F}{\partial x}-xy\frac{\partial^2 F}{\partial x\partial y}-xy\frac{\partial^2 F}{\partial y\partial x}+x^2\frac{\partial^2 F}{\partial y^2}-y\frac{\partial F}{\partial y}$ (3M) • $[\frac{\partial^2 F}{\partial u^2}+\frac{\partial^2 F}{\partial v^2}]=(x^2+y^2)\frac{\partial^2 F}{\partial x^2}+\frac{\partial^2 F}{\partial y^2}$ (1M) • $\frac{\partial^2 F}{\partial x^2}+\frac{\partial^2 F}{\partial y^2}=e^{-2u}[\frac{\partial^2 F}{\partial u^2}+\frac{\partial^2 F}{\partial v^2}]$ (1M)
3.	**If** $u=\log(x^3+y^3+z^3-3xyz)$ **show that** $\left(\frac{\partial}{\partial x}+\frac{\partial}{\partial y}+\frac{\partial}{\partial z}\right)^2 u=\frac{-9}{(x+y+z)^2}$ **(8M) (APR/MAY-2011) .** BTL1 **Answer : Page. 2.35-G.Balaji** • $\frac{\partial u}{\partial x}=\frac{3(x^2-yz)}{(x^3+y^3+z^3-3xyz)}$, $\frac{\partial u}{\partial y}=\frac{3(y^2-xz)}{(x^3+y^3+z^3-3xyz)}$ & $\frac{\partial u}{\partial z}=\frac{3(z^2-xy)}{(x^3+y^3+z^3-3xyz)}$ • $\left(\frac{\partial}{\partial x}+\frac{\partial}{\partial y}+\frac{\partial}{\partial z}\right)u=\frac{3}{(x+y+z)}$ (2M) • Proving $\left(\frac{\partial}{\partial x}+\frac{\partial}{\partial y}+\frac{\partial}{\partial z}\right)^2 u=\frac{-9}{(x+y+z)^2}$ (3M)
4.	**Transform the equation** $Z_{xx}+2Z_{xy}+Z_{yy}=0$ **by changing the independent variables using.** $u=x-y$ and $v=x+y$ **. (8M) (APR/MAY-2012)** BTL1 **Answer : Page. 2.49 -G.Balaji** $\frac{\partial^2 z}{\partial x^2}=\frac{\partial^2 z}{\partial u^2}+\frac{\partial^2 z}{\partial u\partial v}+\frac{\partial^2 z}{\partial v\partial u}+\frac{\partial^2 z}{\partial v^2}$ (3M) • $\frac{\partial^2 z}{\partial y^2}=\frac{\partial^2 z}{\partial u^2}-\frac{\partial^2 z}{\partial u\partial v}-\frac{\partial^2 z}{\partial v\partial u}+\frac{\partial^2 z}{\partial v^2}$ (3M)

	• $Z_{uv} + 2Z_{vv} - Z_{vu} = 0$ (2M)
5.	**If** $y_1 = \frac{x_2 x_3}{x_1}$, $y_2 = \frac{x_3 x_1}{x_2}$ **and** $y_3 = \frac{x_1 x_2}{x_3}$ **prove that** $\frac{\partial(y_1, y_2, y_3)}{\partial(x_1, x_2, x_3)} = 4$ **(8M) (APR/MAY-2015 R-08,2017 R-08) (NOV/DEC-2016-R-13)** BTL2 **Answer : Page. 2.59 -G.Balaji** • Jacobian $= \frac{\partial(y_1, y_2, y_3)}{\partial(x_1, x_2, x_3)} = \begin{vmatrix} \frac{\partial y_1}{\partial x_1} & \frac{\partial y_1}{\partial x_2} & \frac{\partial y_1}{\partial x_3} \\ \frac{\partial y_2}{\partial x_1} & \frac{\partial y_2}{\partial x_2} & \frac{\partial y_2}{\partial x_3} \\ \frac{\partial y_3}{\partial x_1} & \frac{\partial y_3}{\partial x_2} & \frac{\partial y_3}{\partial x_3} \end{vmatrix}$ (2M) • Proving $\frac{\partial(y_1, y_2, y_3)}{\partial(x_1, x_2, x_3)} = 4$ (6 M)
6.	**Find the Jacobian of** $\frac{\partial(x, y, z)}{\partial(r, \theta, \varphi)}$ **where** $x = r\sin\theta\cos\varphi, y = r\sin\theta\sin\varphi, z = r\cos\theta$ **(8M) (APR/MAY-2011,2016) (NOV/DEC-2016-R-13)** BTL1 **Answer : Page. 2.60 -G.Balaji** • Jacobian $= \frac{\partial(x, y, z)}{\partial(r, \theta, \varphi)} = \begin{vmatrix} \frac{\partial x}{\partial r} & \frac{\partial x}{\partial \theta} & \frac{\partial x}{\partial \varphi} \\ \frac{\partial y}{\partial r} & \frac{\partial y}{\partial \theta} & \frac{\partial y}{\partial \varphi} \\ \frac{\partial z}{\partial r} & \frac{\partial z}{\partial \theta} & \frac{\partial z}{\partial \varphi} \end{vmatrix}$ (2M) $\frac{\partial x}{\partial r} = \sin\theta\cos\varphi, \frac{\partial y}{\partial r} = \sin\theta\sin\varphi, \frac{\partial z}{\partial r} = \cos\theta$ • $\frac{\partial x}{\partial \theta} = r\cos\theta\cos\varphi, \frac{\partial y}{\partial \theta} = r\cos\theta\sin\varphi, \frac{\partial z}{\partial \theta} = -r\sin\theta$ (4M) $\frac{\partial x}{\partial \varphi} = -r\sin\theta\sin\varphi, \frac{\partial y}{\partial \varphi} = r\sin\theta\cos\varphi, \frac{\partial z}{\partial \varphi} = 0$ • Jacobian $= r^2\sin\theta$ (2M)
7.	**Find the Jacobian of** u, v, w **with respect to** x, y, z if $u = x + y + z$, $v = xy + yz + zx$, $w = x^2 + y^2 + z^2$ **(8M) (APR/MAY-2015,2018)** BTL2 **Answer : Page. 2.63 -G.Balaji**

- Jacobian $=\dfrac{\partial(u,v,w)}{\partial(\mathrm{x},\mathrm{y},\mathrm{z})}=\begin{vmatrix}\dfrac{\partial u}{\partial x} & \dfrac{\partial u}{\partial y} & \dfrac{\partial u}{\partial z}\\ \dfrac{\partial v}{\partial x} & \dfrac{\partial v}{\partial y} & \dfrac{\partial u}{\partial z}\\ \dfrac{\partial w}{\partial x} & \dfrac{\partial w}{\partial y} & \dfrac{\partial w}{\partial z}\end{vmatrix}$ (2M)
- $J=\begin{vmatrix}1 & 1 & 1\\ y+z & z+x & x+y\\ 2x & 2y & 2z\end{vmatrix}$ (4M)
- Jacobian = 0 (2M)

8\. **Expand** $e^{x}\log(1+y)$ **in powers of** $x\ and\ y$ **.(8M) (APR/MAY-2014 R-08,2016 R-13)** BTL2

Answer : Page. 2.78-G.Balaji

- Taylor theorem,

$$f(x,y)=f(a,b)+\frac{1}{1!}\left[hf_x(a,b)+kf_y(a,b)\right]+\frac{1}{2!}[h^2 f_{xx}(a,b)+k^2 f_{yy}(a,b)+2hk\, f_{xy}(a,b)]+\cdots$$

where $h=x-a$ & $k=y-b$ (2M)

- $f=0,$
  $f_x=f_{xx}=f_{xxx}=0$
  $f_y=f_{xy}=f_{xxy}=1$
  $f_{yy}=f_{xyy}=-1$
  $f_{yyy}=2$ (3M)
- $e^{x}\log(1+y)=y+xy-\left(\dfrac{y^2}{2}\right)+\left(\dfrac{x^2y}{2}\right)-\left(\dfrac{xy^2}{2}\right)+\left(\dfrac{y^3}{3}\right)+\ldots\ldots\ldots..$ (3M)

9\. **Obtain the Taylor series expansion up to second degree of** $\sin xy$ **in powers of** $(x-1)$ and $(y-\dfrac{\pi}{2})$. **(8M) (NOV/DEC-2014,2015)** BTL2

Answer : Page. 2.76 -G.Balaji

- Taylor theorem,

$$f(x,y)=f(a,b)+\frac{1}{1!}\left[hf_x(a,b)+kf_y(a,b)\right]+\frac{1}{2!}[h^2 f_{xx}(a,b)+k^2 f_{yy}(a,b)+2hk\, f_{xy}(a,b)]+\cdots$$

where $h=x-a$ & $k=y-b$

(2M)

	$f=1,$ • $f_x = f_y = 0$, $f_{xx} = -\frac{\pi^2}{4}$ (3M) $f_{yy} = -1$, $f_{xy} = -\frac{\pi}{2}$ • $\text{sinxy} = 1 + \frac{1}{2}\left(-\frac{\pi^2}{2}(x-1)^2 - \pi(x-1)(y-\frac{\pi}{2}) - (y-\frac{\pi}{2})^2\right) + \ldots$ (3M)
10.	**Obtain the Taylor series expansion up to 3rd degree of $e^x cosy$ about $\left(0, \frac{\pi}{2}\right)$ (8M) (APR/MAY-2014) (NOV/DEC-2016-R-08)** BTL2 **Answer : Page. 2.74 -G.Balaji** • Taylor theorem, $f(x,y) = f(a,b) + \frac{1}{1!}\left[hf_x(a,b) + kf_y(a,b)\right] + \frac{1}{2!}[h^2 f_{xx}(a,b) + k^2 f_{yy}(a,b) + 2hk\, f_{xy}(a,b)] + \cdots$ (2M) where $h = x-a$ & $k = y-b$ • $f=0,\ f_x = f_{xx} = f_{xxx} = f_{xyy} = f_{yy} = 0$ $f_y = f_{xy} = f_{xxy} = -1$, $f_{yyy} = 1$ (3M) • $\text{e}^x\text{cosy} = -y + \frac{\pi}{2} + \frac{1}{2}\left(-2xy + 2x\frac{\pi}{2}\right) + \frac{1}{6}\left(-3x^2 y + \frac{3\pi}{2}x^2 + (y-\frac{\pi}{2})^3\right) + \ldots.$ (3M)
11.	**Obtain the Taylor series expansion up to 3rd degree of $x^2y + 3y^2 - 2$ in powers of** $(x-1)$ and $(y+2)$. **(8M) (APR/MAY-2012, 2018)** BTL2 **Answer : Page. 2.79 - G.Balaji** • Taylor theorem, $f(x,y) = f(a,b) + \frac{1}{1!}\left[hf_x(a,b) + kf_y(a,b)\right] + \frac{1}{2!}[h^2 f_{xx}(a,b) + k^2 f_{yy}(a,b) + 2hk\, f_{xy}(a,b)] + \cdots$ (2M) where $h = x-a$ & $k = y-b$ $f = -10,$ • $f_x = f_{xx} = -4,\quad f_{xxx} = f_{xyy} = \quad f_{yyy} = f_{yy} = 0$ (3M) $f_y = 4$ and $f_{xy} = f_{xxy} = 2$ $x^2y + 3y^2 - 2 = -10 - 4(x-1) + 4(y+2) - 2(x-1)^2$ $+ 2(x-1)(y+2) + (x-1)^2(y+2) + \ldots\ldots$ (3M)
12.	**Find the extreme values of the function** $f(x,y) = x^3 + y^3 - 3x - 12y + 20$ **(8M) (NOV/DEC-2012,2014)** BTL2 **Answer : Page. 2.83 - G.Balaji** • The stationary points are $(1,2), (1,-2), (-1,2), (-1,-2)$ (2M) • Saddle points are (1,-2) and (-1,2) (2M)

	• Minimum point (1,2) and Minimum Value=2 (2M) • Maximum point (-1,-2) and Maximum Value=38 (2M)
13.	**Find the extreme values of the function** $f(x,y)=x^3+y^3-12x-3y+20$ **(8M) (APR/MAY-2013)** BTL5 **Answer : Page. 2.92 - G.Balaji** • The stationary points are $(2,1),(2,-1),(-2,-1),(-2,1)$ (2M) • Saddle points are (2,-1) and (-2,1) (2M) • Minimum point (2,1) and Minimum Value=2 (2M) • Maximum point (-2,-1) and Maximum Value=38 (2M)
14.	**Test for the maxima and minima of the function** $f(x,y)=x^3y^2(1-x-y)$ **. (8M) (NOV/DEC-2014)** BTL2 **Answer : Page. 2.84 -G.Balaji** • The stationary points are $(0,0),(\frac{1}{2},\frac{1}{3}),(0,1),(0,\frac{2}{3}),(\frac{3}{4},0),(1,0)$ (2M) • At $(0,0),(0,1),(0,\frac{2}{3}),(\frac{3}{4},0),(1,0)$ the test is inconclusive (4M) • Maximum point $(\frac{1}{2},\frac{1}{3})$ and Maximum Value = $\frac{1}{432}$ (2 M)
15.	**A rectangular box open at top is to have a volume of 32cc. Find the dimensions of the box that requires the least material for its construction (8M) (APR/MAY-2016)** BTL2 **Answer : Page. 2.100 -G.Balaji** • Auxiliary function $F(x,y,z,\lambda)=(xy+2yz+2zx)+\lambda(xyz-32)$ (2 M) $F_x=0 \Rightarrow \frac{1}{z}+\frac{2}{y}=-\lambda$ • $F_y=0 \Rightarrow \frac{1}{z}+\frac{2}{x}=-\lambda$ (3 M) $F_z=0 \Rightarrow \frac{2}{y}+\frac{2}{x}=-\lambda$ • Dimensions are 4,4,2 (3 M)
16.	**Find the dimensions of the rectangular box without top of maximum capacity whose surface area is 108 sq.cm (8M) (NOV/DEC-2017-R-17)** BTL2 **Answer : Page. 2.100 -G.Balaji** Auxiliary function $F(x,y,z,\lambda)=(xyz)+\lambda(xy+2yz+2zx-108)$ (2 M)

	$F_x=0\Rightarrow \frac{1}{z}+\frac{2}{y}=-\frac{1}{\lambda}$ • $F_y=0\Rightarrow \frac{1}{z}+\frac{2}{x}=-\frac{1}{\lambda}$ (3 M) $F_z=0\Rightarrow \frac{2}{y}+\frac{2}{x}=-\frac{1}{\lambda}$ • Dimensions are 6,6,3 (3 M)
17.	**Find the dimensions of the rectangular box without top of maximum capacity whose surface area is 432 sq.cm (8M) (APR/MAY-2014)(NOV/DEC-2013)** BTL2 **Answer : Page. 2.105-G.Balaji** • Auxiliary function $F(x,y,z,\lambda)=(xyz)+\lambda(xy+2yz+2zx-432)$ (2 M) $F_x=0\Rightarrow \frac{1}{z}+\frac{2}{y}=-\frac{1}{\lambda}$ • $F_y=0\Rightarrow \frac{1}{z}+\frac{2}{x}=-\frac{1}{\lambda}$ (3 M) $F_z=0\Rightarrow \frac{2}{y}+\frac{2}{x}=-\frac{1}{\lambda}$ • Dimensions are 12,12,6 (3 M)
18.	**Obtain the volume of the largest rectangular parallelepiped that can be inscribed in the ellipsoid** $\left(x^2/a^2\right)+\left(y^2/b^2\right)+\left(z^2/c^2\right)=1$ **(8M)(APR/MAY-2015) (NOV/DEC-2015)** BTL2 **Answer : Page. 2.113-G.Balaji** • Auxiliary function $F(x,y,z,\lambda)=(8xyz)+\lambda\left(\left(x^2/a^2\right)+\left(y^2/b^2\right)+\left(z^2/c^2\right)-1\right)$ (2 M) $F_x=0\Rightarrow \frac{x^2}{a^2}=-\frac{4xyz}{\lambda}$ • $F_y=0\Rightarrow \frac{y^2}{b^2}=-\frac{4xyz}{\lambda}$ (3 M) $F_z=0\Rightarrow \frac{z^2}{c^2}=-\frac{4xyz}{\lambda}$ • Extreme point is $(\frac{a}{\sqrt{3}},\frac{b}{\sqrt{3}},\frac{c}{\sqrt{3}})$ and Maximum Volume= $\frac{8abc}{\sqrt{3}}$ (3 M)

UNIT-III INTEGRAL CALCULUS

Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

Part-A

1. **Evaluate :** $\int \frac{1}{\sin^2 x \cos^2 x}\, dx$ BTL5

$I = \int \frac{\sin^2 + \cos^2 x}{\sin^2 x \cos^2 x}\, dx$

$= \int \left(\frac{\sin^2 x}{\sin^2 x \cos^2 x} + \frac{\cos^2 x}{\sin^2 x \cos^2 x}\right) dx$

$= \int (\sec^2 x + \operatorname{cosec}^2 x) dx$

$= \tan x - \cot x + c$

2. **Evaluate** $\int \sin 3x \cos 2\, x\, dx$ BTL5

$I = \int \frac{(\sin 5x + \sin x)}{2}\, dx$

$= \frac{1}{2} \int \sin 5x\, dx + \int \sin x dx$

$= \frac{1}{2}\left[\frac{\cos 5x}{5} + \cos x\right]$ $\quad \sin A \cos B = \frac{\sin(A+B)+\sin(A-B)}{2}$

3. **Evaluate** $\int \cot x\, dx$ BTL5

$I = \int \frac{\cos x}{\sin x}\, dx$

$= \int \frac{dt}{t}\, dx$ Put $t = \sin x$

$= \log t$ $\quad dt = \cos x\, dx$

$= \log(\sin x)$

4. **Evaluate** $\int_0^{\frac{1}{\sqrt{2}}} \frac{x^2\, dx}{\sqrt{1-x^2}}$ BTL5

Put $x = \sin\theta$ $\quad dx = \cos\theta\, d\theta$

When $x = \frac{1}{\sqrt{2}}$ $\quad \theta = \frac{\pi}{4}$

$\int_0^{\frac{1}{\sqrt{2}}} \frac{x^2\, dx}{\sqrt{1-x^2}} = \int_0^{\frac{\pi}{4}} \frac{\sin^2\theta \cos\theta\, d\theta}{\sqrt{1-\sin^2\theta}}$

$$= \int_0^{\frac{\pi}{4}} \frac{sin^2\theta\ \cos\theta\ d\theta}{\cos\theta}$$

$$= \int_0^{\frac{\pi}{4}} sin^2\theta\ \cos\theta\ d\theta$$

$$= \frac{1}{2}\left(\theta - \frac{sin2\theta}{2}\right)_0^{\frac{\pi}{4}}$$

$$= \frac{1}{2}\left(\frac{\pi-2}{4}\right) = \frac{\pi-2}{8}$$

5. **Evaluate** $\int \frac{\boldsymbol{x^3 dx}}{\boldsymbol{x^4\,(x^4+1)}}$ BTL5

$\int \frac{\frac{1}{4}dt}{t\,(t+1)}$ Put $x^4 = t$

$= \frac{1}{4}\int \frac{dt}{t\,(t+1)}$ $4x^3 = \frac{dt}{dx}$

$= \frac{1}{4}\int \frac{(t+1-t)dt}{t\,(t+1)}$ $x^3 dx = \frac{1}{4}dt$

$= \frac{1}{4}\int \left(\frac{t+1}{t\,(t+1)} - \frac{t+1}{t\,(t+1)}\right)dt$

$= \frac{1}{4}\int \left(\frac{1}{t} - \frac{1}{t+1}\right)dt$

$= \frac{1}{4}(\log t - \log(t+1))$

$= \frac{1}{4}\left(\log\left(\frac{x^4}{x^4+1}\right)\right)$

6. **Evaluate** $\int \frac{\boldsymbol{dx}}{\boldsymbol{12+13\,cosx}}$ BTL5

Put $t = \tan\frac{x}{2}$, $dx = \frac{2dt}{1+t^2}$, $cosx\ \frac{1-t^2}{1+t^2}$

$= \int \frac{\frac{2dt}{1+t^2}}{12+13\left(\frac{1-t^2}{1+t^2}\right)}$

$= \int \frac{2dt}{12+12t^2+13-13t^2}$

$= \int \frac{2dt}{25-t^2}$ $\therefore \frac{dx}{a^2-x^2} = \frac{1}{2a}\log(\frac{a+x}{a-x}) + c$

$= \frac{2}{2x5}\log\left(\frac{5+t}{5-t}\right) + C$

$= \frac{1}{5}\log\left(\frac{5+\tan\frac{x}{2}}{5-\tan\frac{x}{2}}\right) + C$

7.	**Evaluate** $\int_0^{\frac{1}{\sqrt{2}}} \frac{x^2\,dx}{\sqrt{1-x^2}}$ BTL5 Put $x = sin\theta$ $dx = \cos\theta\, d\theta$ When $x = \frac{1}{\sqrt{2}}$ $\theta = \frac{\pi}{4}$ $\int_0^{\frac{1}{\sqrt{2}}} \frac{x^2\,dx}{\sqrt{1-x^2}} = \int_0^{\frac{\pi}{4}} \frac{sin^2\theta\,\cos\theta\,d\theta}{\sqrt{1-sin^2\theta}}$ $= \int_0^{\frac{\pi}{4}} \frac{sin^2\theta\,\cos\theta\,d\theta}{\cos\theta}$ $= \int_0^{\frac{\pi}{4}} sin^2\theta\,\cos\theta\,d\theta$ $= \frac{1}{2}\left(\theta - \frac{sin2\theta}{2}\right)_0^{\frac{\pi}{4}}$ $= \frac{1}{2}\left(\frac{\pi-2}{4}\right) = \frac{\pi-2}{8}$
8.	**Evaluate** $\int \frac{dx}{\sqrt{a^2-x^2}}$ BTL5 Put $x = a\ sin\theta,\ \ dx = a\,cos\theta d\theta$ $\frac{x}{a} = sin\theta$ $\theta = sin^{-1}\left(\frac{x}{a}\right)$ $\int \frac{dx}{\sqrt{a^2-x^2}} = \int \frac{a\,cos\theta d\theta}{a^2-a^2sin^2\theta}$ $= \int \frac{a\,cos\theta d\theta}{\sqrt{1-sin^2\theta}}$ $= \int \frac{cos\theta d\theta}{cos\theta}$ $= \int d\theta = \theta = sin^{-1}\left(\frac{x}{a}\right)$ +c
9.	**Evaluate** $\int \frac{dx}{x^2+a^2}$ BTL5 Put $x = atan\theta,\ \ dx = a\,sec^2\theta d\theta$ $\int \frac{dx}{x^2+a^2} = \int \frac{asec^2\theta\,d\theta}{a^2tan^2\theta+a^2}$ $\frac{x}{a} = tan\theta$ $= \int \frac{asec^2\theta\,d\theta}{a^2(1+tan^2\theta)}$ $tan^{-1}\left(\frac{x}{a}\right) = \theta$ $= \int \frac{asec^2\theta\,d\theta}{a^2sec^2\theta)}$

$= \quad \frac{1}{a} \int d\theta$

$= \quad \frac{1}{a} \int tan^{-1}\left(\frac{x}{a}\right) x\ C$

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10. **Evaluate** $\int \frac{x^3 dx}{x^4\,(x^4+1)}$ BTL5

$\int \frac{\frac{1}{4}dt}{t\,(t+1)}$ Put $x^4 = t$

$= \frac{1}{4}\int \frac{dt}{t\,(t+1)}$ $\quad 4x^3 = \frac{dt}{dx}$

$= \frac{1}{4}\int \frac{(t+1-t)dt}{t\,(t+1)}$ $\quad x^3 dx = \frac{1}{4}dt$

$= \frac{1}{4}\int \left(\frac{t+1}{t\,(t+1)} - \frac{t+1}{t\,(t+1)}\right) dt$

$= \frac{1}{4}\int \left(\frac{1}{t} - \frac{1}{t+1}\right) dt$

$= \frac{1}{4}(\log t - \log(t+1))$

$= \frac{1}{4}\left(\log\left(\frac{t}{t+1}\right)\right)$

$= \frac{1}{4}\left(\log\left(\frac{x^4}{x^4+1}\right)\right)$

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11. **Evaluate** $\frac{\mathbf{5\ cosx}}{\mathbf{2cosx+sinx}}$ BTL5

$5\ cosx = A\,(2cosx + sinx) + B\,(-2sinx + cosx)$

Equating coefficient $sinx$ & $cosx$ we

0 = A – 2B -- (1M) 2A + B = 5 x 2

5 = 2A +B --(2M) A – 2B = 0

2 x 2 + B = 5 4A + 2B = 10

B = 5-4 = 1 A – 2B = 0

B = 1 **A = 2**

$\therefore \quad \int \frac{A\,(2cosx+sinx) + B\,(2-sinx+cosx)}{2cosx+sinx} dx$

$= 2\int \frac{(2cosx+sinx)}{2cosx+sinx} dx + 1\int \left(\frac{-2sinx+cosx}{2cosx+sinx}\right) dx$

$= 2\int dx +$ put $t = 2cosx + sinx$

	$= \frac{1}{2}x + \frac{1}{2}\int \frac{dt}{t}$ $dt = -2sinx + cosx\,dx$ $= 2x + \log t$ $= 2x + \log(2cosx + sinx) + C$
12.	**Evaluate $\int xe^x\,dx$** BTL5 $\int xe^x\,dx = uv - \int vdu$ $u = x$ $\int dv = \int e^x dx$ $du = dx$ $v = e^x$ $= xe^x - \int e^x dx$ $= xe^x - e^x ec$ $= e^x(x-1) + C$
13.	**Evaluate** $\int \frac{x\,sin^{-1}x}{\sqrt{1-x^2}}dx$ BTL5 $u = sin^{-1}x$ $\int dv = \int \frac{x}{\sqrt{1-x^2}}dx$ $du = \frac{x}{\sqrt{1-x^2}}dx$ Put $u = 1 - x^2$ $v = \frac{\frac{du}{2}}{\sqrt{u}} = \sqrt{1-x^2}$ $du = -2x\,dx$ $\int \frac{x\,sin^{-1}x}{\sqrt{1-x^2}}dx = uv - \int vdu$ $= (sin^{-1}x)(-\sqrt{1-x^2}) - \int -(\sqrt{1-x^2})$ x $\frac{1}{\sqrt{1-x^2}}dx$ $= -(sin^{-1}x)\sqrt{1-x^2} + \int dx$ $= -\sqrt{1-x^2}\,sin^{-1}x + x + C$
14.	**Evaluate** $\int xsin^{-1}x\,dx$ BTL5 $u = tan^{-1}x$ $\int dv = \int xdx$ $du = \frac{1}{1+x^2}$, $v = \frac{x^2}{2}$ $\int udv = uv - \int vdu$ $= tan^{-1}x\left(\frac{x^2}{2}\right) - \int \frac{x^2}{2}\ \frac{1}{1+x^2}dx$ $= \frac{x^2}{2}tan^{-1}x - \frac{1}{2}\int \frac{x^2}{1+x^2}dx$

	$= \frac{x^2}{2}\tan^{-1}x - \frac{1}{2}\int \frac{x^2+1-1}{1+x^2}\,dx$ $= \frac{x^2}{2}\tan^{-1}x - \frac{1}{2}\int \left(\frac{1}{1+x^2}\right)dx$ $= \frac{x^2}{2}\tan^{-1}x - \frac{1}{2}\int (x - \tan^{-1}x) + C$
15.	**Evaluate** $\int x\,sin2x\;dx$ BTL5 $u = x \quad \int dv = \int x\,sin2x\;dx$ $du = dx \quad v = \frac{cos2x}{2}$ $\int vdu = \quad uv - \int vdu$ $= \quad x - \left(\frac{cos2x}{2}\right) - \int \frac{-cos2x}{2}\,dx$ $= \quad -x\frac{cos2x}{2} + \frac{sin2x}{4} + C$
16.	**Prove that** $\int_a^b f(x)dx = -\int_b^a f(x)dx$ BTL1 **L.H.S.** $\int_a^b f(x)dx = [F(x)]_a^b$ $= F(b) - F(a)$ -- (1M) **R.H.S.** $\int_b^a f(x)dx = [F(x)]_b^a$ From (1) & (2) We get $= -(F(a) - F(b))$ $= F(b) - F(a)$ -- (2M) $\therefore \int_a^b f(x)dx = -\int_b^a f(x)dx$
17.	**Prove that** $\int_a^b f(x)dx = \int_b^a f(y)dy$ BTL1 **L.H.S.** $\int_a^b f(x)dx = [F(x)]_a^b$ $= F(b) - F(a)$ -- (1M) **R.H.S.** $\int_b^a f(y)dy = [F(y)]_b^a$ **From (1) & (2) We get** $\therefore \int_a^b f(y)dx = \int_b^a f(y)dy$
18.	**Evaluate** $\int_0^{\frac{\pi}{2}} \frac{sin^3x}{sin^3x + cos^3x}\,dx$ BTL5 Let I $= \int_0^{\frac{\pi}{2}} \frac{sin^3x}{sin^3x + cos^3x}\,dx$-- (1M)

Than I = $\int_0^{\frac{\pi}{2}} \frac{sin^3\left(\frac{\pi}{2}-x\right)}{sin^3\left(\frac{\pi}{2}-x\right)+cos^3\left(\frac{\pi}{2}-x\right)}\, dx$ by property 4

$\int_0^a f(x)dx = \int_0^a f(a-x)dx$

I = $\int_0^{\frac{\pi}{2}} \frac{cos^3 x}{cos^3 x + sin^3 x}$ -- (2M)

Adding (1) & (2) we get

2I = $\int_0^{\frac{\pi}{2}} \frac{(sin^3 x + cos^3)}{sin^3 x + cos^3 x}\, dx$

2I = $\int_0^{\frac{\pi}{2}} dx$

I = $\frac{\pi}{4}$

19. **Evaluate** $\int_0^{\frac{\pi}{2}} \frac{dx}{1+\sqrt{cotx}}$ BTL5

$\int_0^{\frac{\pi}{2}} \frac{dD}{1+\sqrt{\frac{cosx}{sinx}}}$

I = $\int_0^{\frac{\pi}{2}} \frac{\sqrt{sinx}}{\sqrt{sinx}+\sqrt{cosx}}\, dx$ -- (1M)

by property (4)

I = $\int_0^{\frac{\pi}{2}} \frac{\sqrt{\sin(\frac{\pi}{2}-x)}}{\sqrt{\sin(\frac{\pi}{2}-x)}+\sqrt{\cos(\frac{\pi}{2}-x)}}\, dx$ $\quad sin\left(\frac{\pi}{2}-x\right) = cosx$

I = $\int_0^{\frac{\pi}{2}} \frac{\sqrt{\cos x\ dx}}{\sqrt{sinx}+\sqrt{cosx}}\, dx$ -- (2M)

Adding (1) & (2)

2I = $\int_0^{\frac{\pi}{2}} \frac{(\sqrt{sinx}+\sqrt{cosx})}{\sqrt{sinx}+\sqrt{cosx}}\, dx$

2I = $\int_0^{\frac{\pi}{2}} dx$

I = $\frac{\pi}{4}$

20. **Evaluate** $\int_0^{\frac{\pi}{2}} \log\ (tanx)\ dx$ BTL5

I = $\int_0^{\frac{\pi}{2}} \log\ (tanx)\ dx$ -- (1M)

$$= \int_0^{\frac{\pi}{2}} \log\left(\tan(\tfrac{\pi}{2} - x)\right) dx \qquad \tan(\tfrac{\pi}{2} - x) = cotx$$

$$I = \int_0^{\frac{\pi}{2}} \log\ (costx)\ dx \text{-- (2M)} \quad \text{logmn} = \text{logm} + \text{logn}$$

Adding (1) & (2) we get

$$2I = \int_0^{\frac{\pi}{2}} (log\ tan\ x + \ log\ cotx)\ dx$$

$$2I = \int_0^{\frac{\pi}{2}} log\ tan\ x\ .\ cotx\ \ dx$$

$$2I = \int_0^{\frac{\pi}{2}} \log(\tan x\ \frac{1}{tanx})\ dx$$

$$2I = \int_0^{\frac{\pi}{2}} log1dx \qquad (\therefore\ log^1 = 0)$$

$$I = 0$$

21. **Evaluate** $\int_t^2 \frac{1}{\sqrt{x-1}} dx$ BTL5

$$\int_s^2 \frac{dx}{\sqrt{x-1}} = \lim_{t\to 2^-} \int_t^2 \frac{dx}{\sqrt{x-1}}$$

$$= \lim_{t\to 2^-} \left[2\sqrt{x-1}\right]_t^2$$

$$= \lim_{t\to 2^-} \left[2\sqrt{1} - \ 2\ \sqrt{t-1}\right]$$

$$= \lim_{t\to 2^-} 2\sqrt{1} - \ 2\ \sqrt{1}$$

$$= 0$$

22. **Verify** $\int_0^{\frac{\pi}{2}}$ **sec** $\boldsymbol{x\ dx}$ **is convergent or divergent** BTL2

$$\int_0^{\frac{\pi}{2}} \sec x\ dx = \lim_{t-\frac{-\pi}{2}} \int_0^t \sec x\ dx$$

$$= \lim_{t-\frac{-\pi}{2}} (\log\ (\sec x + tanx)\ {}_{\partial}^{6}$$

$$= \lim_{t-\frac{-\pi}{2}} (\log\ (\sec t + tant)\ - log1)$$

$$= \lim_{t-\frac{-\pi}{2}} (\sec\frac{\pi}{2} + \tan\frac{\pi}{2})$$

$= \infty$ It is divergent

23. **Evaluate** $\int_0^2 \frac{dx}{\sqrt{1-x^2}}$ **is convergent or divergent** BTL5

	$\int_0^{\prime} \frac{dx}{\sqrt{1-x^2}} = \lim_{t\to 1^-} \int_0^t \frac{dx}{\sqrt{1-x^2}}$ $= \lim_{t\to 1^-} [sin_x^{-1}]_0^t$ $= \lim_{t\to 1^-} (sin^{-1}t - sin_{(0)}^{-1})$ $= sin_{(0)}^{-1} - 0 = \frac{\pi}{2}$ It is convergent
24.	**Show that $\int_a^{\infty} e^{-x^2} dx$ is convergent** BTL3 $\int_a^{\infty} e^{-x^2} dx = \int_{\partial}^{1} e^{-x^2} dx + \int_J^{\propto} e^{-x^2} dx$ Since $\int_0^1 e^{-x^2} dx$ is ordinary definite integral. Hence it is convergent $\int_a^{\infty} e^{-x^2} dx$ is the improper integral we have $x \geq 1,\ x^2 > x, -x^2 \leq x$ there the $e^{-x^2} \leq e^{-x}$ Consider ${}_a^{\infty}\int e^{-x^2} dx$ is convergent
25.	**Find ${}_0^3\int \frac{dx}{x-1}$ is convergent** BTL1 $= {}_0^3\int \frac{dx}{x-1}$ $\int \frac{dx}{x} = \log x$ $= (\log(x-1))_0^3$ $= log2 - \log(-1)$ $= log2$ ${}_0^3\int \frac{dx}{x-1}$ is not convergent , It is divergent
	PART * B
1.	**Evaluate $\int \frac{\sec^2 x}{(\sec x + \tan x)^3} dx$ (8M) (NOV/DEC2017)** BTL5 **Answer : Page. 3.36 -M.B.K. MOORTHY** Put $t = secx + tanx$ (1M) $\frac{dt}{dx} = secxtanx + secx^2$ $\frac{1}{t} = secx - tanx$-- (2M) $= secx(secx + tanx)$ $= 2secx = t + \frac{1}{t}$ $dt = secx\ (t)dx$ (2M)

$$= \quad secx = \frac{1}{2}\left(t+\frac{1}{t}\right) \qquad \frac{dt}{t} = secxdx$$

$$\therefore \int \frac{secx - secxdx}{(secx+tanx)^3} = \int \frac{\frac{1}{2}\left(t+\frac{1}{t}\right)\frac{dt}{t}}{t^3}$$ (2M)

$$= \frac{1}{2}\int \frac{\left(1+\frac{1}{t^2}\right)dt}{t^3}$$

$$= \frac{1}{2}\int t^{-3}\left(1+\frac{1}{t^2}\right)dt$$ (2M)

$$= \frac{1}{2}\int (t^{-3}+t^{-5})\,dt$$

$$= \frac{1}{2}\left(\frac{t^{-3+1}}{-3+1}+\frac{t^{-5+1}}{-5+1}\right)$$

$$= \frac{1}{2}\left(\frac{t^{-2}}{-2}+\frac{t^{-4}}{-4}\right)$$

$$= \frac{1}{2}\left(\frac{-1}{2t^2}+\frac{-1}{4t^4}\right)$$ (2M)

$$= -\frac{1}{2}\left[\frac{1}{2(secx+tanx)^2}+\frac{1}{4(secx+tanx)^4}\right]$$

2.

Evaluate $\int \frac{x^3\,dx}{(x^2+1)^3}$ **(8M) (NOV/DEC2017)** BTL5

Answer : Page. 3.59 -M.B.K. MOORTHY (2M)

$$= \int \frac{x^2\;x\;dx}{(x^2+1)^3} \qquad \text{Put } t = x^2+1$$

$$= \int \frac{(t-1)\frac{dt}{2}}{t^3} \qquad t-1 = x^2$$

$$= \frac{1}{2}\int \frac{(t-1)}{t^3}dt \qquad \frac{dt}{dx} = 2x$$

$$= \frac{1}{2}\int (t-1)t^{-3}\,dt \qquad dt = 2x\,dx$$

$$= \frac{1}{2}\int (t^{-2}-t^{-3})dt \qquad \frac{dt}{2} = xdx$$

$$= \frac{1}{2}\left(\frac{t^{-2+1}}{-2+1}+\frac{t^{-3+1}}{-3+1}\right)$$ (2M)

$$= \frac{1}{2}\left(\frac{t^{-1}}{-1}+\frac{t^{-2}}{-2}\right)$$

$$= \frac{1}{2}\left(\frac{-1}{t}+\frac{-1}{2t^2}\right)$$ (2M)

$$= \frac{1}{2}\left[\frac{1}{x^2+1}+\frac{1}{2(x^2+1)^2}\right]$$ (2M)

3.	**Evaluate** $\int_0^{\frac{1}{\sqrt{2}}} \frac{x^2\,dx}{\sqrt{1-x^2}}$ **(8M) (NOV/DEC2017)** BTL5 **Answer : Page. 3.110 -M.B.K. MOORTHY** Put $x = sin\theta$ $dx = \cos\theta\, d\theta$ (2M) When $x = \frac{1}{\sqrt{2}}$ $\theta = \frac{\pi}{4}$ $\int_0^{\frac{1}{\sqrt{2}}} \frac{x^2\,dx}{\sqrt{1-x^2}} = \int_0^{\frac{\pi}{4}} \frac{sin^2\theta\ \cos\theta\, d\theta}{\sqrt{1-sin^2\theta}}$ (2M) $= \int_0^{\frac{\pi}{4}} \frac{sin^2\theta\ \cos\theta\, d\theta}{\cos\theta}$ $= \int_0^{\frac{\pi}{4}} sin^2\theta\ \cos\theta\, d\theta$ (2M) $= \frac{1}{2}\left(\theta - \frac{sin2\theta}{2}\right)_0^{\frac{\pi}{4}}$ $= \frac{1}{2}\left(\frac{\pi}{4} - \frac{1}{2}\right)$ (2M) $= \frac{1}{2}\left(\frac{\pi-2}{4}\right) = \frac{\pi-2}{8}$
4.	**Evaluate i)** $\int \frac{dx}{x^2+a^2}$ **ii)** $\int \frac{dx}{\sqrt{a^2-x^2}}$ **(4+4M) (NOV/DEC2017, 2018)** BTL5 **Answer : Page. 3.105 -M.B.K. MOORTHY** Put $x = a\ \ tan\theta,\ \ dx = a\, sec^2\theta d\theta$ (2M) $\int \frac{dx}{x^2+a^2} = \int \frac{asec^2\theta\, d\theta}{a^2tan^2\theta+a^2}$ $\frac{x}{a} = tan\theta$ $= \int \frac{asec^2\theta\ d\theta}{a^2(1+tan^2\theta)}$ $tan^{-1}\left(\frac{x}{a}\right) = \theta$ $= \int \frac{asec^2\theta\, d\theta}{a^2sec^2\theta)}$ $= \frac{1}{a}\int d\theta$ (2M) $= \frac{1}{a}(\theta)$ $= \frac{1}{a}\int tan^{-1}\left(\frac{x}{a}\right) x\ C$ **ii)** Put $x = a\ \ sin\theta,\ \ dx = a\, cos\theta d\theta$ $\frac{x}{a} = sin\theta$ $\theta = sin^{-1}\left(\frac{x}{a}\right)$ (2M)

$$\int \frac{dx}{\sqrt{a^2-x^2}} = \int \frac{a\cos\theta d\theta}{a^2-a^2\sin^2\theta}$$

$$= \int \frac{a\cos\theta d\theta}{\sqrt{1-\sin^2\theta}}$$

$$= \int \frac{\cos\theta d\theta}{\cos\theta} \qquad \text{(2M)}$$

$$= \int d\theta = \theta = \sin^{-1}\left(\frac{x}{a}\right) + c$$

5. **Evaluate** $\int \frac{x^3 dx}{x^4(x^4+1)}$ **(8M)(NOV/DEC2017)** BTL5

Answer: Page. 3.110 -Dr.M. Chandrasekar

$$\int \frac{\frac{1}{4}dt}{t(t+1)} \qquad \text{Put } x^4 = t \qquad \text{(2M)}$$

$$= \frac{1}{4}\int \frac{dt}{t(t+1)} \qquad 4x^3 = \frac{dt}{dx}$$

$$= \frac{1}{4}\int \frac{(t+1-t)dt}{t(t+1)} \qquad x^3 dx = \frac{1}{4}dt \qquad \text{(2M)}$$

$$= \frac{1}{4}\int \left(\frac{t+1}{t(t+1)} - \frac{t+1}{t(t+1)}\right) dt$$

$$= \frac{1}{4}\int \left(\frac{1}{t} - \frac{1}{t+1}\right) dt \qquad \text{(2M)}$$

$$= \frac{1}{4}(\log t - \log(t+1))$$

$$= \frac{1}{4}\left(\log\left(\frac{t}{t+1}\right)\right) \qquad \text{(2M)}$$

$$= \frac{1}{4}\left(\log\left(\frac{x^4}{x^4+1}\right)\right)$$

6. **Evaluate** $\int \frac{2x+3}{x^2+5x+7}$ **(8M) (NOV/DEC2017)** BTL5

Answer: Page. 3.157 -Dr.M. Chandrasekar

Let $2x+3 = A(2x+5) + B$ (2M)

Equating Coefficients of x

$2 = 2A \Rightarrow (A = 1)$

Equating constant term, $3 = 5A + B$

$3 = 5 + B$

$-2 = B$

$\therefore \int \frac{2x+3}{x^2+5x+7} dx$ (2M)

$= \int \frac{A\,(2x+5)+13}{x^2+5x+7}$

$= \int \frac{1\,(2x+5)-2}{x^2+5x+7}$ Split into two firm

$= \int \frac{2x+5}{x^2+5x+7}\,dx - \int \frac{2}{x^2+5x+7}\,dx$ (2M)

Put $t = x^2+5x+7$ $\frac{dx}{x^2+a^2} \Rightarrow$ (2M)

$dt = 2x+5\,dx$ $\frac{dx}{\left(x+\frac{5}{2}\right)^2-\left(\frac{5}{2}\right)+7}$

$\int \frac{dt}{t} = -2\int \frac{dx}{x^2+5x+7}$ $\frac{dx}{\left(x+\frac{5}{2}\right)^2+\frac{3}{4}}$

$= -2\int \frac{dx}{\left(x+\frac{5}{2}\right)^2-\left(\frac{\sqrt{3}}{2}\right)^2} \Rightarrow \frac{dx}{\left(x+\frac{5}{2}\right)^2-\left(\frac{\sqrt{3}}{2}\right)^2}$

$logt = -2x\,\frac{2}{\sqrt{3}}tan^{-1}\left(\frac{x+\frac{5}{2}}{\frac{\sqrt{3}}{2}}\right)+C$ (2M)

$\log(x^2+5x+7)-\frac{4}{\sqrt{3}}\,tan^{-1}\left(\frac{2x+5}{\sqrt{3}}\right)+C$

7\. **Evaluate** $\int \frac{2x+3}{x^2-2x-35}\,dx$ **(8M) (NOV/DEC2017)** BTL5

Answer: Page. 3.159 -Dr.M. Chandrasekar

Let $5x+1 = A\,(2x-2)+B$ (2M)

Equating Coefficients of x

$5 = 2A \Rightarrow \left(A = \frac{5}{2}\right)$ (2M)

Equating constant term, $-2A+B = 1$

$B = 6$

$= \int \frac{5x+1}{x^2-2x-35}\,dx$ (2M)

$= \int \frac{A\,(2x-2)+B}{x^2-2x-35}\,dx$

$= \int \frac{5}{2}\,\frac{(2x-2)+6}{x^2-2x-35}\,dx$

$= \int \frac{\frac{5}{2}(2x-2)}{x^2-2x-35}\,dx + \int \frac{6}{x^2-2x-35}\,dx$

Put $t = x^2-2x-35$ (2M)

$dt \quad = \quad (2x-2)dx$

$= \quad \int \frac{5}{2}\frac{dt}{t} + 6\int \frac{dx}{x^2-2x-35}$

$= \quad \int \frac{5}{2}\frac{dt}{t} + 6\int \frac{dx}{(x-1)^2-36} \qquad \therefore \int \frac{dx}{x^2-a^2} = \frac{1}{2a}\log\left(\frac{(x-a)}{x+a}\right) + C$

$= \quad \frac{5}{2}\log t + 6\int \frac{dx}{(x-1)^2-6^2}$

$= \quad \frac{5}{2}\log\left(x^2+2x-35\right) + 6\,x\,\frac{1}{2x6}\log\left(\frac{x-1-6}{x-1+6}\right) + C$

$= \quad \frac{5}{2}\log\left(x^2+2x-35\right) + \frac{1}{2}\log\left(\frac{x-7}{x+5}\right) + C$

8.

Evaluate $\int \frac{2x+2}{\sqrt{x^2+4x+7}}$ **(8M) (NOV/DEC2017)** BTL5

Answer: Page. 3.158 -Dr.M. Chandrasekar

Let $2x+2 = A(2x+4) + B$ (2M)

Equating Coefficients of x

$2A = 2(A = 1)$

Equating constant term, $4A + B = 2$

$4 + B = 2$

$B = -2$

$\therefore \quad \int \frac{A(2x+4)+B}{\sqrt{x^2+4x+7}}dx$ (2M)

$= \quad \int \frac{1(2x+4)-2}{\sqrt{x^2+4x+7}}dx$

$= \quad \int \frac{2x+4\,dx}{\sqrt{x^2+4x+7}} - \int \frac{2}{\sqrt{x^2+4x+7}}dx$

Put $t^2 \quad = \quad x^2+4x+7 \qquad dx \quad = \quad (2x+4)dx$ (2M)

$= \quad \int \frac{dt}{\sqrt{t}} - 2\int \frac{dx}{\sqrt{x^2+4x+7}} \quad = \quad 2\sqrt{t} - 2\int \frac{dx}{\sqrt{x^2+4x+7}}$

$= \quad 2\sqrt{x^2+4x+7} - 2\log\left[(x+2) + \sqrt{(x+2)^2+3}\right]$

Integration Type: $\int \frac{a\,sinx+cosx}{(sinx+cosx)}dx$ (2M)

Method of Integration

Take number $= A\,(Demoniator) + B\,\frac{d}{dx}(Demoniator)$

9.

Evaluate $\int \frac{dx}{1+\tan x}$ **(8M) (NOV/DEC2017)** BTL5

Answer: Page. 3.63-Dr.M. Chandrasekar

$$\int \frac{dx}{1+\frac{sinx}{cosx}} \Rightarrow \int \frac{cosx}{sinx+cosx}\,dx \qquad (2M)$$

Let $cosx = A\,(sinx + cosx) + B\,(cosx - sinx)$

Equating the coefficients of $sinx$ & $cosx$

$$A - B = 0$$

$$A + B = 1$$

$\boldsymbol{A}$ = ½ , B = ½ (2M)

$\therefore \quad \int \frac{A\,(sinx+cosx)+B\,(cosx-sinx)}{sinx+cosx}\,dx$

$= \int \frac{\frac{1}{2}(sinx+cosx)+\frac{1}{2}(cosx-sinx)}{sinx+cosx}\,dx$ (2M)

$= \frac{1}{2}\int dx\,\frac{1}{2}\int \frac{cosx-sinx}{sinx+cosx}\,dx$

$= \frac{1}{2}\,x + \frac{1}{2}\int \frac{dt}{t}$ (2M)

$= \frac{1}{2}\,x + \frac{1}{2}\log t \Rightarrow \frac{1}{2}x + \frac{1}{2}\log(sinx + cosx)$

Put $t = sinx + cosx$

$dt = cosx - sinx\;dx$

10.

Evaluate $\int \frac{x\sin^{-1}x}{\sqrt{1-x^2}}\,dx$ **(8M) (NOV/DEC2017)** BTL5

Answer: Page. 3.124 -Dr.M. Chandrasekar

$u = sin^{-1}x \quad \int dv = \int \frac{x}{\sqrt{1-x^2}}\,dx$ (2M)

$du = \frac{x}{\sqrt{1-x^2}}\,dx$ Put $u = 1 - x^2$

$v = \frac{\frac{du}{2}}{\sqrt{u}} = \sqrt{1-x^2}$ $du = -2x\,dx$

$\int \frac{x\,sin^{-1}x}{\sqrt{1-x^2}}\,dx = uv - \int v\,du$ (2M)

$= (sin^{-1}x)\left(-\sqrt{1-x^2}\right) - \int -\,(\sqrt{1-x^2})$ x

$\frac{1}{\sqrt{1-x^2}}\,dx$ (2M)

$$= \quad -(\sin^{-1}x)\sqrt{1-x^2} + \int dx$$

$$= \quad -\sqrt{1-x^2}\,\sin^{-1}x + x + C \qquad \text{(2M)}$$

11.

Evaluate $\int e^x\, sinbx\, dx$ **(8M) (NOV/DEC2017)** BTL5

Answer: Page. 3.91 -Dr.M. Chandrasekar

Put $u = sinbx \quad \int dv = \int e^{ax}dx$ (2M)

$du = b\, cosbx\, dx \qquad v = \frac{e^{ax}}{a}$

$$\int vdu \quad = \quad uv - \int vdu \qquad \text{(2M)}$$

$$= \quad sinbx\,\frac{e^{ax}}{a} - \int \frac{e^{ax}}{a}\, b\, cosbx\ dx$$

$$= \quad sinbx\,\frac{e^{ax}}{a} - \frac{-b}{a}\int \frac{e^{ax}}{a}\ cosbx\ dx \qquad \text{(1M)}$$

$$= \quad \frac{e^{ax}}{a}\, sinbx\,\frac{-b}{a}\left(uv - \int vdu\right) \qquad \text{(2M)}$$

$$= \quad \frac{e^{ax}}{a}\, sinbx\,\frac{-b}{a}\left(cosbx\,\frac{e^{ax}}{a} - \int \frac{e^{ax}}{a}\,(-sinbx - b\,dx\right)$$

$$\int_e^{ax} sinbx\,dx \; = \; \frac{e^{ax}}{a}\, sinbx - \frac{b}{a}\left(\frac{e^{ax}}{a} cosbx + \frac{b}{a}\int \frac{e^{ax}}{a} sinbx\,dx\right)$$

$$\int_e^{ax} sinbx\,dx \; = \; \frac{e^{ax}}{a}\, sinbx\,\frac{-b}{a}\, e^{ax}\, cosbx - \frac{b^2}{a^2}\int \frac{e^{ax}}{a} sinbx\,dx$$

$$\int_e^{ax} sinbx\,dx + \frac{b^2}{a^2}\int \frac{e^{ax}}{a} sinbx\,dx \; = \; \frac{e^{ax}}{a}\, sinbx - \frac{b}{a^2} e^{ax}\, cosbx$$

$$\int_e^{ax} sinbx\,dx\left(1 + \frac{b^2}{a^2}\right) \; = \; \frac{ae^{ax}sinbx - be^{ax}cosx}{a^2} \qquad \text{(2M)}$$

$$\int_e^{ax} sinbx\,dx\left(\frac{a^2+b^2}{a^2}\right) \; = \; e^{ax}\,\frac{(asinbx - bcosx)}{a^2}$$

$$\int_e^{ax} sinbx\,dx \; = \; \frac{a^2e^{ax}}{a^2+b^2}\,\frac{(acosbx - bsinbx)}{a^2}$$

$$= \; \frac{e^{ax}}{a^2+b^2}\,(acosbx - bsinbx)$$

12.

Evaluate i) $\int_\tau^2 \frac{1}{\sqrt{x-1}}dx$ **ii)** $\int_0^2 \frac{dx}{\sqrt{1-x^2}}$ **is convergent or divergent (4+4M)** BTL5

Answer: Page. 3.92 -Dr.M. Chandrasekar

i) $$\int_s^2 \frac{dx}{\sqrt{X-1}} \; = \; \lim_{t\to 2^-}\int_t^2 \frac{dx}{\sqrt{x-1}} \qquad \text{(2M)}$$

$$= \; \lim_{t\to 2^-}\left[2\sqrt{x-1}\right]_t^2$$

$$= \; \lim_{t\to 2^-}\left[2\sqrt{1} - 2\sqrt{t-1}\right] \qquad \text{(2M)}$$

	$= \lim\limits_{t\to 2^-} 2\sqrt{1} - \ 2\sqrt{1}$ $= 0$ ii) $\int_0^{\prime} \frac{dx}{\sqrt{1-x^2}} = \lim\limits_{t\to 1^-} \int_0^{t} \frac{dx}{\sqrt{1-x^2}}$ (2M) $= \lim\limits_{t\to 1^-} [sin_x^{-1}]_0^t$ $= \lim\limits_{t\to 1^-} (sin^{-1}t - sin_{(0)}^{-1})$ $= sin_{(0)}^{-1} - \ 0 = \frac{\pi}{2}$ (2M) It is convergent
13.	**Verify $\int_0^{\frac{\pi}{2}} \sec x\, dx$ is convergent or divergent (8M) (NOV/DEC2017)** BTL5 **Answer: Page. 3.91 -Dr.M. Chandrasekar** $\int_0^{\frac{\pi}{2}} \sec x\, dx = \lim\limits_{t-\frac{-\pi}{2}} \int_0^{t} \sec x\, dx$ (2M) $= \lim\limits_{t-\frac{-\pi}{2}} (\log\ (\sec x + tanx)\ {}_{\partial}^{6}$ (2M) $= \lim\limits_{t-\frac{-\pi}{2}} (\log\ (\sec t + tant)\ - log1)$ (2M) $= \lim\limits_{t-\frac{-\pi}{2}} (\sec\frac{\pi}{2} + \tan\frac{\pi}{2})$ $= \infty$ It is divergent (2M)

UNIT-IV MULTIPLE INTEGRALS

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of ids – Change of variables in double and triple integrals.

	PART - A
1.	Evaluate $\int_2^3\int_1^2 \frac{dxdy}{xy}$ **(NOV/DEC-2010)** BTL1 $\int_2^3\int_1^2 \frac{dxdy}{xy} = \int_2^3 \left(\frac{\log x}{y}\right)_{x=1}^{x=2} dx = \int_2^3 (\log 2 - \log 1)\frac{dy}{y} = \log 2\left(\log y\right)_{y=2}^{y=3} \qquad (\because \log 1 = 0)$ $= \log 2(\log 3 - \log 2) = \log 2\left(\log\frac{3}{2}\right)$
2.	Evaluate $\int_2^a\int_2^b \frac{dxdy}{xy}$ **(NOV/DEC-2014)** BTL1 $\int_2^a\int_2^b \frac{dxdy}{xy} = \int_2^a \left(\frac{\log x}{y}\right)_{x=2}^{x=b} dx = \int_2^a (\log b - \log 2)\frac{dy}{y} = \log\left(\frac{b}{2}\right)\left(\log y\right)_{y=2}^{y=a}$ $= \log\left(\frac{b}{2}\right)(\log a - \log 2) = \left(\log\frac{b}{2}\right)\left(\log\frac{a}{2}\right)$
3.	Evaluate $\int_0^3\int_0^2 e^{x+y}\,dx\,dy$ **(APR/MAY-2015 R-08)** BTL1 $\int_0^3\int_0^2 e^{x+y}\,dx\,dy = \left[\int_0^3 e^x\,dx\right]\left[\int_0^2 e^y\,dy\right] = \left[e^x\right]_0^3\left[e^y\right]_0^2 = \left(e^3-1\right)\left(e^2-1\right)$
4.	Evaluate: $\int_0^1\int_0^x e^{y/x}\,dy\,dx.$ **(NOV/DEC-2014 R-08)** BTL1 $\int_0^1\int_0^x e^{y/x}\,dy\,dx. = \left[\int_0^1 \left(\frac{e^{y/x}}{\frac{1}{x}}\right)_0^x dx\right] = \int_0^4 x(e^1-1)dx = \left[(e^1-1)\frac{x^2}{2}\right]_0^1 = \left[\frac{(e^1-1)}{2}\right]$
5.	Evaluate: $\int_0^4\int_0^{x^2} e^{y/x}\,dy\,dx.$ **(APR/MAY-2015)** BTL1

	$\int_0^4\int_0^{x^2} e^{y/x}\,dy\,dx = \left[\int_0^4 \left(\frac{e^{y/x}}{\frac{1}{x}}\right)_0^{x^2} dx\right] = \int_0^4 x(e^x-1)dx$ By using Bernoulli's formula $\int_0^4\int_0^{x^2} e^{y/x}\,dy\,dx = \left[x(e^x-1)-(e^x-\frac{x^2}{2})\right]_0^4 = 3e^4-8+1=3e^4-7$
6.	Evaluate $\int_0^\infty\int_0^y \frac{e^{-y}}{y}\,dx\,dy$ **(APR/MAY-2011) (NOV/DEC-2017-R-17)** BTL1 $\int_0^\infty\int_0^y \frac{e^{-y}}{y}\,dx\,dy = \left[\int_0^\infty \frac{e^{-y}}{y}\,dy\right]\left[\int_0^y dx\right] = \left[\int_0^\infty \frac{e^{-y}}{y}\,dy\right]\left[x\right]_0^y = \left[\int_0^\infty \frac{e^{-y}}{y}(y)dy\right]$ $= \left[\int_0^\infty e^{-y}dy\right] = (-e^{-y})_0^\infty = (0-(-1)) = 1$
7.	**Find the limits of the integration in the double integral** $\iint_R f(x,y)\,dx\,dy$ **where R is the first quadrant and bounded by** $x=1, y=0, y^2=4x$. **(NOV/DEC-2017-R-17)** BTL2 Given $x=1, y=0, y^2=4x$ Put $y=0$ in $y^2=4x$ We get $x=0$ $\therefore \iint_R f(x,y)\,dx\,dy = \int_{x=0}^{x=1}\int_{y=0}^{y=2\sqrt{x}} f(x,y)\,dy\,dx$ or Equivalently, $\iint_R f(x,y)\,dx\,dy = \int_{y=0}^{y=2}\int_{x=\frac{y^2}{4}}^{x=1} f(x,y)\,dx\,dy$
8.	**Evaluate** $\int_0^1\int_x^{\sqrt{x}} xy(x+y)\,dx\,dy$ **(APR/MAY-2009)** BTL2

	$\int_0^1\int_x^{\sqrt{x}} xy(x+y)\,dx\,dy = \int_0^1\int_x^{\sqrt{x}} xy(x+y)\,dydx$ (correct form) $= \int_0^1 \left[\frac{x^2y^2}{2}+\frac{xy^3}{3}\right]_{y=x}^{y=\sqrt{x}} dx$ $= \int_0^1 \left[\frac{x^3}{2}+\frac{x^{5/2}}{3}-\frac{x^4}{2}-\frac{x^4}{3}\right] dx$ $= \int_0^1 \left[\frac{x^3}{2}+\frac{x^{5/2}}{3}-\frac{5x^4}{6}\right] dx$ $= \left[\frac{x^4}{8}+\frac{x^{7/2}}{\left(\frac{21}{2}\right)}-\frac{5x^5}{30}\right]_{x=0}^{x=1}$ $= \left[\frac{1}{8}+\frac{1}{\left(\frac{21}{2}\right)}-\frac{1}{6}\right] = \frac{3}{56}$
9.	**Evaluate** $\int_0^{\pi}\int_0^{\sin\theta} rdrd\theta$ **(APR/MAY-2014) (NOV/DEC-2014 R-08)** BTL2 $\int_0^{\pi}\int_0^{\sin\theta} rdrd\theta = \int_0^{\pi}\left(\frac{r^2}{2}\right)_0^{\sin\theta} d\theta = \int_0^{\pi}\frac{\sin^2\theta}{2}d\theta = \int_0^{\pi}\left(\frac{1-\cos 2\theta}{2}\right)d\theta$ $= \frac{1}{4}\left(\theta-\frac{\sin 2\theta}{2}\right)_0^{\pi} = \frac{1}{4}((\pi-0)-(0-0)) = \frac{\pi}{4}$
10	**Evaluate** $\int_0^{\frac{\pi}{2}}\int_0^{\sin\theta} rd\theta dr$ **(APR/MAY-2013) (NOV/DEC-2014 R-13)** BTL2 $\int_0^{\frac{\pi}{2}}\int_0^{\sin\theta} rd\theta dr = \int_0^{\frac{\pi}{2}}\int_0^{\sin\theta} rdrd\theta$ (correct form) $= \int_0^{\frac{\pi}{2}}\left(\frac{r^2}{2}\right)_0^{\sin\theta} d\theta = \int_0^{\frac{\pi}{2}}\frac{\sin^2\theta}{2}d\theta = \int_0^{\frac{\pi}{2}}\left(\frac{1-\cos 2\theta}{2}\right)d\theta$ $= \frac{1}{4}\left(\theta-\frac{\sin 2\theta}{2}\right)_0^{\frac{\pi}{2}} = \frac{1}{4}((\frac{\pi}{2}-0)-(0-0)) = \frac{\pi}{8}$

11

Evaluate $\int_0^{\pi}\int_0^{a} r\,dr\,d\theta$ **(NOV/DEC-2015 R-13)** BTL2

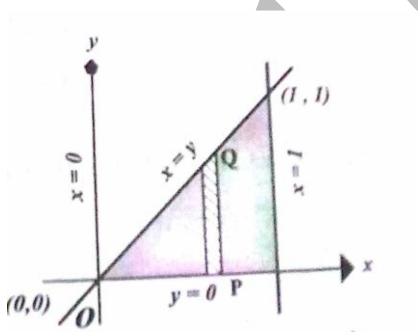
$$\int_0^{\pi}\int_0^{a} r\,dr\,d\theta = \int_0^{\pi}\left(\frac{r^2}{2}\right)_0^{a} d\theta = \int_0^{\pi}\frac{a^2}{2}\,d\theta =$$

$$=\left(\frac{a^2(\theta)}{2}\right)_0^{\pi} = \frac{\pi a^2}{2}$$

12

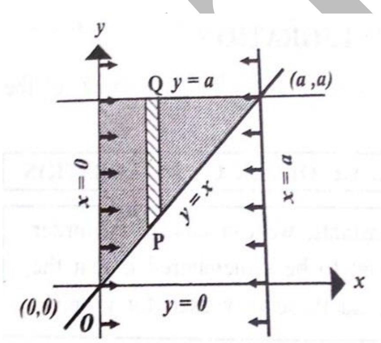
Sketch roughly the region of integration for $\int_0^{1}\int_0^{x} f(x,y)\,dy\,dx$ **(APR/MAY-2016) (NOV/DEC-2016)** BTL2

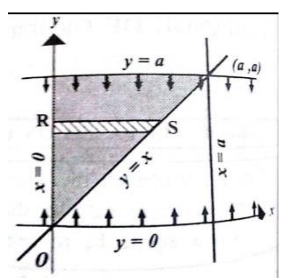
Given $\int_0^{1}\int_0^{x} f(x,y)\,dy\,dx$ Here x varies from $x=0$ to $x=1$; y varies from $y=0$ to $y=x$



13

Change the order of integration in $\int_0^{a}\int_x^{a} f(x,y)\,dy\,dx.$ **(APR/MAY-2012)** BTL2





x varies from $x=0$ to $x=a$

y varies from $y=x$ to $y=a$

By Changing the order of integration

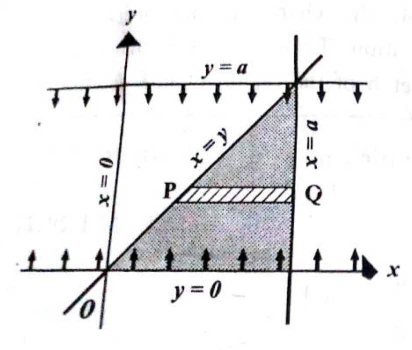
x varies from $x=0$ to $x=y$

y varies from $y=0$ to $y=a$

$$\therefore \int_0^{a}\int_x^{a} f(x,y)\,dy\,dx = \int_0^{a}\int_0^{y} f(x,y)\,dx\,dy.$$

14

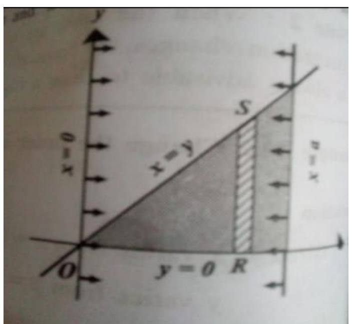
Change the order of integration in $\int_0^a\int_y^a f(x,y)\,dx\,dy.$ **(APR/MAY-2009) (NOV/DEC-2011 R-08) (APR/MAY-2013)** BTL2



x varies from $x = y$ to $x = a$

y varies from $y = 0$ to $y = a$

By Changing the order of integration



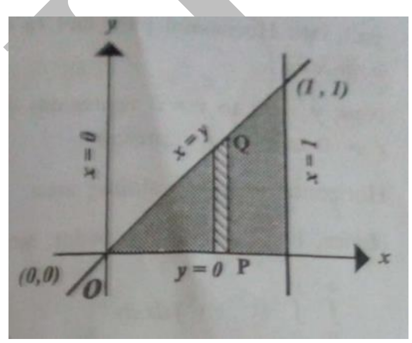
x varies from $x = 0$ to $x = a$

y varies from $y = 0$ to $y = x$

$$\therefore \int_0^a\int_y^a f(x,y)\,dx\,dy. = \int_0^a\int_0^x f(x,y)\,dy dx.$$

15

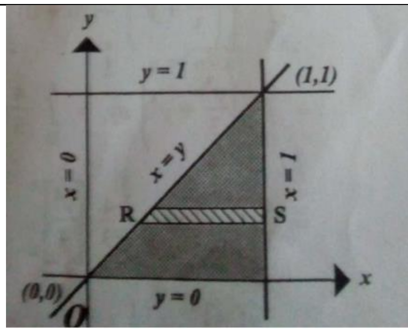
Change the order of integration $\int_0^1\int_0^x f(x,y)\,dy\,dx.$ **(NOV/DEC-2010)** BTL2



x varies from $x = 0$ to $x = 1$

y varies from $y = 0$ to $y = x$

By Changing the order of integration



x varies from $x = y$ to $x = 1$

y varies from $y = 0$ to $y = 1$

$$\therefore \int_0^1\int_0^x f(x,y)\,dy\,dx. = \int_0^1\int_y^1 f(x,y)\,dxdy$$

16. **Find the area bounded by the lines** $x = 0, y = 1$ and $y = x$ **(APR/MAY-2015 R-08)** BTL2

$$\text{Area } = \iint_R dxdy = \int_0^1\int_0^y dxdy = \int_0^1 [x]_0^y\, dy$$

$$= \int_0^1 y dy = \left[\frac{y^2}{2}\right]_0^1 = \frac{1}{2} \text{ square units}$$

17. **Find the area bounded by** $x = 0, x = 2, y = 0$ and $y = 2$ **(NOV/DEC-2007)** BTL3

$$\text{Area } = \iint_R dxdy = \int_0^2\int_0^2 dxdy = \int_0^1 [x]_0^2\, dy$$

$$= \int_0^2 2dy = [2y]_0^2 = 4 \text{ square units}$$

18. **Evaluate** $\iint xy\,dxdy$ **over the positive quadrant of the circle** $x^2 + y^2 = 1$ **(NOV/DEC-2014 R-13)** BTL5

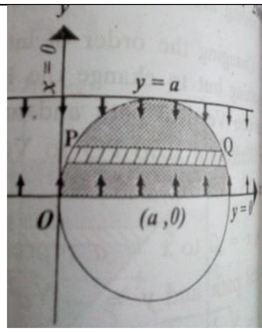
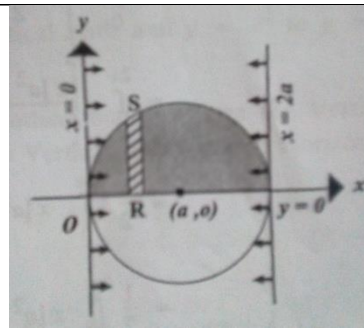
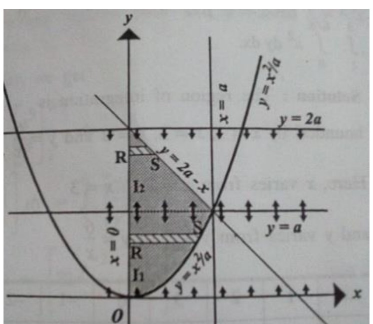
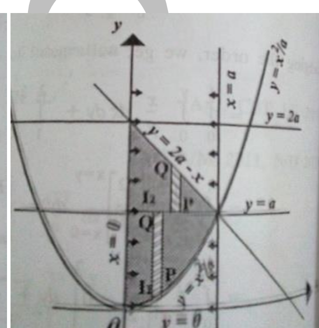
$$\text{Area } = \int_0^1 \int_0^{\sqrt{1-y^2}} xydxdy = \int_0^1 \left[\frac{yx^2}{2}\right]_0^{\sqrt{1-y^2}} dy$$

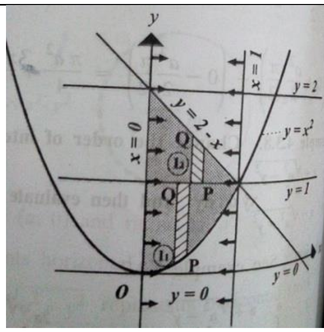
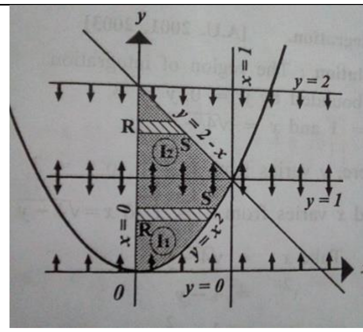
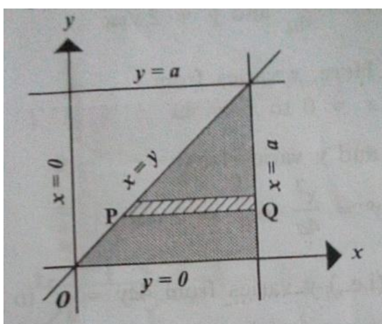
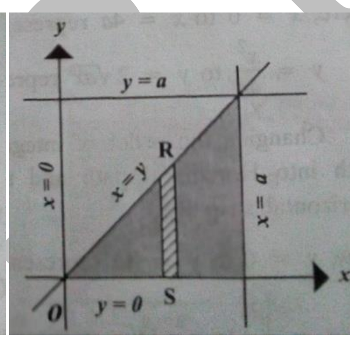
$$= \frac{1}{2}\int_0^1 (y - y^3)dy = \frac{1}{2}\left[\frac{y^2}{2} - \frac{y^4}{4}\right]_0^1 = \frac{1}{2}\left[\frac{1}{2} - \frac{1}{4}\right] = \frac{1}{8} \text{ square units}$$

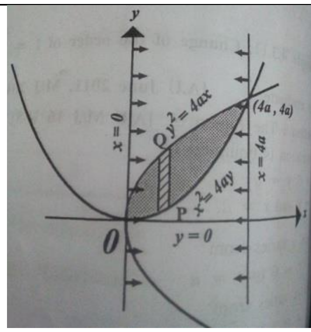
19. **Find the area enclosed by the ellipse** $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1.$ **(APR/MAY-2013) (NOV/DEC-2011 R-08) (NOV/DEC-2016 R-13)** BTL2

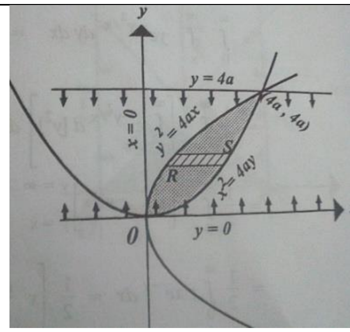
	$\text{Area } = \int_0^b \int_0^{\frac{a}{b}\sqrt{b^2-y^2}} dxdy = \int_0^b (x)_0^{\frac{a}{b}\sqrt{b^2-y^2}} dy$ $= \int_0^b (\frac{a}{b}\sqrt{b^2-y^2})dy = \frac{4a}{b}\left[\frac{b^2}{2}\sin^{-1}\frac{y}{b} + \frac{y}{2}\sqrt{b^2-y^2}\right]_0^b = \frac{4a}{b}\left[\frac{b^2}{2}\left(\frac{\pi}{2}\right)\right]$ $= \pi ab$ square units
20	**Find the area of the curve** $r^2 = a^2\cos 2\theta$ **(NOV/DEC-2015 R-08) (NOV/DEC-2016 R-08)** BTL2 Area $= 4$ x Area of upper half of one loop $=4\int_0^{\frac{\pi}{4}}\int_0^{a\sqrt{\cos 2\theta}} rdrd\theta \; = 4\int_0^{\frac{\pi}{4}}\left(\frac{r^2}{2}\right)_0^{a\sqrt{\cos 2\theta}} d\theta = 2a^2\int_0^{\frac{\pi}{4}}\cos 2\theta\, d\theta$ $= 2a^2\left(\frac{\sin 2\theta}{2}\right)_0^{\frac{\pi}{4}} = a^2$ square units
21	**Calculate** $\iint r^3 dr\,d\theta$ **over the area included between the circles** $r = 2\sin\theta$ **and** $r = 4\sin\theta$ **. (NOV/DEC-2007)** BTL2 $\text{Area } = \int_0^{\pi}\int_{2\sin\theta}^{4\sin\theta} r^3\,drd\theta \; = \int_0^{\pi}\left(\frac{r^4}{4}\right)_{2\sin\theta}^{4\sin\theta} d\theta = \int_0^{\pi}\left[64\sin^4\theta - 4\sin^4\theta\right]d\theta$ $= \int_0^{\pi}\left[60\sin^4\theta\right]d\theta = 60\int_0^{\pi}\left[\sin^4\theta\right]d\theta$ $=120\int_0^{\frac{\pi}{2}}\left[\sin^4\theta\right]d\theta = 120\left(\left(\frac{3}{4}\right)\left(\frac{1}{2}\right)\left(\frac{\pi}{2}\right)\right)$ $(\because$ by using reduction formula) $= \frac{45\pi}{2}$ square units
22	**Evaluate** $\int_0^a\int_0^b\int_0^c e^{x+y+z}dzdydx.$ **(APR/MAY-2010)** BTL1 $\int_0^a\int_0^b\int_0^c e^{x+y+z}dzdydx. = \left[\int_0^a e^x\,dx\right]\left[\int_0^b e^y\,dy\right]\left[\int_0^c e^z\,dz\right] = \left[e^x\right]_0^a\left[e^y\right]_0^b\left[e^z\right]_0^c$ $= (e^a - 1)(e^b - 1)(e^c - 1)$
23	**Evaluate** $\int_0^1\int_0^2\int_0^3 xyz\,dzdydx.$ **(NOV/DEC-2010)** BTL1

	$\int_0^1\int_0^2\int_0^3 xyz\, dzdydx. = \left[\int_0^1 xdx\right]\left[\int_0^2 y\,dy\right]\left[\int_0^3 z\,dz\right] = \left[\frac{x^2}{2}\right]_0^1\left[\frac{y^2}{2}\right]_0^2\left[\frac{z^2}{2}\right]_0^3$ $=\left(\frac{1}{2}\right)\left(\frac{4}{2}\right)\left(\frac{9}{2}\right)=\left(\frac{9}{2}\right)$
24	**Evaluate** $\int_0^{\log a}\int_0^{x}\int_0^{x+y} e^{x+y+z} dzdydx.$ **(APR/MAY-2012) (APR/MAY-2013)** BTL1 $\int_0^{\log a}\int_0^{x}\int_0^{x+y} e^{x+y+z} dzdydx. = \left[\int_0^{\log a}\int_0^{x}\left(e^{x+y+z}\right)_0^{x+y} dydx.\right] = \left[\int_0^{\log a}\int_0^{x}\left(e^{2x+2y}-e^{x+y}\right)dydx.\right]$ $=\left[\int_0^{\log a}\left(\frac{e^{2x+2y}}{2}-e^{x+y}\right)_0^{x} dx.\right]$ $=\left[\int_0^{\log a}\left(\left(\frac{e^{4x}}{2}-e^{2x}\right)-\left(\frac{e^{2x}}{2}-e^{x}\right)\right)dx.\right]$ $=\left(\frac{e^{4x}}{8}-\frac{e^{2x}}{2}-\frac{e^{2x}}{4}+e^{x}\right)_0^{\log a} = \frac{1}{8}\left(a^4-6a^2+8a-3\right)$
25	**Express the region** $x\ge 0, y\ge 0, z\ge 0,\ x^2+y^2+z^2\le 1$ **by triple integration. (APR/MAY-2011) (NOV/DEC-2005)** BTL2 Given region, x varies from $x=0$ to $x=1$ y varies from $y=0$ to $y=\sqrt{1-x^2}$ z varies from $z=0$ to $z=\sqrt{1-x^2-y^2}$ $\therefore \mathrm{I} = \int_0^1\int_0^{\sqrt{1-x^2}}\int_0^{\sqrt{1-x^2-y^2}} dzdydx.$
	PART * B
1.	**Change the order of integration** $\int_0^a\int_{a-\sqrt{a^2-y^2}}^{a+\sqrt{a^2-y^2}} dxdy$ **and hence evaluate. (8M) (NOV/DEC-2009)** BTL2 **Answer : Page. 4.24 -G.Balaji**

	•   **(2M)** • $\int_0^a \int_{a-\sqrt{a^2-y^2}}^{a+\sqrt{a^2-y^2}} dxdy = \int_0^{2a} \int_0^{\sqrt{a^2-(x-a)^2}} dydx$ **(2M)** • $\int_0^{2a} \int_0^{\sqrt{a^2-(x-a)^2}} dydx = \frac{\pi a^2}{2}$ **(4M)**
2.	**Change the order of integration in** $\int_0^a \int_{\frac{x^2}{a}}^{2a-x} xydxdy$ **and hence evaluate it. (8M) (APR/MAY-2010) (NOV/DEC-2007,2013,2014)** BTL2 **Answer : Page. 4.38 -G.Balaji** •   **(2M)** • $\int_0^a \int_{\frac{x^2}{a}}^{2a-x} xydydx = \int_0^a \int_0^{\sqrt{ay}} xy\, dxdy + \int_a^{2a} \int_0^{2a-y} xy\, dxdy$ **(2M)** • $\int_0^a \int_0^{\sqrt{ay}} xy\, dxdy + \int_a^{2a} \int_0^{2a-y} xy\, dxdy = \frac{a^4}{6} + \frac{5a^4}{24} = \frac{3a^4}{8}$ **(4M)**
3.	**Change the order of integration in** $\int_0^1 \int_{x^2}^{2-x} xydydx$ **and hence evaluate it. (8M) (APR/MAY-2014) (NOV/DEC-2015)** BTL2 **Answer : Page. 4.26 -G.Balaji**

	•   **(2M)** • $\int_0^1 \int_{x^2}^{2-x} xydydx. = \int_0^1 \int_0^{\sqrt{y}} xy\,dxdy + \int_1^2 \int_0^{2-y} xy\,dxdy$ **(2M)** • $\int_0^1 \int_0^{\sqrt{y}} xy\,dxdy + \int_1^2 \int_0^{2-y} xy\,dxdy = \frac{1}{6} + \frac{5}{24} = \frac{3}{8}$ **(4M)**
4.	**Change the order of integration in** $\int_0^a \int_y^a \frac{x}{x^2+y^2}\,dxdy$ **and hence evaluate it. (8M)** **(NOV/DEC-2013)** BTL2 **Answer : Page. 4.29-G.Balaji** •   **(2M)** • $\int_0^a \int_y^a \frac{x}{x^2+y^2}\,dxdy = \int_0^a \int_0^x \frac{x}{x^2+y^2}\,dydx$ **(2M)** • $\int_0^a \int_0^x \frac{x}{x^2+y^2}\,dydx = \frac{\pi a}{4}$ **(4M)**
5.	**Change the order of integration in** $\int_0^{4a} \int_{\frac{x^2}{4a}}^{2\sqrt{ax}} xy\,dydx$ **and hence evaluate it. (8M) (APR/MAY-2017 R-08)** BTL2 **Answer : Page. 4.30-G.Balaji**

- 



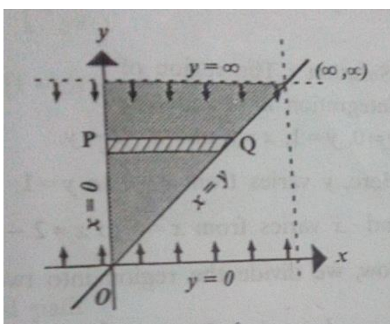
(2M)
- $\int_0^{4a}\int_{\frac{x^2}{4a}}^{2\sqrt{ax}} xy\,dydx = \int_0^{4a}\int_{\frac{y^2}{4a}}^{2\sqrt{ay}} xy\,dxdy$ **(2M)**
- $\int_0^{4a}\int_{\frac{y^2}{4a}}^{2\sqrt{ay}} xy\,dxdy = \frac{64a^4}{3}$ **(4M)**

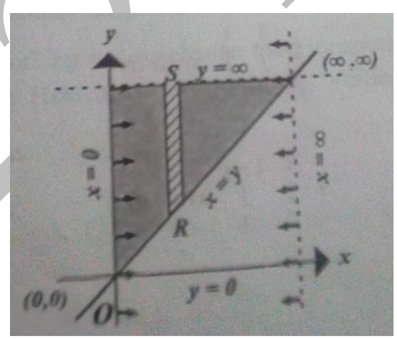
6.

Using change the order of integration evaluate $\int_0^{\infty}\int_0^{y} ye^{\frac{-y^2}{x}}\,dxdy$. **(8M)**

(NOV/DEC-2014 R-13) BTL2

Answer : Page. 4.31 -G.Balaji

- 



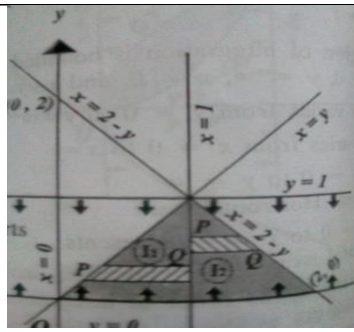
(2M)
- $\int_0^{\infty}\int_0^{y} ye^{\frac{-y^2}{x}}\,dxdy = \int_0^{\infty}\int_x^{\infty} ye^{\frac{-y^2}{x}}\,dydx$ **(2M)**

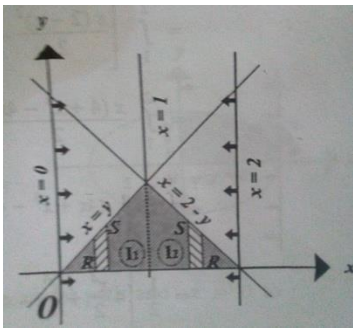
$\int_0^{\infty}\int_x^{\infty} ye^{\frac{-y^2}{x}}\,dydx = \frac{1}{2}$ **(4M)**

7.

Change the order of integration in $\int_0^{1}\int_y^{2-y} xydxdy$ **and hence evaluate it. (8M) (APR/MAY-2015) (NOV/DEC-2011)** BTL2

Answer : Page. 4.32-G.Balaji

- 

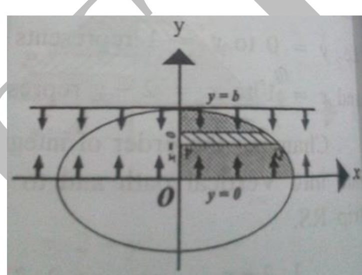
- 

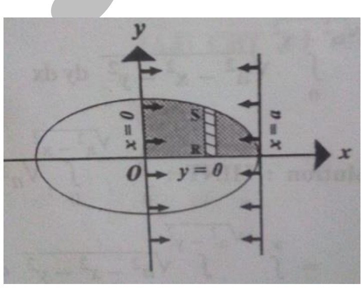
(2M)
- $\int_0^1 \int_y^{2-y} xydxdy = \int_0^1 \int_0^x xydydx + \int_1^2 \int_0^{2-x} xydydx$ **(2M)**
- $\int_0^1 \int_0^x xydydx + \int_1^2 \int_0^{2-x} xydydx = \frac{1}{8} + \frac{5}{24} = \frac{1}{3}$ **(4M)**

8. **Change the order of integration in** $\int_0^b \int_0^{\frac{a}{b}\sqrt{b^2-y^2}} xy\,dxdy$ **and hence evaluate it.**

(8M)(NOV/DEC-2006) BTL2

Answer : Page. 4.34 -G.Balaji

- 

- 

(2M)

	• $\int_0^b \int_0^{\frac{a}{b}\sqrt{b^2-y^2}} xy\,dxdy = \int_0^a \int_0^{\frac{b}{a}\sqrt{a^2-x^2}} xy\,dydx$ **(2M)** • $\int_0^a \int_0^{\frac{b}{a}\sqrt{a^2-x^2}} xy\,dydx = \frac{a^2b^2}{8}$ **(4M)**
9.	**Using double integral find the area bounded by** $y = x$ and $x^2 = y$. **(8M)/DEC-2017 R-17)** BTL3 **Answer : Page. 4.52 -G.Balaji** • Area $= \int_0^1 \int_{x^2}^{x} dydx$ **(2M)** • $\int_0^1 \int_{x^2}^{x} dydx = \int_0^1 (x - x^2)dx$ **(2M)** • $\int_0^1 (x - x^2)dx = \frac{1}{6}$ Square units **(4M)**
10.	**Show that the area between the parabola's** $y^2 = 4ax$ and $x^2 = 4ay$ is $\frac{16a^2}{3}$ **(8M)** **(APR/MAY-2011) (NOV/DEC-2010)** BTL3 **Answer : Page. 4.58 -G.Balaji** • Area $= \int_0^{4a} \int_{\frac{x^2}{4a}}^{2\sqrt{ax}} dydx$ **(2M)** • $\int_0^{4a} \int_{\frac{x^2}{4a}}^{2\sqrt{ax}} dydx = \int_0^{4a} (2\sqrt{ax} - \frac{x^2}{4a})dx$ **(2M)** • For Showing $\int_0^{4a} (2\sqrt{ax} - \frac{x^2}{4a})dx = \frac{16a^2}{3}$ **(4M)**
11.	**Find the area of the cardioid** $r = a(1+\cos\theta)$ **using double integration.** **(8M) (APR/MAY-2011,2014,2015) (NOV/DEC-2014)** BTL2 **Answer : Page. 4.67 -G.Balaji** • Area $= 2\int_{\theta=0}^{\theta=\pi} \int_{r=0}^{r=a(1+\cos\theta)} rdrd\theta$ **(2M)** • $2\int_{\theta=0}^{\theta=\pi} \int_{r=0}^{r=a(1+\cos\theta)} rdrd\theta = a^2 \int_{\theta=0}^{\theta=\pi} (1+\cos^2\theta + 2\cos\theta)d\theta$ **(2M)** • $a^2 \int_{\theta=0}^{\theta=\pi} (1+\cos^2\theta + 2\cos\theta)d\theta = \frac{3\pi a^2}{2}$ square unit **(4M)**

12.	**Find the area of the cardioid** $r = a(1-\cos\theta)$ **using double integration. (8M) (APR/MAY-2008)** BTL3 **Answer : Page. 4.67 -G.Balaji** • Area $= 2\int_{\theta=0}^{\theta=\pi}\int_{r=0}^{r=a(1-\cos\theta)} r\,dr\,d\theta$ **(2M)** • $2\int_{\theta=0}^{\theta=\pi}\int_{r=0}^{r=a(1-\cos\theta)} r\,dr\,d\theta = a^2\int_{\theta=0}^{\theta=\pi}(1+\cos^2\theta-2\cos\theta)d\theta$ **(2M)** • $a^2\int_{\theta=0}^{\theta=\pi}(1+\cos^2\theta-2\cos\theta)d\theta = \frac{3\pi a^2}{2}$ square unit **(4M)**
13.	**Evaluate** $\int_0^a\int_0^{\sqrt{a^2-x^2}}\int_0^{\sqrt{a^2-x^2-y^2}}\frac{dzdydx}{\sqrt{a^2-x^2-y^2-z^2}}$ **(8M) (APR/MAY-2004)** BTL1 **Answer : Page. 4.77 -G.Balaji** • $\int_0^a\int_0^{\sqrt{a^2-x^2}}\int_0^{\sqrt{a^2-x^2-y^2}}\frac{dzdydx}{\sqrt{a^2-x^2-y^2-z^2}} = \int_0^a\int_0^{\sqrt{a^2-x^2}}(\sin^{-1}1)dydx$ **(2M)** • $\int_0^a\int_0^{\sqrt{a^2-x^2}}(\sin^{-1}1)dydx = \frac{\pi}{2}\int_0^a\sqrt{a^2-x^2}\,dx$ **(2M)** • $\frac{\pi}{2}\int_0^a\sqrt{a^2-x^2}\,dx = \frac{\pi^2a^2}{8}$ **(4M)**
14.	**Evaluate** $\int_0^1\int_0^{\sqrt{1-x^2}}\int_0^{\sqrt{1-x^2-y^2}}\frac{dzdydx}{\sqrt{1-x^2-y^2-z^2}}$ **(8M) (NOV/DEC-2009,2013) (APR/MAY-2015)** BTL1 **Answer : Page. 4.85 -G.Balaji** • $\int_0^1\int_0^{\sqrt{1-x^2}}\int_0^{\sqrt{1-x^2-y^2}}\frac{dzdydx}{\sqrt{1-x^2-y^2-z^2}} = \int_0^1\int_0^{\sqrt{1-x^2}}(\sin^{-1}1)dydx$ **(2M)** • $\int_0^1\int_0^{\sqrt{1-x^2}}(\sin^{-1}1)dydx = \frac{\pi}{2}\int_0^1\sqrt{1-x^2}\,dx$ **(2M)** • $\frac{\pi}{2}\int_0^1\sqrt{1-x^2}\,dx = \frac{\pi^2}{8}$ **(4M)**
15.	**Evaluate** $\iiint_V\frac{dzdydx}{(x+y+z+1)^3}$ **over the region of integration bounded by the planes** $x=0, y=0, z=0, x+y+z=1$ **. (8M) (APR/MAY-2015,2016) (NOV/DEC-2014,2015)** BTL3 **Answer : Page. 4.96 -G.Balaji**

- x varies from $x=0$ to $x=1$
  y varies from $y=0$ to $y=1-x$
  z varies from $z=0$ to $z=1-x-y$ **(2M)**
- $\text{Volume} = \int_0^1 \int_0^{1-x} \int_0^{1-x-y} \frac{dzdydx}{(x+y+z+1)^3}$ **(2M)**
- $\int_0^1 \int_0^{1-x} \int_0^{1-x-y} \frac{dzdydx}{(x+y+z+1)^3} = \frac{\log 2}{2} - \frac{5}{16}$ cubic units **(4M)**

16. **Evaluate** $\iiint xyz\,dxdydz$ **taken throughout the volume for which** $x^2+y^2+z^2 \le 9$ **and** $x, y, z \ge 0,$ **(8M) (APR/MAY-2017 R-13,2016 R-08)** BTL3

Answer : Page. 4.129 -G.Balaji

- $x = r\sin\theta\cos\phi$
  $y = r\sin\theta\sin\phi$
  $z = r\cos\theta$ **(2M)**
  $dxdydz = r^2 \sin\theta\ drd\theta d\phi$
- $\iiint xyz\,dxdydz = \int_0^{\frac{\pi}{2}} \int_0^{\frac{\pi}{2}} \int_0^3 r^5 \sin^3\theta\cos\theta\cos\phi\,drd\theta d\phi$ **(2M)**
- $\int_0^{\frac{\pi}{2}} \int_0^{\frac{\pi}{2}} \int_0^3 r^5 \sin^3\theta\cos\theta\cos\phi\,drd\theta d\phi = \frac{243}{16}$ cubic units **(4M)**

17. **Find the Volume of the sphere** $x^2+y^2+z^2 = a^2$ without transformation **(8M) (APR/MAY-2015 R-13)** BTL3

Answer : Page. 4.89 -G.Balaji

- x varies from $x=0$ to $x=a$
  y varies from $y=0$ to $y=\sqrt{a^2-x^2}$ **(2M)**
  z varies from $z=0$ to $z=\sqrt{a^2-x^2-y^2}$
- $\text{Volume} = 8\int_0^a \int_0^{\sqrt{a^2-x^2}} \int_0^{\sqrt{a^2-x^2-y^2}} dzdydx$ **(2M)**
- $8\int_0^a \int_0^{\sqrt{a^2-x^2}} \int_0^{\sqrt{a^2-x^2-y^2}} dzdydx = \frac{4\pi a^3}{3}$ cubic units **(4M)**

18. **Find the Volume of that portion of the ellipsoid** $\frac{x^2}{a^2}+\frac{y^2}{b^2}+\frac{z^2}{c^2}=1$ which lies in the first octant using triple integration **(8M) (APR/MAY-2011) (NOV/DEC-2010)** BTL3

	Answer : Page. 4.92 -G.Balaji x varies from $x=0$ to $x=a$ • y varies from $y=0$ to $y=b\sqrt{1-\frac{x^2}{a^2}}$ **(2M)** z varies from $z=0$ to $z=c\sqrt{1-\frac{x^2}{a^2}-\frac{y^2}{b^2}}$ • $\text{Volume}=\int_0^a\int_0^{b\sqrt{1-\frac{x^2}{a^2}}}\int_0^{c\sqrt{1-\frac{x^2}{a^2}-\frac{y^2}{b^2}}} dzdydx$ **(2M)** • $\int_0^a\int_0^{b\sqrt{1-\frac{x^2}{a^2}}}\int_0^{c\sqrt{1-\frac{x^2}{a^2}-\frac{y^2}{b^2}}} dzdydx=\frac{\pi abc}{6}$ cubic units **(4M)**
19.	**Evaluate by Changing to Polar coordinates** $\int_0^{2a}\int_0^{\sqrt{2ax-x^2}}(x^2+y^2)\,dy\,dx$ **(8M) (APR/MAY-2008)** BTL2 **Answer : Page. 4.104 -G.Balaji** • $\int_0^{2a}\int_0^{\sqrt{2ax-x^2}}(x^2+y^2)\,dy\,dx=\int_{\theta=0}^{\theta=\frac{\pi}{2}}\int_{r=0}^{r=2a\cos\theta} r^3\,drd\theta$ **(2M)** • $\int_{\theta=0}^{\theta=\frac{\pi}{2}}\int_{r=0}^{r=2a\cos\theta} r^3\,drd\theta=\int_{\theta=0}^{\theta=\frac{\pi}{2}}\left(\frac{r^4}{4}\right)_0^{2a\cos\theta}d\theta$ **(2M)** • $\int_{\theta=0}^{\theta=\frac{\pi}{2}}\left(\frac{r^4}{4}\right)_0^{2a\cos\theta}d\theta=\frac{3\pi a^4}{4}$ **(4M)**
20.	**Evaluate by Changing to Polar coordinates** $\int_0^{2}\int_0^{\sqrt{2x-x^2}}(x^2+y^2)\,dy\,dx$ **(8M) (NOV/DEC-2014 , 2018 R-13)** BTL2 **Answer : Page. 4.106 -G.Balaji** • $\int_0^{2}\int_0^{\sqrt{2x-x^2}}(x^2+y^2)\,dy\,dx=\int_{\theta=0}^{\theta=\frac{\pi}{2}}\int_{r=0}^{r=2\cos\theta} r^3\,drd\theta$ **(2M)** • $\int_{\theta=0}^{\theta=\frac{\pi}{2}}\int_{r=0}^{r=2\cos\theta} r^3\,drd\theta=\int_{\theta=0}^{\theta=\frac{\pi}{2}}\left(\frac{r^4}{4}\right)_0^{2\cos\theta}d\theta$ **(2M)** • $\int_{\theta=0}^{\theta=\frac{\pi}{2}}\left(\frac{r^4}{4}\right)_0^{2\cos\theta}d\theta=\frac{3\pi}{4}$ **(4M)**

21.	**Evaluate by Changing into Polar coordinates** $\int_0^2 \int_0^{\sqrt{2x-x^2}} \frac{x}{(x^2+y^2)} dx\, dy$ **. (8M)** BTL2 **Answer : Page. 4.105 -G.Balaji** • $\int_0^2 \int_0^{\sqrt{2x-x^2}} \frac{x}{(x^2+y^2)} dx\, dy = \int_{\theta=0}^{\theta=\frac{\pi}{2}} \int_{r=0}^{r=2\cos\theta} \cos\theta dr d\theta$ **(2M)** • $\int_{\theta=0}^{\theta=\frac{\pi}{2}} \int_{r=0}^{r=2\cos\theta} \cos\theta dr d\theta = \int_{\theta=0}^{\theta=\frac{\pi}{2}} \left(r\cos\theta\right)_0^{2\cos\theta} d\theta$ **(2M)** • $\int_{\theta=0}^{\theta=\frac{\pi}{2}} \left(r\cos\theta\right)_0^{2\cos\theta} d\theta = \frac{\pi}{2}$ **(4M)**
22.	**Evaluate by Changing to Polar coordinates** $\int_0^\infty \int_0^\infty e^{-(x^2+y^2)} dx\, dy$ **(8M) (APR/MAY-2016 R-13) (NOV/DEC-2010,2016 R-13)** BTL2 **Answer : Page. 4.107-G.Balaji** • $\int_0^\infty \int_0^\infty e^{-(x^2+y^2)} dx\, dy = \int_{\theta=0}^{\theta=\frac{\pi}{2}} \int_{r=0}^{r=\infty} re^{-r^2}\ dr d\theta$ **(2M)** • $\int_{\theta=0}^{\theta=\frac{\pi}{2}} \int_{r=0}^{r=\infty} re^{-r^2}\ dr d\theta = \frac{1}{2}\int_{\theta=0}^{\theta=\frac{\pi}{2}} \left(-e^{-t}\right)_{t=0}^{t=\infty} d\theta \quad [\because t = r^2 \text{ and } dt = 2rdr]$ **(2M)** • $\frac{1}{2}\int_{\theta=0}^{\theta=\frac{\pi}{2}} \left(-e^{-t}\right)_{t=0}^{t=\infty} d\theta = \frac{\pi}{4}$ **(4M)**

UNIT-V DIFFERENTIAL EQUATIONS

Higher order linear differential equations with constant coefficients - Method of variation of parameters – Homogenous equation of Euler‘s and Legendre‘s type – System of simultaneous linear differential equations with constant coefficients - Method of undetermined coefficients.

PART – A

1. **Solve: $(D^2+4)y=0$ (A.U.Nov/dec.2002,2018)** BTL1

A.E $m^2+4=0 => \ m=\pm 2i,$

C.F = $e^{\alpha x}(A\cos\beta x+B\sin\beta x)$

$y(x)=(A\cos 2x+B\sin 2x)$

2. **Find the particular Integral of $(D^2+2)y=X^2$ (A.U.Nov/Dec 2003)** BTL1.

P.I=$\frac{1}{(D^2+2)}\ x^2=\frac{1}{2}\left(1+\frac{D^2}{2}\right)x^2=\frac{1}{2}\ (x^2+1)$

3. **solve $(D^2-6D+13)y=0$ (A.U.Nov/Dec 2003)** BTL1

A.E $m^2-6m+13=0 \ggg \ m=3\pm 2i,$

C.F = $e^{\alpha x}(A\cos\beta x+B\sin\beta x)$

$y(x)=e^{3x}(A\cos 2x+B\sin 2x)$

4. **Solve $(D^3+2D^2-D-2)y=0$(A.U.Nov/Dec 2001)** BTL1

A.E $m^3+2m^2-m-2=0 \ggg \ m=1,-1,-2$

C.F = $Ae^{mx}+Be^{mx}+Ce^{mx}$

$y(x)=Ae^{x}+Be^{-x}+Ce^{-2x}$

5. **Find the particular integral of $(D-1)^2y=\sinh 2x$(A.U.Nov/Dec 2003)** BTL1.

P.I=$\frac{1}{(D-1)^2}\ sinh2x=\frac{1}{(D-1)^2}(e^{2x}-e^{-2x})/2\ =(\frac{1}{2}\ e^{2x}-\frac{1}{9}\ e^{-2x})$

6. **Solve $(D-2)^2y=e^{2x}$ (A.U.Apr /may 2004)** BTL1.

P.I=$\frac{1}{(D-2)^2}\ e^{2x}=\frac{x}{2(D-2)}e^{2x}\ =\frac{x^2}{2}\ e^{2x}$

7. **Find the particular integral of $(D^2+2D+1)y=e^{-2x}\cos x$ (A.U.JAN 2009, 2018)** BTL1

P.I=$\frac{1}{(D^2+2D+1)}\ e^{-2x}\cos x=e^{-2x}\frac{1}{(D^2-2D+1)}\ \cos x$

$=e^{-2x}\frac{1}{(-1-2D+1)}\ \cos x=\frac{e^{-2x}}{(2)}\ \sin x$

8. **Solve $(D^2+D)y=e^{-x}$ (A.U.jan 2008)** BTL1

	A.E $m^2+m=0 \Rightarrow m=0,-1$ C.F = $(A\,e^{mx}+Be^{mx}) = (A+Be^{-x})$ P.I=$\frac{1}{(D^2+D)}\ e^{-x}=\frac{1}{2}e^{-x}$ $y(x)=(A+Be^{-x})+\frac{1}{2}e^{-x}$
9.	**Find the particular integral of (D^2+4D+4)y=xe^{-2x} (A.U.Nov/Dec 2005)** BTL1. P.I=$\frac{1}{(D^2+4D+4)}xe^{-2x}=e^{-2x}\frac{1}{(D^2)}\ x=\ e^{-2x}\frac{x^3}{6}$
10	**Find the particular integral of (D^2+D)y=x^2+2x+4 (A.U.April 2000)** BTL1 P.I=$\frac{1}{(D^2+D)}\ x^2+2x+4=\frac{1}{D}(1+D)^{-1}\ (x^2+2x+4)$ $=\frac{1}{D}(1-D+D^2-\cdots)\ (x^2+2x+4)=\frac{1}{D}\ (x^2+2x+4-2x-2+2)$ $=\frac{x^3}{3}+4x$
11	**Find the particular integral of (D^2+1)y=cosh2x (A.U. JUN/JUL 2009)** BTL1. P.I=$\frac{1}{(D^2+1)}\ cosh2x=\frac{1}{(D^2+1)}(e^{2x}+e^{-2x})/2\ =(\frac{1}{5}\ e^{2x}+\frac{1}{5}\ e^{-2x})$
12	**Find the particular integral of (D^2+4)y=sin2x (A.U.Nov/2003)** BTL1. P.I=$\frac{1}{(D^2+4)}\ \sin 2x=\frac{1}{((-2)^2+4)}\ \sin 2x$ $=\frac{-x}{4}\ \cos 2x$
13	**Find the particular integral of (D-1)^{2}y=e^x sinx (A.UApril/may 2003)** BTL1. P.I=$\frac{1}{(D-1)^2)}\ e^x\sin x=e^x\frac{1}{D}\ \sin x=-e^x\cos x$
14	**Find the particular integral of (D^2+1)^{2}y=sin2x (A.U NOV 2003)** BTL1. P.I=$\frac{1}{(D^2+1)^2}\ \sin 2x=\frac{1}{25}\ \sin 2x$
15	**Find the particular integral of (D^3-1)y=e^{2x} (A.U Jan 2005)** BTL1. P.I=$\frac{1}{(D^3-1)}e^{2x}=e^{2x}\frac{1}{(2^3-1)}\ =\ \frac{e^{2x}}{7}$
16	**Solve the equation x^{2}y”-xy’+y=0 (A.U.MAY/JUN 2009)** BTL1 **Given** $(x^2D^2-xD+1)y=0$

	Put $xD = D'$, $x^2D^2 = D'^2 - D'$ therefore $D'^2 - D' - D' + 1 = 0$ A.E $m^2 - 2m + 1 = 0$ $m = -1, -1$ C.F = $(A\,\mathrm{x} + B)e^{mx} = (A\,\mathrm{x} + B)e^{-x}$ General solution $y(x) = (A\,\mathrm{x} + B)e^{-x}$
17	**Solve (x^2D^2+xD)y=0(A.U.jan 2006)** BTL1 **Given** $(x^2D^2 + xD)y = 0$ Put $xD = D'$, $x^2D^2 = D'^2 - D'$ therefore $D'^2 - D' - D' = 0$ A.E $m^2 - 2m = 0$ $m = 0, -2$ C.F = $(A\,e^{mx} + Be^{mx}) = (A\,e^{0x} + Be^{-2x})$ General Solution $y(x) = (A \quad + Be^{-2x})$
18	**Transform differential equation of variable coefficients into differential equation of constant coefficients x^2y”-xy’-3y=0** BTL1 **Given** $(x^2D^2 - xD - 3)y = 0$ Put $xD = D'$, $x^2D^2 = D'^2 - D'$ therefore $D'^2 - D' - D' - 3 = 0$ $(D'^2 - 2D' - 3)y = 0$ Which is the ODE with constant coefficient.
19	**Transform differential equation of variable coefficients into differential equation of constant coefficients (x^3D^3+2x^2D^2-xD+1)y=logx** BTL1 **Given** $(x^3D^3 + 2x^2D^2 - xD + 1)y = 0$ Put $xD = D'$, $x^2D^2 = D'^2 - D', x^3D^3 = D'^3 - 3D'^2 + 2D'$ And $e^z = \log x$ therefore $D'^3 - 3D'^2 + 2D' + D'^2 - D' - D' + 1 = 0$ $(D'^3 - 2D'^2 + 1)y = 0$ which is the ODE with constant coefficient.
20	**Solve x^2y”+y=0 (A.U.Nov/dec2004)** BTL1

	Given $(x^2D^2+1)y=0$ Put $xD=D',\ x^2D^2=D'^2-D'$ And $e^z=\log x$ therefore $D'^2-D'+1=0$
21	**Solve ($\frac{dx}{dt}$-y)=0; ($\frac{dy}{dt}$-x)=0 (A.U.jan 2008)** BTL1 **Put** $y=\frac{dx}{dt}$ in $x+\frac{dy}{dt}=0 \Rightarrow\ x+\frac{d^2x}{d^2t}=0$ A.E $m^2=-1 \Rightarrow\ m=\pm i$ C.F = $(A\cos t+B\sin t)$
PART * B	
1.	**Solve (D^2-2D+2)y=$e^x x^2$+5+e^{-2x} (8M) (April/May 2003)** BTL1 **Answer : Page. 5.50-M.B.K. MOORTHY** A.E $m^2-2m+2=0$ $m=1-i,1+i$ C.F = $e^x(A\cos x+B\sin x)$ (2M) P.I=$\frac{1}{(D^2-2D+2)}[e^x x^2+\mathbf{5}+e^{-2x}]$ (2M) P.I=$\frac{5}{2}+\frac{1}{10}\ e^{-2x}+e^x[x^2-2]$ (3M) $y(x)=e^x(A\cos x+B\sin x)+\frac{5}{2}+\frac{1}{10}\ e^{-2x}+e^x[x^2-2]$ (1M)
2.	**Solve (D^2-3D+2)y=2(cos(2x+3)+2 e^x (8) (Jan 2005/2009)** BTL1 **Answer : Page. 5.34-M.B.K. MOORTHY** A.E $m^2-3m+2=0$ $m=1,2$ C.F = $(A\,e^x+Be^{2x})$ (2M) P.I=$\frac{1}{(D^2-3D+2)}\ 2\cos(2x+3)+2e^{2x}$ (2M) P.I=$\frac{-1}{10}\ [3\sin(2x+3)+\sin(2x+3)-2xe^{2x}$ (3M) General solution is, $y(x)=(A\,e^x+Be^{2x})-\frac{1}{10}\ [3\sin(2x+3)+\sin(2x+3)-2xe^{2x}$ (1M)
3.	**Solve (D^2+1)y=$\sin^2$x (8M) (A.UNov 2006)** BTL1 **Answer: Page. 5.35-M.B.K. MOORTHY** A.E $m^2+1=0$ $m=-i,+i$ C.F = $(A\cos x+B\sin x)$ (2M)

	P.I=$\frac{1}{2(D^2+1)}[1-\cos 2x]$ (2M) P.I=$\frac{1}{2}\ [1+\frac{1}{3}\cos 2x]$ (3M) $y(x)=(A\cos \mathrm{x}+B\sin x)+\frac{1}{2}\ [1+\frac{1}{3}\cos 2x]$ (1M)
4.	**Solve (D^2+4)y= x^{2}cos2x (8M) (Jan'09))** BTL1 **Answer : Page. 5.63 -M.B.K. MOORTHY** A.E $m^2+4=0$ $m=-2i,+2i$ C.F = $(A\cos 2\mathrm{x}+B\sin 2x)$ (2M) P.I=$\frac{1}{(D^2+4)}[x^2\cos 2x]$ (2M) P.I=$\frac{1}{4}\ [(\frac{x^3}{3}-\frac{x}{8})\sin 2x+\frac{1}{4}\left(x^2-\frac{1}{8}\right)\cos 2x]$ (3M) $y(x)=(A\cos 2\mathrm{x}+B\sin 2x)+\frac{1}{4}\ [(\frac{x^3}{3}-\frac{x}{8})\sin 2x+\frac{1}{4}\left(x^2-\frac{1}{8}\right)\cos 2x]$ (1M)
5.	**Solve (x^{2}D^2-3xD+5}y=x^{2}sin(log x) (8M) (Jan'09)** BTL1 **Answer: Page. 5.92 -M.B.K. MOORTHY** Given $(x^2D^2-3xD+5)y=0$ (1M) Put $xD=D'$, $x^2D^2={D'}^2-D'$, $e^z=x, z=\log x$ therefore ${D'}^2-4D'-5=\sin z$ A.E $m^2-4m-5=0$ $m=-1{,}5$ C.F = $(A\,e^{mx}+Be^{mx})=\ (A\,e^{-z}+Be^{5z})$ (2M) P.I=$\frac{1}{26}\ [2\cos z-3\sin z]$ (3M) $y(x)=(A\,e^{-z}+Be^{5z})+\frac{1}{26}\ [2\cos z-3\sin z]$ (2M)
6.	**Solve [(2x+3)^{2}D^2-2(2x+3)D-12]y=6x (8M) (Dec 02)** BTL1 **Answer: Page. 5.107 -M.B.K. MOORTHY** Given $(x^2D^2-3xD+5)y=0$ (1M) Put $(2x+3)D=2D'$, $(2x+3)^2D^2=4{D'}^2-4D'$ $e^z=2x+3, z=\log(2x+3)$ therefore ${D'}^2-2D'-3=\frac{3}{4}e^z-\frac{9}{4}$ A.E $m^2-2m-3=0$ $m=-1{,}3$ C.F = $(A\,e^{mx}+Be^{mx})=\ (A\,e^{-z}+Be^{3z})$ (2M)

	P.I=$\frac{-3}{16}\ e^{z}+\frac{9}{12}$ (3M) $y(x)=(A\,e^{-z}+Be^{3z})+\frac{-3}{16}\ e^{z}+\frac{9}{12}$ (2M)
7.	**Solve (D+1)^{2}y=e^{-x} cosx (8M) (Jan'09)** BTL1 **Answer: Page. 5.34-M.B.K. MOORTHY** A.E $(m+1)^2=0$ $m=-1,-1$ C.F = $(A\,\mathrm{x}+B)e^{-x})$ (2M) P.I=$\frac{1}{D}\ e^{-x}\cos X$ (3M) P.I=$e^{-x}\sin x$ (3M)
8.	**Solve Dx+y= sint ; Dy+x= cost Given that x=2, y=0, at t=0 (8M) (A.UJan'09)** BTL1 **Answer: Page. 5.76-M.B.K. MOORTHY** $Dx+y=sin\,t,x+Dy=cos\,t$ To solve the above equations, we have $(D^2-1)x=0$ A.E $m^2-1=0$ $m=-1,1$ (2M) C.F = $(A\,e^{t}+B\ e^{-t})$ (2M) $y(x)=(\sin t-A\,e^{t}+B\ e^{-t})$ (2M) $y(x)=(\sin t-2\ sinht)$ (2M)
9.	**Solve Dx+2x+3y=2e^{2t} ; Dy+3x+2y=0 (8M) (April/May'03)** BTL1 **Answer: Page. 5.74 -M.B.K. MOORTHY** The given equations can be rewritten as $$Dx+2x+3y=2e^{2t},3x+Dy+2y=0$$ To solve the above equations, we have $$(D^2+4D-5)y=-6e^{2t}$$ A.E $m^2+4m-5=0$ $m=1,-5$ (2M) C.F = $(A\,e^{t}+B\ e^{-5t})$ (2M) $P.I=\frac{-6}{7}\ e^{2t}$ (1M) $y(t)=(A\,e^{t}+B\ e^{-5t})+\frac{-6}{7}\ e^{2t}$ $x(t)=(C\ e^{t}+D\ e^{-5t})+\frac{8}{7}\ e^{2t}$ (3M)
10.	**Solve Dx-y=t ; Dy+x=t^2 (8M) (Nov/Dec'03)** BTL1

Answer : Page. 5.82 -M.B.K. MOORTHY
The given equations can be rewritten as

$$Dx - y = t, x + Dy = t^2$$

To solve the above equations, we have

$$(D^2 + 1)x = t^2 + 1$$

A.E $m^2 + 1 = 0$ $\quad m = +i, -i$ (2M)

C.F = $(A\,cos\;t + B\sin t)$ (2M)

$P.I = \; t^2 - 1$ (1M)

$x(t) = (A\,cos\;t + B\sin t) + t^2 - 1$

$y(t) = (-C\sin \mathrm{t} + D\cos t) + t$ (3M)

11. **Solve (D^2+1)y=cosecx by using method of variation of parameter (8M) (Nov'09)** BTL1

Answer : Page. 5.113 -M.B.K. MOORTHY
To solve the above equations, we have

$(D^2 + 1)y = cosec\;x$

A.E $m^2 + 1 = 0$ $\quad m = +i, -i$ (2M)

C.F = $(A\,cos\;t + B\sin t)$ (2M)

$y_1 = cost \quad y_2 = sint \;, \quad y_1' = -sint \quad {y_2}' = \cos t$ (1M)

$P(t) = -t, \quad Q(t) = \log(\sin t)$

$P.I = -t\cos t + \log(\sin t)\sin t$

The Solution $y(t) = \; (A\,cos\;t + B\sin t) - t\cos t + \log(\sin t)\sin t$ (3M)

12. **Solve Dx+y=sint+1 ; Dy+x=cost given that x=1;y=2 when t=0 (8M) (Nov'01)** BTL1

Answer : Page. 5.71 -M.B.K. MOORTHY
The given equations can be rewritten as

$Dx + y = sin\;t + 1, x + Dy = cos\;t$

To solve the above equations, we have $\quad (D^2 - 1)x = 0$

A.E $m^2 - 1 = 0$ $\quad m = +1, -1$ (2M)

$x(t) = (Ae^t + Be^{-t})$ (2M)

$P.I = \; sint + 1$ (1M)

$y(t) = (Ae^t + Be^{-t}) + sint + 1$ (3M)

PH8151 ENGINEERING PHYSICS

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OBJECTIVES

To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

UNIT I PROPERTIES OF MATTER 9

Elasticity – Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple - torsion pendulum: theory and experiment - bending of beams - bending moment – cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment - I-shaped girders - stress due to bending in beams.

UNIT II WAVES AND FIBER OPTICS 9

Oscillatory motion – forced and damped oscillations: differential equation and its solution – plane progressive waves – wave equation. Lasers : population of energy levels, Einstein‘s A and B coefficients derivation – resonant cavity, optical amplification (qualitative) – Semiconductor lasers: homojunction and heterojunction – Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, mode) – losses associated with optical fibers - fibre optic sensors: pressure and displacement.

UNIT III THERMAL PHYSICS 9

Transfer of heat energy – thermal expansion of solids and liquids – expansion joints - bimetallic strips - thermal conduction, convection and radiation – heat conductions in solids – thermal conductivity – Forbe's and Lee‘s disc method: theory and experiment - conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.

UNIT IV QUANTUM PHYSICS 9

Black body radiation – Planck‘s theory (derivation) – Compton effect: theory and experimental verification – wave particle duality – electron diffraction – concept of wave function and its physical significance – Schrödinger‘s wave equation – time independent and time dependent equations – particle in a one-dimensional rigid box – tunnelling (qualitative) - scanning tunnelling microscope.

UNIT V CRYSTAL PHYSICS 9

Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distances - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures - crystal imperfections: point defects, line defects – Burger vectors, stacking faults – role of imperfections in plastic deformation - growth of single crystals: solution and melt growth techniques.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course,

- ✓ The students will gain knowledge on the basics of properties of matter and its applications
- ✓ The students will acquire knowledge on the concepts of waves and optical devices and their applications in fibre optics
- ✓ The students will have adequate knowledge on the concepts of thermal properties of materials and their applications in expansion joints and heat exchangers,

- ✓ The students will get knowledge on advanced physics concepts of quantum theory and its applications in tunneling microscopes, and
- ✓ The students will understand the basics of crystals, their structures and different crystal growth techniques.

TEXT BOOKS:

1. Bhattacharya, D.K. & Poonam, T. ―Engineering Physics‖. Oxford University Press, 2015.
2. Gaur, R.K. & Gupta, S.L. ―Engineering Physics‖. Dhanpat Rai Publishers, 2012.
3. Pandey, B.K. & Chaturvedi, S. ―Engineering Physics‖. Cengage Learning India, 2012.

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1. Halliday, D., Resnick, R. & Walker, J. ―Principles of Physics‖. Wiley, 2015.
2. Serway, R.A. & Jewett, J.W. ―Physics for Scientists and Engineers‖. Cengage Learning, 2010.

UNIT I –PROPERTIES OF MATTER

Elasticity-Stress-strain diagram and its uses-factors affecting elastic modulus and tensile strength-Torsional stress and deformations-twisting couple-Torsional pendulum: theory and experiment-bending of beams-bending moment-cantilever: theory and experiment-uniform and non-uniform bending : theory and experiment-I shaped girders- stress due to bending in beams.

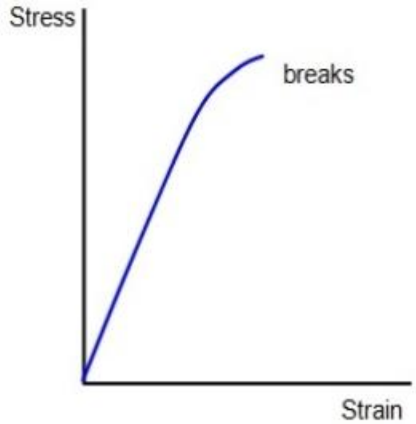
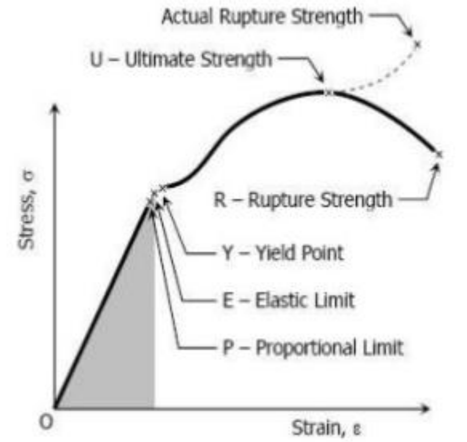
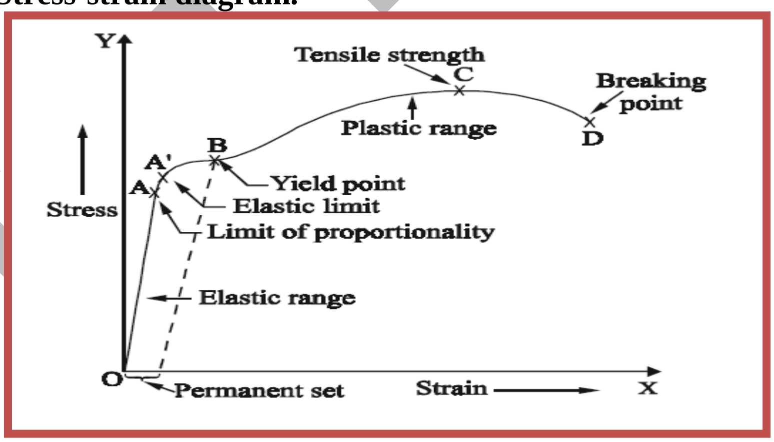
PART * A

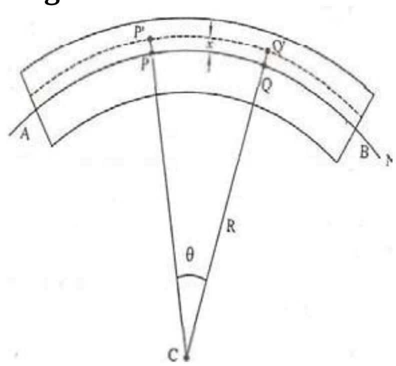
Q.No.	Questions
1.	**Define Neutral axis. How are the various filaments of a beam affected when the beam is loaded? (June 89, May 93, Dec 93,95)** BTL4 In the middle of the beam there is a layer which is not elongated or compressed. This is due to bending of the beam. The layer is called neutral surface and the line at which the neutral layer intersects the plane of the bending is called neutral axis. Filaments which are lying above it are elongated and those lying below it are compressed.
2	**Define stress and strain and write down their units. (Nov 2008, Jan 2012)** BTL1 When external force is applied on a body, it gets deformed. The restoring or recovering force per unit area inside the body is called as stress. Its unit is N/m^2. The change in dimension or shape of a body due to the applied deforming force is called strain. Since it is the ratio, it has no unit.
3	**What is the inference from Stress-strain diagram? (Dec 98, Jan 2011, 2012)** BTL2 A graph plotted between strain along x-axis and stress along y-axis is known as Stress-strain diagram. From the stress-strain diagram, we can infer the following points. ➢ The stress is directly proportional to the strain, within the elastic limit. ➢ It distinguishes the elastic and plastic limit of a material. ➢ It determines the elastic and plastic limit of a material. ➢ The stress-strain diagram also helps us to distinguish the material based on the properties such as ductility and brittleness.
4	**State Hooke's law. (May 2010, Jan 2019)** BTL1 Within the elastic limit, stress developed in the body is directly proportional to the strain produced in it. This is called as Hooke's law. Stress α strain Stress = E x strain Where, E – coefficient of elasticity or modulus of elasticity.
5	**What is Poisson's Ratio?** BTL1 Within the elastic limit, the ratio between lateral strain per unit stress (β) and longitudinal strain per unit stress (α) is known as bulk modulus is known as Poisson ratio.
6	**How do temperature and impurity in a material affect the elasticity of the materials? (Dec 99, Dec 2009)** BTL4 **Effect of temperature**: Rise in temperature usually decreases the elasticity of the material. **Effect of impurities**: The elastic property of the material is either increased or decreased due to the addition of impurities. It depends upon the elastic or plastic properties of the impurities added.
7	**What is I shaped girders? (Dec 2009)** BTL1 A girder is a metallic beam supported at its two ends by pillars on opposite walls. It should be designed in such a way that it should not bend too much or break under its own weight. The cross section of beam is in the form of letter I.
8	**Give the advantages of I-shaped girders. (Nov 2001, May 2003, Dec 2016)** BTL I-shape girders are made by reducing the area of the neutral axis. Hence it has the following

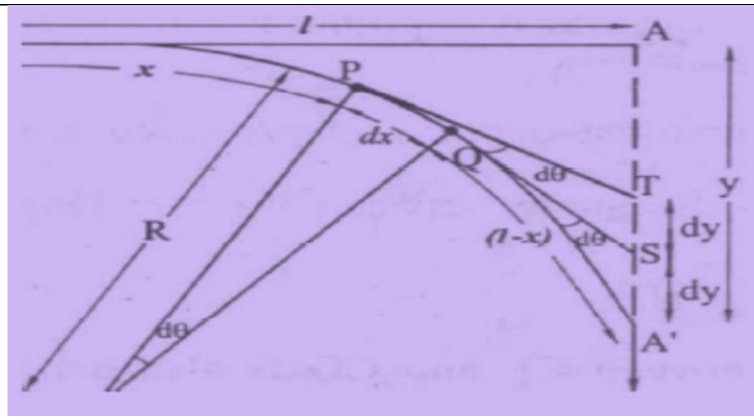
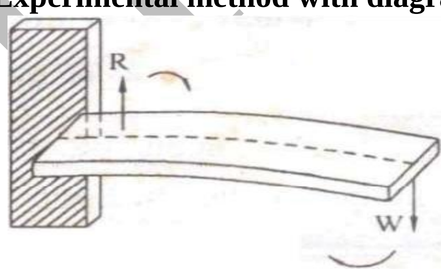
	advantages. ➢ More stability ➢ More strength ➢ High durability ➢ Girders are manufactured by using less amount of raw material.
9	**Mention the factors affecting the elasticity of a material. (May 95, Nov 95, Dec 97)**BTL1 ➢ Temperature ➢ Impurity ➢ Hammering, Rolling and Annealing ➢ Stress ➢ Crystalline nature
10	**What are the effects of hammering and annealing on elasticity of a material? (May 95)** BTL4 While being hammered or rolled, crystal grains break into smaller units resulting in increase of their elastic properties. While annealing constitutes crystals are uniformly oriented and form larger crystal grains, which results in decrease in their elastic properties.
11	**When a wire is bent back and forth, it becomes hot. Why? (Jan 2016)** BTL4 The wire becomes hot when it is bent back and forth due to area of the elastic hysteresis and frictional force.
12	**Define elasticity. What are elastic bodies? (Jan 2010, Dec 2011)** BTL1 Elasticity is the property of the body by virtue of which it tends to regain its original shape or size after the removal of deforming external forces. Bodies which regain its original shape and size after the removal of deforming force are called elastic bodies.
13	**Define young's modulus and rigidity modulus. (Dec 2012, Dec 2013)** BTL1 **Young's modulus**: It is defined as the ratio between linear stress and linear strain within the elastic limit. $Young's\ modulus = \frac{Longitudinal\ stress}{Longitudinal\ strain}$ $Y = \frac{F/A}{\Delta L/L} = \frac{FL}{A\Delta L}$ **Rigidity modulus**: It is defined as the ratio between shearing stress and shearing strain within the elastic limit. $S = \frac{F/A}{\Phi}$
14	**State bulk modulus. (Apr 2012)** BTL1

	It is defined as the ratio between volume stress and volume strain within the elastic limit. $B = \frac{Volume\ Stress}{Volume\ Strain} = \frac{-F/A}{\Delta V/V}$
15	**Write elastic and plastic limit.** BTL1 **Elastic limit**: The maximum stress up to which a body can recover its original shape and size after removing the external forces is called as elastic limit. **Plastic limit**: After elastic limit, if the elasticity of the body is completely lost then the body will be in a limit called plastic limit.
16	**Define Yield point and Elastic fatigue.** BTL2 **Yield point**: If the external stress applied is very large, then the body will lose its elastic property even after the removal of the stress. The point at which the body loses its elasticity is called yield point **Elastic fatigue**: If a body is continuously subjected to stress or strain, its get fatigued called as elastic fatigue.
17	**What is meant by uniform and non-uniform bending? (Apr 2010, Jan 2011, DEC 2017)** BTL2 **Uniform bending**: The beam is loaded uniformly on its both ends; the bent beam forms an arc of a circle. The radius of curvature of the bent beam is constant for given load. This type of bending is called as uniform bending. **Non-uniform bending**: If the beam is loaded at its mid-point, the depression produced does not form an arc of a circle. This type of bending is called as non-uniform bending.
18	**Define Torque. What is moment of a force?** BTL2 Torque is the rotating force and is equal to the moment of the couple. Torque is the product of one of the forces forming couple and the perpendicular distance between the two opposite forces. The moment of a force about a point is defined as the product of the magnitude of the force and the perpendicular distance from the point to the line of action of force.
19	**What is Torsional Pendulum? Mention its applications.** BTL2 A circular metallic disc suspended using a thin wire that executes Torsional oscillation is called Torsional pendulum. It is used to determine ➢ Rigidity modulus of the wire ➢ Moment of inertia of the disc ➢ Moment of inertia of an irregular body
20	**Clarify bending moment of beam. (Nov 97, May 2011)** BTL1 The moment of the couple due to the elastic reactions which balances the external Couple due to the applied load is called the bending moment.
21	**A wire of length 1 meter and diameter 1 mm is fixed at one end and a couple is applied at the other end so that the wire twists by π/2 radians. Calculate the moment of the couple required if rigidity modulus of the material =2.8x10^{10} N/m^2. (May 2014)** BTL3 Required couple $\tau = (\pi n \Theta r)^4/2l$

	Substituting the given values, we have $\tau = ((3.14 x 2.8 x 10^{10} x 0.5 x 3.14 x (0.5 x 10^{-3})^4) / (2x1)$ $\tau = 4.3 \times 10^{-3}$ Nm
22	**A cantilever of rectangular cross-section has a length of 50 cm. Its breadth is 3 cm and thickness 0.6 cm. A weight of 1 Kg is attached at the free end. The depression produced is 4.2 cm. Calculate Young's modulus of the material of the bar. Given data g=9.8 m/sec^2. (Jan 2010)** BTL3 Young's modulus of the beam $Y=(4Mgl^3) / (bd^3y)$ $Y=((4x1x9.8x(50x10^{-2})) / (3x10^{-2}x(0.6x10^{-2})^3x4.2x10^{-2})$ $Y= 1.8x10^{10}$ Nm^{-2}
23	**Uniform rectangular bar 1m long, 2 cm broad and 0.5 cm thick is supported on its flat face symmetrically on two knife edges 70 cm apart. If loads of 200 g are hung from the two ends the elevation of the center 0f the bar is48 mm. Find young's modulus of the bar. (Jan 2010)** BTL3 Young's modulus $Y=(3Mgal^2) / (2bd^3y)$ Substituting the given values, we have $Y= (3x200x10^{-3}x9.8x15x10^{-2}x(70x10^{-2})^2) / (2x2x10^{-2}x(0.5x10^{-2})^3x48x10^{-3})$ $Y=1.8x10^{10}$ Nm^{-2}
24	**A bar of length 1 m and cross-section $5x10^{-3}$ m^2 is supported at its two ends and loaded in the middle. The depression observed in the middle is $1.96x10^{-3}$ m when a load of 0.1 Kg is placed. Calculate the Young's modulus of the material. (May 2015)** BTL3 We know that for non-uniform bending $Y=(Mgl^3) / (4bd^3y)$ Substituting the given values, we have $Y= ((0.1x9.8x(1)^3) / (4x(5x10^{-3})^3x(1.96x10^{-3}))$ $Y=4x10^{10}$ Nm^{-2}
25	**A circular and a square cantilever are made of same material and have equal area of cross-section and length. Find the ratio of their depression for a given load. (Dec 2008)**BTL3 **Solution : Depression for a given load $y=(Mgl^3) / (3YI)$** **Depression in circular cantilever for a given load** $\boldsymbol{y_c} = (Mgl^3) / (3YI_c)$ **Depression in square cantilever for a given load** $\boldsymbol{y_s} = (Mgl^3) / (3YI_s)$ $\boldsymbol{y_c / y_s = I_s / I_c}$ $= (a^4/12) / (\pi r^4/4)$ $\boldsymbol{y_c / y_s} = a^4/3\pi r^4$ Since cross sectional areas of circular and square cantilevers are equal, we have $\pi r^2 = a^2$ $a^2 / r^2 = \pi$ Therefore $\boldsymbol{y_c / y_s} = (1a^4/3\pi r^4)$ $= (1/(3\pi)) \times ((a^2/r^2)^2)$ $= \pi^2 / (3\pi)$ $\boldsymbol{y_c / y_s} = \pi / 3$
26	**Draw stress-strain diagram for ductile and brittle material. (2017)** BTL4

	 **BRITTLE MATERIAL**  **DUCTILE MATERIAL**
27.	**What is tensile strength? (Jan 2019)** BTL1 The tensile strength of a material is the maximum amount of tensile stress that it can take before failure.
28.	**List the applications of I-Shape girders. (or) Appraise the applications of I-shape girder.** BTL1 Used in construction of buildings, bridges, fly overs, rail way track etc. (2M)
	PART * B
1	**Write a short note on stress strain diagram. (or) Draw stress-strain diagram of a typical wire and explain its behaviour and uses. (or) What is stress-strain diagram? Explain how it is used to study the mechanical behaviour of ductile material. (Jan 2019)** BTL2 **Answer: Page: 1.5 - Dr.P.MANI** ➢ **Stress-Strain Diagram** The graph drawn between stress along Y-axis and strain along X-axis of a material. (1 M) ➢ **Stress-strain diagram.**  (3 M) ➢ **Behaviour of solid material** Proportionality limit Hooke’s law Elastic limit Yield point Tensile strength Breaking stress (4 M)

2	**Derive an expression for the internal bending moment of a rectangular beam and circular rod. (Nov 98, Jan 2013, Jan 2016) (16M)** BTL1 **Answer : Page 1.35 –Dr.P.MANI** ➢ **Bending Moment of a beam** (2M) Static reaction - balances external couple - due to applied load. ➢ **Diagram** (2M)  ➢ **Explanation** (4M) Beam points on neutral axis-Radius of curvature(R) - Centre of curvature(O). ➢ **Derivation** Original length PQ = Rθ Extended length = P'Q'= $(R+x)\theta$ (4M) Linear strain = Increase- length/Original length Linear strain = x/R Young's modulus Y = Linear Stress/Linear Strain, Stress = Y* Linear Strain Tensile Force = Yx. δA/R (2M) Total moment of all the forces (or) Internal bending moment = YI_g/R* (2M)
3	**What is cantilever? Obtain expression for the depression at the loaded end of cantilever whose other end is fixed assuming that its own weight is not effective in bending. Describe an experiment to determine the Young's modulus of the cantilever material using this expression. (or) Derive an expression for the deflection produced at the free end of rectangular cantilever subjected to point load at free end. What will be the deflection produced at the free end, with same load, if the cantilever is of circular cross-section. (Apr 2011, Jan 2012, Jan 2014, June 2014, Jan 2016, Jan 2018) (16M)** BTL3 **Answer : Page: 1.38 –Dr.P.MANI** ➢ **Cantilever** (2M) Beam fixed horizontally-fixed at one end-loaded at another end. ➢ **Diagram** (2M)

	 ➢ **Derivation for Young's modulus (rectangular and circular beam)** $Internal\ Bending\ Moment = \frac{YI}{R}$ $External Bending Moment = w(l-x)$ (2M) **In Equilibrium position,** $w(l-x) = \frac{YI}{R}$ (2M) ➢ **Find R value** $R = \frac{(l-x)\,dx}{dy}$ (2M) ➢ **Substitute "R" value** $dy = \frac{W}{YI}(l-x)^2 dx$ ➢ **Total depression** $\int dy = \int_0^l \frac{W}{YI}(l-x)^2 dx$ $y = \frac{Wl^3}{3YI}$ (2M) ➢ **Experimental method with diagram.** (2M)  Beam clamped at one end- weight hanger suspended other end-focus tip of pin by using microscope- find depression. (2M)
4	**Describe with necessary theory, the method to determine the Young's modulus of the material of a rectangular bar and circular beam by uniform bending. (June 89, May 95, June 98, Jan**

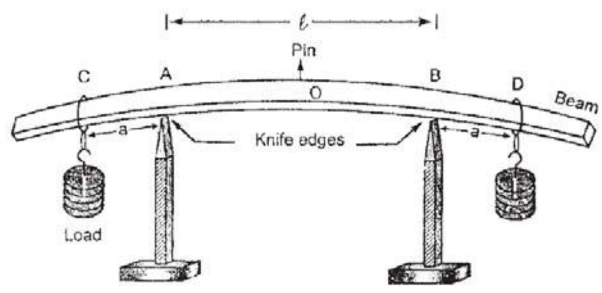
2011, Nov 2001) (or) Derive an expression for the elevation produced at the center of the beam which is loaded at both ends. (Dec 2017) (16M) BTL2

Answer : Page: 1.45 –Dr.P.MANI

- **Young's modulus** (2M)

Within elastic limit- the ratio between linear stress to linear strain - Beam loaded uniformly -forms arc at both ends.

- **Diagram** **(**2M)



Young's Modulus – Uniform Bending

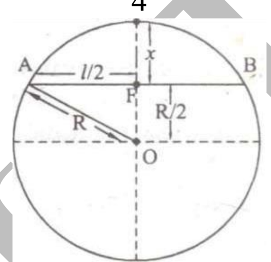
- **Derive the expression for young's modulus (rectangular and circular beam)**

  Internal bending moment= $\frac{YI}{R}$

  External bending moment=Wa (2M)

- **Property of a circle**

  2yR-y²= $\frac{l^2}{4}$



(2M)

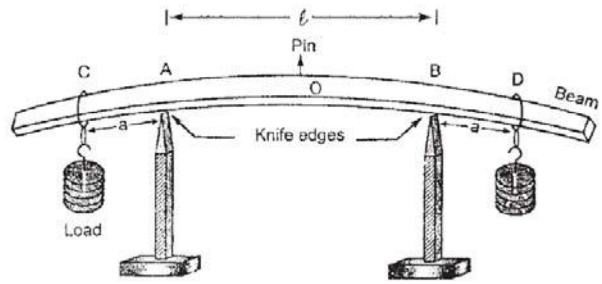
- **Find** $\frac{1}{R}$ **Value**

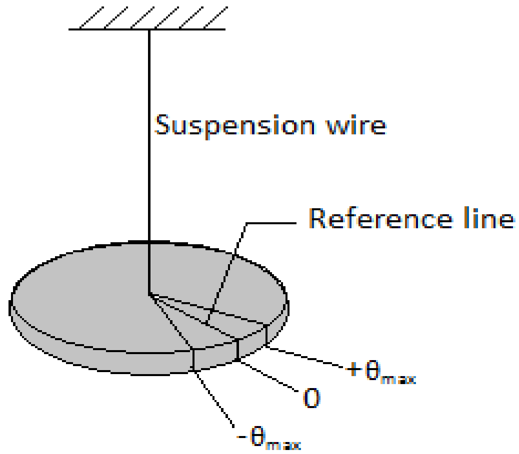
  $\frac{1}{R} = \frac{8y}{l^2}$ (2M)

- **Young's modulus-beam**

  $$Y = \frac{3Mgal^2}{2byd^3}$$ (2M)

- **Experimental method with diagram and description** (2M)

	 Young's Modulus – Uniform Bending Rectangular beam – horizontal support on knife edges - two weight hangers with equal masses - pin fixed at centre point - microscope focus on pin - equal weights loaded – removed at both ends - mean elevation determined. ➢ **Formula and table** (2M)
5	**Describe the factors affecting elasticity of a material. (8M)** BTL4 **Answer : Page: 1.15-Dr.P.MANI** ➢ **Factors affecting elasticity** • Stress, impurities • Annealing • Temperature • crystalline nature ➢ **Annealing** (2M) Heating Material – gradual cooling - forms larger crystal grains - elasticity decreases. ➢ **Hammering** (2M) Hammered (or) rolled- crystal grain breaks smaller-elasticity increases. ➢ **Addition of impurities** (2M) Less impurity: less elasticity - more impurity: more elasticity. ➢ **Effect of stress** (2M) Large constant stress-losses elasticity gradually.
6	**What is Torsional pendulum? Explain how it is used to determine the moment of inertia of a circular disc and rigidity modulus of the material of a thin wire?(May 93, May 95, , Nov 95, Dec 97, May 2003, Dec 2017, Jan 2018) (16M) (or) Derive an expression for the rigidity modulus using torsional pendulum. (May 2019) (8 M)** BTL4 **Answer :Page: 1.24-Dr.P.MANI** ➢ **Torsional Pendulum** (2M) Circular metallic disc- suspended using thin wire - Executes Torsional oscillation. ➢ **Diagram** (1 M)



- **Description** (3M)

Metal wire suspended - upper end fixed - metallic disc connected with lower end - twist applied- disc oscillates - torsional oscillations.

- **Derivation**

T=2 $\pi\sqrt{I/C}$ (4 M)

- **Determination of Rigidity Modulus of the wire and moment of inertia of a circular disc**

Time period of oscillation $T^2 = 4\pi^2 I/C$ (2M)

Rigidity Modulus $n= \frac{8\pi I}{r^4}(\frac{l}{T^2})$ (2M)

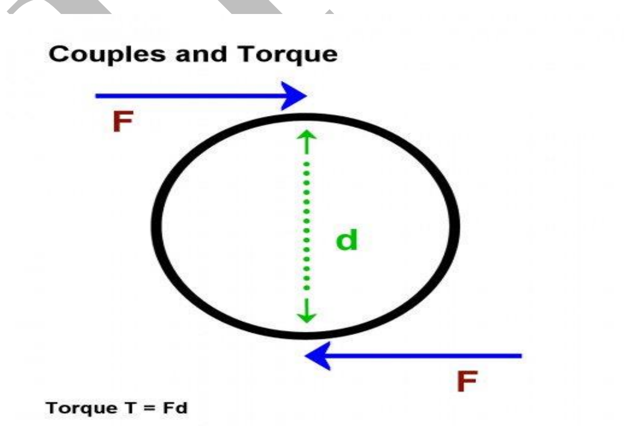
Moment of inertia $I = MR^2 / 2$ (2 M)

7

Deduce an expression for the couple to produce a unit twist in a long cylindrical wire fixed at one end. (Dec 94, July 1995) (8M) BTL2

Answer :Page: 1.19-Dr.P.MANI

- **Diagram** (2M)



- **Derivation**

Shearing force = $\dfrac{2\pi n\theta}{l} x^3 dx$ (4M)

The torque per unit twist C=$\frac{\pi n r4}{2L}$ (2M)

8

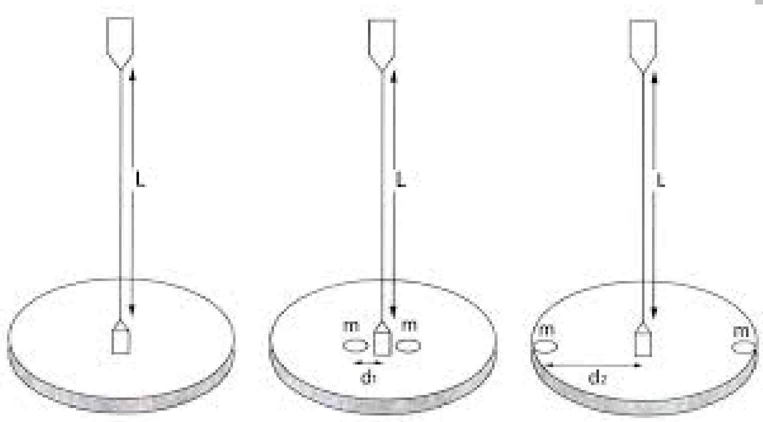
Describe how the rigidity modulus of the material in the form of a wire and rigidity modulus of the circular disc may be determine by symmetrical mass and a Torsional pendulum (Dynamic method). (16M) BTL2

Answer :Page: 1.29-Dr.P.MANI

- **Construction** (2M)

Steel wire fixed at one end-circular disc fixed at other end – executed Torsional oscillations.

- **Diagram** (2M)



- **Derivation-To find Moment of Inertia**

Mean time period $T_1^2 = \dfrac{4\pi^2}{C}(I_0 + 2i + 2md_1^2)$ (2M)

Mean time period $T_2^2 = \dfrac{4\pi^2}{C}(I_0 + 2i + 2md_2^2)$ (2M)

Moment of inertia = $2m\,(d_2^2 - d_1^2)T_0^2 / T_2^2 - T_1^2$ (4M)

- **Calculation of rigidity modulus**

$n = 16\pi lm(d_2^2 - d_1^2)/(T_2^2 - T_1^2)r^4\ Nm^{-2}$ (4M)

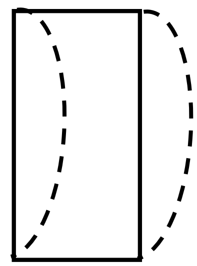
9.

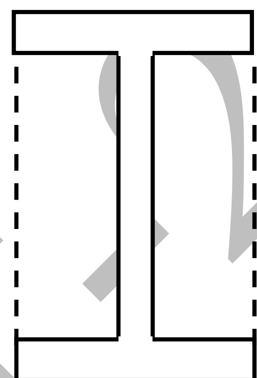
What is I shaped girders? Give the advantages and uses of I-shaped girders. (or) Write a short note on I-Shape girders. (Nov 2001, May 2003, Dec 2016, Jan 2019) BTL2

Answer :Page: 1.53-Dr.P.MANI

A girder is a metallic beam supported at its two ends by pillars on opposite walls. It should be designed in such a way that it should not bend too much or break under its own weight. The cross section of beam is in the form of letter I.

The depression (y) at the center of a beam of length *l*, breadth *b* and thickness *d* under a load M*g* at its mid-point is given as $Mgl^3 / 4bd^3Y$ (2M)

- Hence to reduce the bending for a given load, Y of the material of the beam should be large, b and d of the beam must also be large.
- The length should be as small as possible.
- Since depression y is inversely proportional to d^3, the depression can be reduced more effectively by increasing the thickness d rather than increasing the breadth b of the beam.
- But on increasing the thickness, unless the load is at the centre, the beam may bend. This is called ***buckling*** of the beam.
- 
- To prevent buckling, a large load-bearing surface is required.
- Hence, the beam is designed to have a large thickness to minimize bending and a large load bearing surface to prevent buckling.
- The shape which satisfies these conditions is I. So it is called the I section of the beam or girder.



(2M)

I-shape girders are made by reducing the area of the neutral axis. Hence it has the following advantages.

- ➢ More stability
- ➢ More strength
- ➢ High durability
- ➢ Girders are manufactured by using less amount of raw material. **(2M)**

Applications of I-Shape girders

Used in construction of buildings, bridges, fly overs, rail way track etc. (2M)

10.

Describe the theory of non-uniform bending with neat sketch. Explain how it is used to determine the Young's modulus of the material of a rectangular bar and circular beam by non-uniform bending. (16 M) BTL2

Answer :Page: 1.51-Dr.P.MANI

Non-uniform bending definition:

	If the beam is loaded at its mid-point, the depression produced does not form an arc of a circle. This type of bending is called non-uniform bending. (1 M) Diagram (1 M) Cantilever depression = Wl^3 / 3YI (2 M) Non-uniform bending is formed by two cantilevers, y = Wl^3 / 48 IY (4 M) Special cases (i) For rectangular Beam I = bd^3 / 12 Therefore y = Mgl^3 / $4bd^3Y$ (2 M) Case (ii) For circular beam I = πr^4 / 4 Therefore y = Mgl^3 / 12 $\pi r^4 Y$ (2M) Experiment to determine Y = Mgl^3 / $4bd^3y$ (1M) Diagram and description (2 M) Table (1 M)
	UNIT-II WAVES AND OPTICS
	Oscillatory motion–Forced and damped oscillation: differential equation and its solution-Plane progressive waves–wave equation-Lasers: Population of energy levels, Einstein's A and B coefficients derivation–resonant cavity, optical amplification (qualitative)–Semiconductor lasers: homojunction and hetrojunction–Fiber optics: principle, Numerical aperture and Acceptance angle –Types of optical fibres (material, refractive index, mode)–losses associated with optical fibres–fibre optic sensors: pressure and displacement.
	PART * A
Q.No.	**Questions**
1.	**Define oscillatory motion. Give examples.** BTL1 An oscillatory motion is one in which a body moves to and fro repeated about a mean position. Eg. Motion of a pendulum, Oscillation of a loaded spring, motion of the prongs of tuning fork.
2	**Define forced oscillations and damped oscillations.** BTL1 **Forced Oscillation**: When an oscillating body is maintained in the state of oscillations by a periodic force of frequency (n) other than its natural frequency of the body, the oscillation is called forced oscillations. **Damped Oscillation**: The oscillation in which the amplitude of oscillations decreases with time and finally becomes zero is called as damped oscillation.
3	**Can we use a two level system for the production of Laser? How? (Or) How many energy levels are required for producing laser action? (Jan.2011, Jan2014)** BTL2 No. Two level system cannot be used for the production of laser. Because minimum of three energy (Ground State, Excited State and Meta Stable State levels are required to achieve the population inversion.

4

Why do we call laser as a non-material knife? BTL4

In Laser surgery, without knife or hammer blood less operation, cutting tissues and cutting bones etc. can be made. Hence laser is called as Non Material Knife.

5

What is recombination radiation? Also define activation energy. (Or) What is injection luminance laser? State the principle of laser diode. (Homo Junction and hetero junction) (Jan. 2009) BTL2

When p-n junction diode laser is in forward bias, electron from n-region and holes from p-region recombine with each other at the junction. The electrons and holes are injected in to junction region in considerable concentration recombination takes place to give light photons. So it is known as injection laser.

6

What is meant by LASER? Give its characteristics. (Jan. 2009) (or) Abbreviate the term LASER. List out its characteristics. BTL2

The term LASER stands for Light Amplification by Stimulated Emission of Radiation.

Characteristics of LASER

- It has high directionality
- It has high degree of coherence
- It has high intensity
- It is highly monochromatic

7

Distinguish between ordinary light and LASER light. BTL4

S.No.	**Ordinary light**	**Laser light**
1	Its angular spread is high	Its angular spread is low
2	It is not a coherent beam	It is a coherent beam
3	They are not directional	They are highly directional
4	It is a low intense beam	It is a high intense beam
5	It is polychromatic	It is highly monochromatic

8

Define the terms "normal population" , "population inversion" and population of energy levels.(Jan 2009., Jan. 2011., Jan 2012., Dec.2014). BTL1

Normal population: In a system at thermal equilibrium, It is the situation in which the number of atoms in the lower energy level is greater than the number of atoms in the exited level. i.e, $N_1 > N_2$

Population inversion: It is the situation in which the number of atoms in the exited level is greater than the number of atoms in the lower energy level. i.e, $N_2 > N_1$

Population Energy level: No of atoms per unit volume.

9

Distinguish between Spontaneous and Stimulated emission. (Dec.94, May 2005, Jan 2009). BTL4

Sl. No.	Spontaneous emission	Stimulated emission
1	Emission is a spontaneous process	Emission is triggered by external energy
2	Emitted photons move in all direction randomly	Emitted photons move in same direction
3	Emitted photons are not in phase	Emitted photons are in phase

4	Radiation is less intense and incoherent	Radiation is high intense and coherent

10

Distinguish between homo junction and hetero junction semiconductor diode laser. (Jan 2009., Jan 2010) BTL4

Sl. No.	Homo-Junction Semiconductor diode Laser	Hetero-Junction semiconductor diode laser
1.	Homojunction laser is made by a single crystalline material.	Hetrojunction laser is made by different materials.
2.	Power output is low.	Power output is high.
3.	It has high threshold current density.	It has low threshold current density.
4.	Cost is less	Cost is more
5.	Life time is less	Life time is more

11

What is optical fiber? List out the types of optical fiber. BTL2

Optical fiber is a wave guide which guides light for propagation.

- **Material**
  - Glass fiber
  - Plastic fiber
- **Mode of Propagation**
  - Single mode fiber
  - Multi mode fiber
- **Refractive index profile**
  - Step index fiber
  - Single mode
  - Multi mode step index fiber
  - Graded index (GIN)- Multimode graded index fiber

12

What are the advantages of fiber optic communication over the wire (conventional) communication?
BTL2

- Large information carrying capacity (Large band width)
- Minimum loss of energy
- Signal security and no cross talk
- High corrosion resistance

13 +

State the principle of fiber optics. (or) What is total internal reflection? Write the conditions to achieve total internal reflection. BTL1

When light travels from denser to rarer medium with the angle of incidence greater than critical angle, there is no refraction and reflection only takes place. This phenomenon is called Total Internal Reflection.

Conditions to achieve Total Internal Reflection

- Light should travel from denser to rare medium $n_1>n_2$
- Angle of incidence should be greater than critical angle

14

Define critical angle. BTL1

It is the angle of incidence at which the angle of refraction is at 90^0.

	$\phi_C = Sin^{-1}\left(\frac{n_2}{n_1}\right)$
15	**Define acceptance angle and numerical aperture.(Jan 2009)** BTL1 **<u>Acceptance angle</u>**: The maximum angle at or below which a ray of light can suffer total internal reflection is called the acceptance angle of the fiber. $\phi_a = Sin^{-1}\sqrt{n_2^2 - n_1^2}$ **<u>Numerical Aperture</u>**: It is defined as the sine of the acceptance angle of the fiber $Numerical\ Aperture\ (N.A) = Sin\phi_a = \sqrt{n_2^2 - n_1^2}$
16	**What is attenuation?** BTL2 Attenuation is the loss of optical power as light travels along the fiber. Signal attenuation is defined as the ratio of optical input power (p_I) to the optical output power (p_o). $\alpha = \frac{10}{L}\log\left(\frac{P_i}{P_o}\right)$ dB/m
17	**Distinguish step index and graded index fiber. (May 2003, May 2004, Jan. 2009)** BTL4

Sl. No	Step index fibre	Graded index fibre
1.	n_1 is uniform throughout the core and undergoes abrupt change at the core cladding interface.	n_1 varies gradually as a function of radial distance from the axis of the fibre being maximum at the fibre axis.
2.	Attenuation is more for multimode step index and very less for single mode step index fiber	Attenuation is less
3.	It has lower bandwidth	It has higher bandwidth
4.	Light propagates in the form of meridonal rays. It crosses the fiber axis.	Light propagates in the form of skew rays. It never crosses the fiber axis.
5.	Light propagation is in zig-zag manner	Light propagation is in helical manner

18	**What is sensor? Give the types of sensors.** BTL2 A fiber optical sensor is a transducer which converts any form of Signal into an optical signal, in a measurable form
19	**Name the types of losses in fiber optics.** BTL2 1. Absorption loss • Absorption due to Imperfection • Intrinsic absorption • Extrinsic absorption 2. Scattering loss **3.** Bending loss or Radiative loss • Micro bending loss • Macro bending loss
20	**Laser action occurs by transition from an excited state (E_2) to the ground state (E_1=0). If the transition produces a light of wavelength 6930A^0, find the energy level of the excited state.** BTL1

	E_2-E_1 =hυ/λ =$6.625x10^{-34}x3x10^{8}/6930x10^{-10}$ E_2= $2.868x10^{-19}$J=1.79eV.
21	**Calculate the wavelength of light emission from GaAs whose band gap is 1.44eV.** BTL2 Band gap E_g=1.44eV=$1.44x1.6x10^{-19}$J $\Lambda = 6.625x10^{-34}x3x10^{8}/1.44x1.6x10^{-19}$ Wavelength = 8628 A^0
22	**Compute the numerical aperture and acceptance angle of an optical fiber from the following data.** BTL4 **Refractive index of core n_1=1.55** **Refractive index of cladding n_2=1.50** **Surrounding medium n_0=1** $Numerical\ Aperture\ (N.A) = Sin\phi_a = \sqrt{n_2^2 - n_1^2}$ NA=0.39 Acceptance angle $\phi_a = Sin^{-1}\sqrt{n_2^2 - n_1^2}$ $Acceptance\ angle = 23\ degree$
23	**In an optical fiber, the core material has a refractive index 1.6 and refractive index of cladding material is 1.3. What is the value of critical angle?** BTL1 $= Sin^{-1}n\text{-}2 - n1$ $= Sin^{-1}(0.813)$ Critical angle =54.3^0
24	**Mention the types of sensors used in the fiber optics. (May.2013)** BTL2 There are two types of sensors used ➢ Intrinsic sensors – Here, fiber itself acts as a sensing element. ➢ Extrinsic sensors – Separate sensing system collects the light from the fiber. Fiber acts only a guiding medium.
25.	**What is meant by cavity loss? (Jan. 2019)** The loss which occurs in optical cavity due to misalignment of optical mirrors, absorption, scattering and losses in optical elements.
26.	**Why does inter-modal dispersion occur? (Jan. 2019)** Intermodal modal dispersion occurs when more than one mode is propagating through a fiber. Since many modes are propagating , they will have different wavelengths and will take different time to propagate through the fiber which leads to inter-modal dispersion.
27.	**Why population inversion is necessary for laser action and how it can be achieved? (Dec. 2017)** BTL 4 For laser action stimulated emission is the principle. Without population inversion, stimulated emission can't be achieved. Population inversion can be achieved by pumping processes.
28.	**What is the condition to achieve total internal reflection? (Dec 2017)** BTL1 ➢ Light should travel from denser medium to rarer medium ➢ Angle of incidence should be greater than critical angle
	PART * B

1

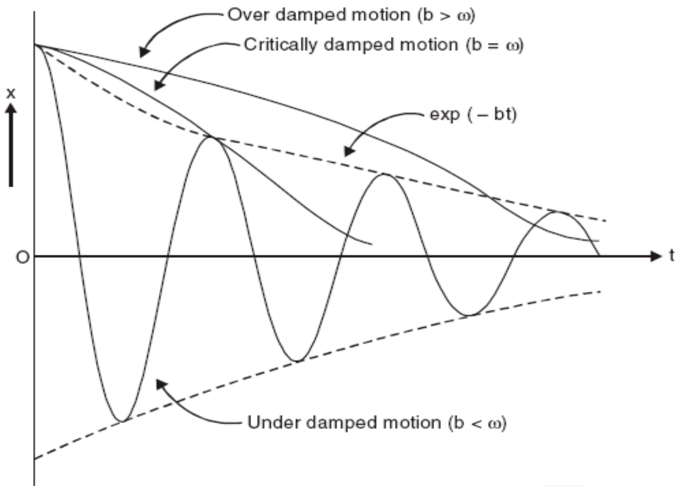
Define damped oscillation. Derive differential equations and solutions for damped oscillations. (P2.10-2.16)(16M) BTL1

Answer : Page: 2.10-Dr.P.MANI

- **Damped Oscillation** (2M)

  Resistance by any medium -Amplitude decreases with time -becomes zero.

- **Diagram** (2M)



- **Derivation**

$$\frac{d^2y}{dx^2} + 2b\frac{dy}{dx} + \omega^2 y = 0$$ (3M)

- **General solution**

$$x = e^{-bt}\left[A_1 \exp(\sqrt{b^2-\omega^2}\,t) + A_2 \exp(-\sqrt{b^2-\omega^2}\,t)\right]$$ (4M)

- **Case(i)-Heavy Damping**

  ($-b+\sqrt{b^2-\omega^2}$) and ($-b-\sqrt{b^2-\omega^2}$) becomes negative (1M)

- **Case(ii)-Critical Damping**

  $Y=e^{-bt}(p+qt)$ (2M)

- **Case (iii)-Low Damping**

  $Y=ae^{-bt}\sin(\sqrt{(\omega^2-b^2)}t+\phi)$ and $T=2\pi/\sqrt{(\omega^2-b^2)}$ (2M)

2

Define forced oscillation. Derive differential equations and solutions for forced oscillations. (16M) BTL1

Answer : Page : 2.16-Dr.P.MANI

- **Forced oscillation** (2M)

  Periodic force of frequency-other than natural frequency -driven by external force.

- **Diagram** (3M)

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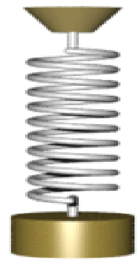

➢ **Derivation**

Restoring force

Frictional force

➢ **External periodic force**

$$\frac{d^2y}{dx^2}+2b\frac{dy}{dt}+\omega^2 y = f \sin pt \qquad (5M)$$

Θ= tan^{-1}(2bp/w^2-p^2

➢ **CASE(i)**

Θ= tan^{-1}(2bp/w^2-p$^{2)}$ =0 (2M)

➢ **CASE(ii)**

$$\theta = \frac{\pi}{2} \qquad (2M)$$

➢ **CASE(iii)**

$$\theta = \pi \qquad (2M)$$

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<tr><td>3</td><td>

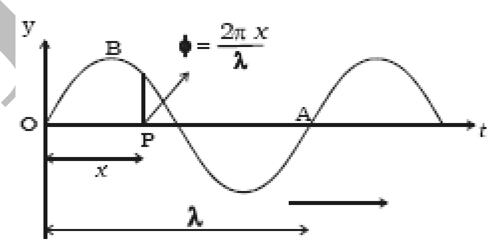
Define plane progressive wave. Obtain the wave equation for plane progressive wave with solutions. (BTL1)(16M) BTL

Answer : Page: 2.23-Dr.P.MANI

➢ **Plane Progressive wave** (2M)

Originating point source-isotropic medium- travel with equal velocity.

➢ **Diagram** (2M)



Plane Progressive wave

➢ **Derivation**

Y= A sin($\omega t + kx$) (5M)

➢ **Differential-wave equation**

$$\frac{d^2y}{dx^2} = \frac{1}{v^2}\frac{d^2y}{dx^2} \qquad (5M)$$

$$Y' = a \sin\frac{2\pi}{\lambda}(vt - x) \qquad (2M)$$

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4

Explain in brief about population of energy levels. Derive the equation for Einstein's coefficients. Why does spontaneous emission dominate over stimulated emission at normal temperatures? (or) Derive Einstein's relation for spontaneous and stimulated emission of radiation. (or) Give a schematic sketch of normal population and population inversion state of a laser and obtain Einstein's coefficients A and B. (Jan.2009., Jan.2011, May 2019)(16M) BTL2

Answer : Page: 3.4&3.9-Dr.P.MANI

- **Spontaneous Emission** (1M)

  The atom in excited state E_2 returns to ground state E_1 by emitting a photon of energy h_γ without the action of an external agency.

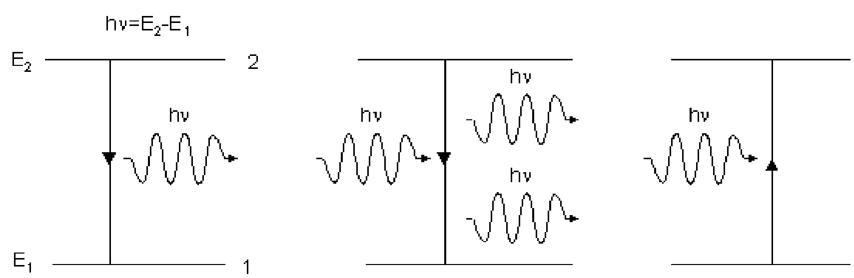
- **Stimulated Emission** (1M)

  The atom in excited state E_2 returns to ground state E_1 by emitting a photon of energy h_γ with the action of an external agency.

- **Stimulated absorption** (1M)

  Light radiation -with external triggering- energy level-shifted to ground state to excited state.

- **Diagram** (2M)



- **Derivation**

  Under equilibrium i.e., $A_{21} N_2 + B_{21} N_2 Q = B_{12} N_1 Q$

$$Q = \frac{A_{21}}{B_{21}} \frac{1}{\left(\frac{B_{21}}{B_{21}}\right)\frac{N_1}{N_2} - 1}$$ (4M)

- **Result**

$$\frac{B_{12}}{B_{21}} = 1$$

$$\frac{A_{21}}{B_{21}} = \frac{8\pi h\nu^3}{c^3}$$ (5M)

- **Conclusion** (2M)

  Spontaneous emission more predominant than stimulated-population inversion required for laser action- relation between spontaneous emissions to stimulated emission.

5

Explain the principle, construction and working of homo-junction semiconductor lasers.(Jan.2011, Dec 2017)(16M) (or) Explain the principle, construction and working of a semiconductor laser with neat sketch. (8 M) BTL1

Answer: Page: 3.24-Dr.P.MANI

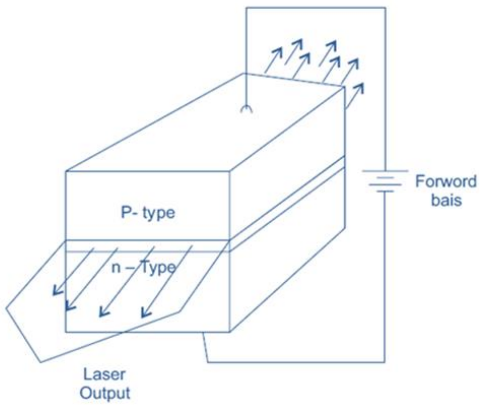
- **Homo-junction laser** (2M)

Semiconductor diode laser - fabricated with a PN junction - forward bias – emitting laser light.

- **Construction** (3M)

  Active medium-PN junction diode - upper region (P -Region)-lower region (n-region) - forward
  Bias – stimulated emission, optical resonator.

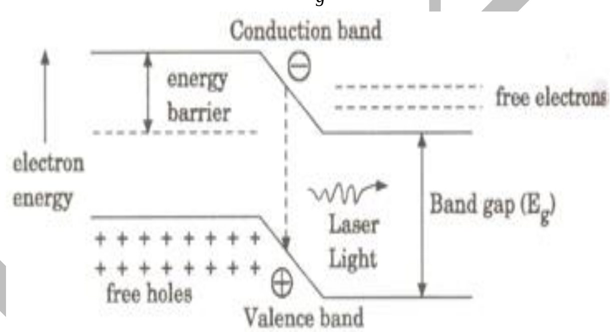
- **Diagram** (2M)



- **Working** (4M)

PN junction-forward bias, electron-hole injected, conduction band-more electrons, valence band-more holes, electron-hole-recombination, light photon-released, Forward bias, polished mirror, laser beam wavelength-8400 A.

$$\lambda = \frac{hc}{E_g}$$



- **Advantages** (2M)

  Very small-size, high efficiency, continuous wave output.

- **Disadvantages**

  Poor coherence - poor monochromatic – large divergence.

- **Applications** (3M)

  Laser printer – CD players – pain killers – fiber optic communication.

6

Explain the principle, construction and working of hetro-junction semiconductor lasers. (Jan.2014)(16M) (or) Explain the principle, construction and working of a semiconductor laser with neat sketch. (8 M) BTL1

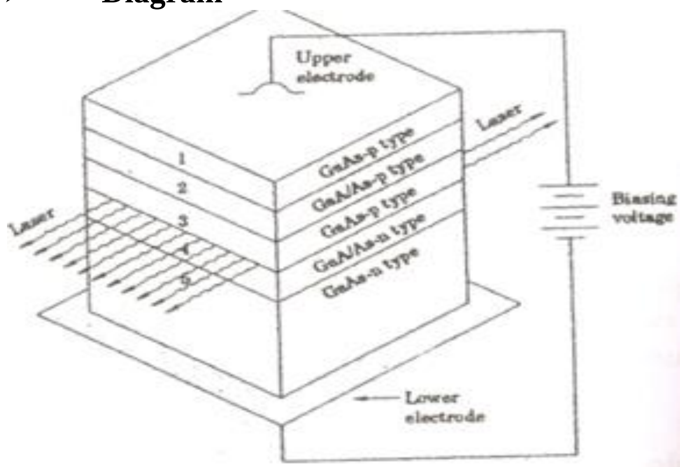
Answer : Page : 3.28-Dr.P.MANI

- **Hetro-junction laser** (2M)

Semiconductor diode laser - fabricated with a PN junction - forward bias – emitting laser light.

- **Construction** (3M)
  - Active medium-PN junction diode - upper region (P -Region)-lower region (n-region) - forward
  - Bias – stimulated emission, optical resonator.

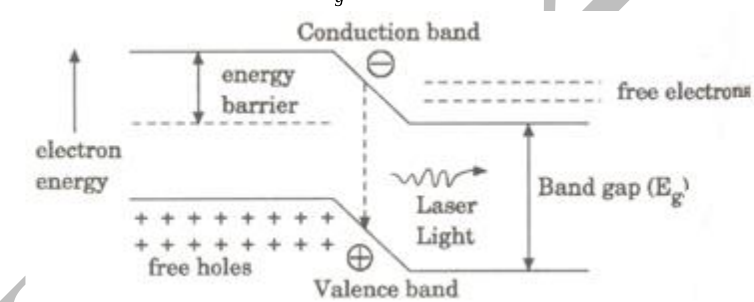
- **Diagram** (2M)



- **Working** (6M)

Array of PN junction-forward bias - electron-hole injected - conduction band-more electrons - valence band-more holes - electron-hole-recombination - light photon released - Forward bias, polished mirror - laser beam wavelength-8000 A.

$$\lambda = \frac{hc}{E_g}$$



- **Advantages** (1M)

Continuous output – very high output.

- **Disadvantages** (1M)

Very high cost – very difficult to grow.

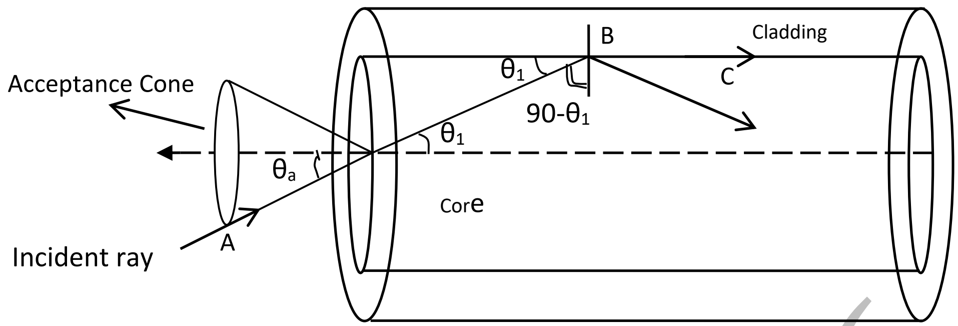
- **Applications** (1M)

Fiber optic communication – CD-ROM.

7 **Describe the theory of propagation of light through an optical fiber. (16M) (OR) Define Acceptance angle and N.A. Derive the equation for acceptance angle and numerical aperture of an optical fiber. Write the necessary conditions and variation of fractional index change with respect to N.A. (Jan.2010, Jan.2011, Jan 2018) (2+8+4+2)** BTL4

Answer : Page : 4.6-Dr.P.MANI

- **Theory of propagation of light through a fibre**



(2M)

- Consider an incident ray AO, entering the core at an angle θ_a to the axis. The ray is refracted along OB at an angle θ_1 in the core.
- It falls on core - cladding boundary at the critical angle θ_c = (90- θ_1). Since it is falling at the critical angle, it graces the surface of separation between core and cladding boundary (i.e. along BE).
- Any ray which enters into the core at an angle of incidence less than θ_a will have an angle of incidence greater than θ_c = (90- θ_1) and hence totally internally reflected. (1M)

Mathematical expression for acceptance angle.

Acceptance angle θ_a : The maximum angle θ_a at which a ray of light can enter through one end of the fiber and still be totally internally reflected. **(1M)**

Let n_0, n_1, n_2 are the refractive indices of air, core and cladding respectively.

Applying Snell's law of refraction at AO.

$$\frac{\sin\theta_a}{\sin\theta_1} = \frac{n_1}{n_0} \quad \text{(or) } n_0 \text{ Sin } \theta_a = n_1 \sin \theta_1 \qquad (1M)$$

$$\sin\theta_a = \frac{n_1}{n_0}\sin\theta_1$$

$$\sin\theta_a = \frac{n_1}{n_0}\sqrt{1-\cos^2\theta_1} \ \ldots(3) \ (\because \sin^2\theta_1 + \cos^2\theta_1 = 1, \therefore \sin\theta_1 = \sqrt{1-\cos^2\theta_1})$$

Applying Snell's law at B, the interface between core and cladding.

$$\frac{\sin(90^\circ - \theta_1)}{\sin 90^\circ} = \frac{n_2}{n_1} \qquad \text{OR} \qquad n_1 \sin(90°-\theta_1) = n_2 \text{ Sin } 90°$$

$$n_1 \cos\theta_1 = n_2 \quad (\because \sin(90^\circ - \theta_1) = \cos\theta_1 \text{ and } \quad \text{Sin } 90° = 1)$$

$$\cos\,\theta_1 = n_2/n_1 \qquad (2M)$$

Substituting for Cos θ_1

$$\sin\theta_a = \sqrt{1-\frac{n_2^2}{n_1^2}} \quad \text{OR} \quad \sin\theta_a = \frac{n_1}{n_0}\sqrt{\frac{n_1^2-n_2^2}{n_1^2}}$$

$$\sin\theta_a = \frac{\sqrt{n_1^2-n_2^2}}{n_0} \quad \text{and} \quad \theta_a = \sin^{-1}\frac{\sqrt{n_1^2-n_2^2}}{n_0} \qquad \text{(2M)}$$

If the surrounding medium is air, $n_o = 1$, then the Acceptance angle θ_a is given by

$$\theta_a = \sin^{-1}\sqrt{n_1^2-n_2^2} \qquad \text{(1M)}$$

Numerical Aperture

Numerical aperture (NA) represents the light gathering power of the fiber.

The measure of the amount of light rays that can be accepted by the fiber.

NA = sine of the acceptance angle of the fiber i.e. NA = sin θ_a (1M)

$$NA = \sin\left(\sin^{-1}\frac{\sqrt{n_1^2-n_2^2}}{n_0}\right) \quad \text{or} \quad \therefore NA = \frac{\sqrt{n_1^2-n_2^2}}{n_0} \qquad \text{(2M)}$$

If the surrounding medium is air, $n_o = 1$, then the numerical aperture is given by

$$NA = \sqrt{n_1^2-n_2^2} \qquad \text{(1M)}$$

Conditions to achieve total internal reflections,

If θ_i is the angle of incidence, then the ray will be propagated if $\theta_i < \theta_a$

i.e. if Sin θ_i < Sin θ_a

ie. Sin θ_i < N.A.

or Sin $\theta_i < \sqrt{n_1^2-n_2^2}$ (1M)

This is the condition for the propagation of light within the fiber.

Fractional Refractive Index Change

The ratio of the difference in refractive index of core and cladding, to the refractive index of core.

i.e. $\Delta = \frac{n_1-n_2}{n_1}$ or $\Delta n_1 = n_1 - n_2$ = Relative refractive index difference

We know that NA = $\sqrt{n_1^2-n_2^2}$ or $NA = \sqrt{(n_1-n_2)(n_1+n_2)}$

Therefore, we get $NA = \sqrt{\Delta n_1(n_1+n_2)}$

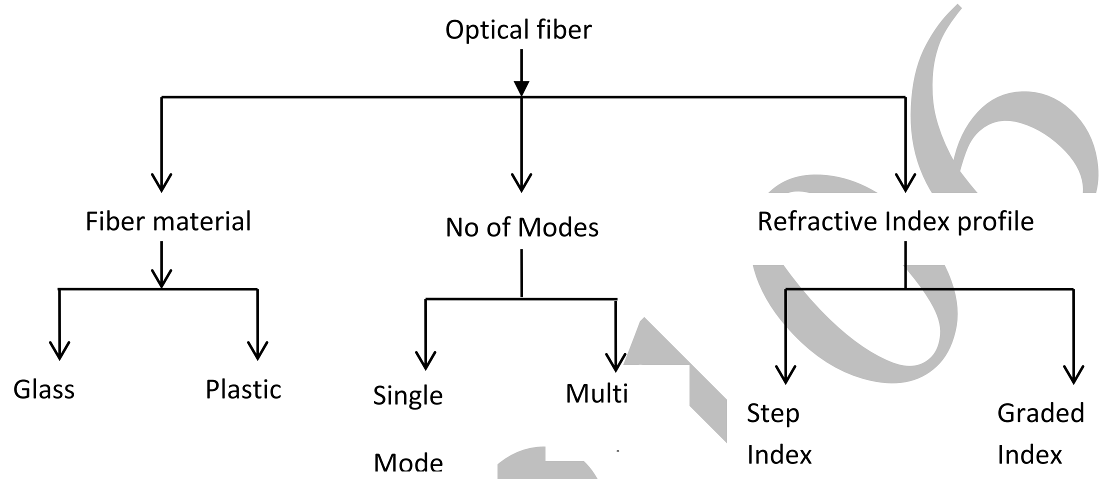
if $n_1 \approx n_2$, then $NA = \sqrt{\Delta n_1(2n_1)}$ $\quad NA = \sqrt{2\Delta n_1^2}$ $\quad \Rightarrow NA = n_1\sqrt{2\Delta}$

That is, if Δ increases, NA can increase and hence the light gathering capacity of the fiber enhances. (1M)

Explain how optical fibers are classified. Discuss their characteristics features in detail. (Dec.2014, Jan 2009, Jan.2011) (16M) (or) Explain how optical fibers are classified. Discuss the characteristics features of single mode fiber and multi-mode fiber. (8M) BTL2

Answer : Page: 4.13-Dr.P.MANI

Optical fibers are classified based on Material, Number of modes, Refractive index profile



(2M)

Based on materials

Glass

Mixture of metal oxides-silica glass-core-SiO_2- Cladding-P_2O_3-SiO_2.

Core	Cladding
SiO_2	B_2O_3-SiO_2
GeO_2-SiO_2	SiO_2
P_2O_5-SiO_2	SiO_2

Plastic

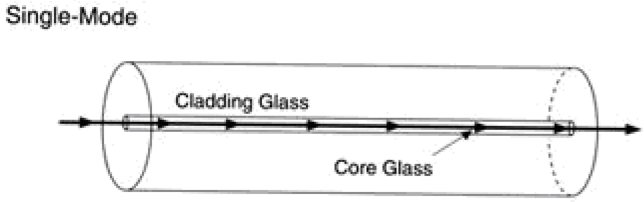
Toughness – durability - handled without care.

Core	Cladding
Polysterene	Methyl methacrylate
Polymethyl methacrylate	copolymer

(2 M)

Single mode Fiber

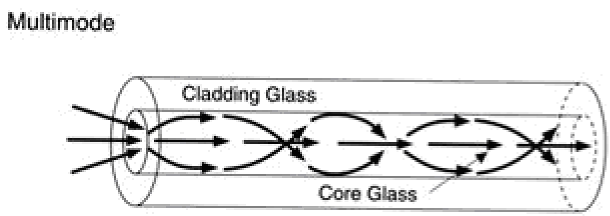
- Only one mode propagation
- Very small core diameter
- Very low optical loss
- Difference in refractive index of core and cladding



(3 M)

Multimode fiber

More than one mode propagation-very large cladding diameter-less band width.



(3 M)

- **Step index fiber**

Variation of refractive index -step by step process- small core diameter-small numerical aperture.

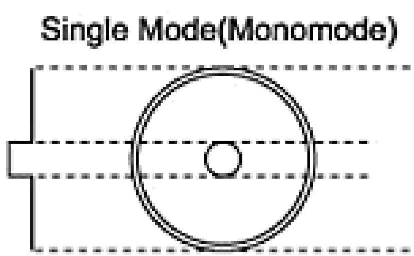
- **Graded index fiber**

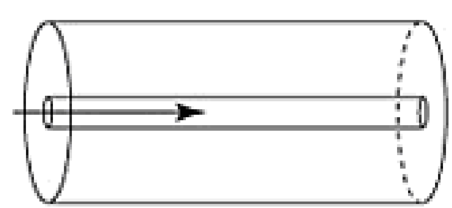
Core refractive index maximum-gradually decreases-large core diameter- large intermodal dispersion.

Refractive Index Profile

- **Step Index Fiber**

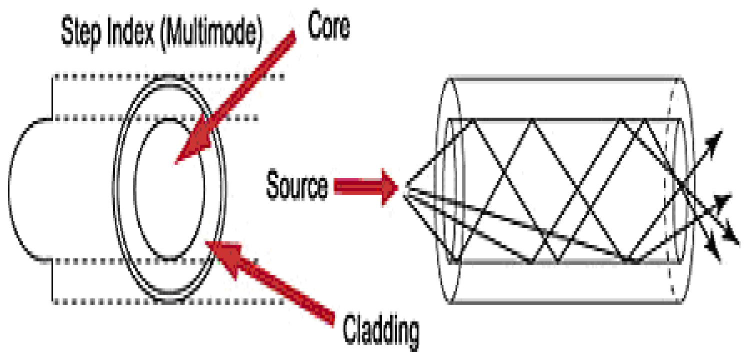
Refractive index varies step by step process- less dispersion than multimode-low intermodal dispersion.





(3 M)

- **Graded Index Fiber**



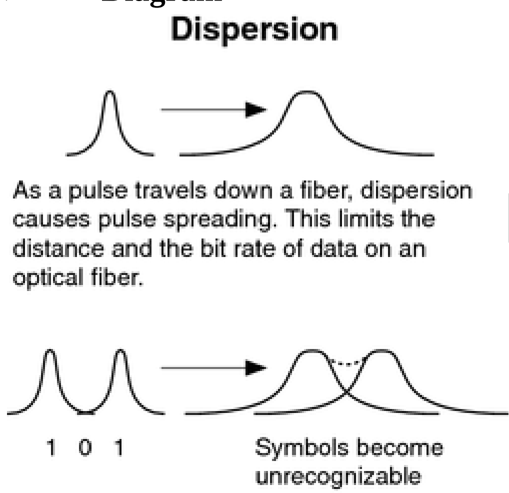
Refractive index-gradually decreases-very less intermodal dispersion. (3 M)

9

Describe the losses associated with optical fibre. (10M) BTL2

Answer : Page : 4.26-Dr.P.MANI

- **Diagram** (2M)



Types of losses

- **Material absorption Loss** (3M)

(a)Extrinsic absorption

Light absorption-presence of impurities in fiber-light interact with impurities-Photons moving to excited levels-loss of light.

(b) Intrinsic absorption

Connected with fiber material- absorb small amount of light energy in material-small loss of light.

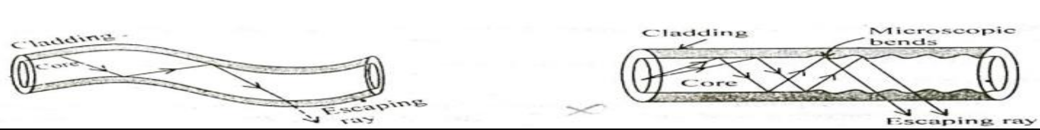
(c)Absorption by atomic defects

Defects in fiber material-small absorption loss.

- **Scattering Loss** (2M)

Light scattered-power loss-light scatter all directions.

- **Bending Loss** (3M)



- **Macroscopic bending loss**

radius of curvature greater than fiber diameter-not satisfied total internal reflection-light escape out.

- **Microscopic bending**

Small bend occurs inside fiber-creation of non-uniform pressure-loss of light.

10

What are fiber optic sensors? Mention its types. Describe working of temperature and displacement sensors. (or) What are different types of fiber optic sensors? Explain the working of any two sensors. (Jan.2008.Jan.2010, Jan 2011.,Jan 2013, Dec 2017) (16M) BTL2

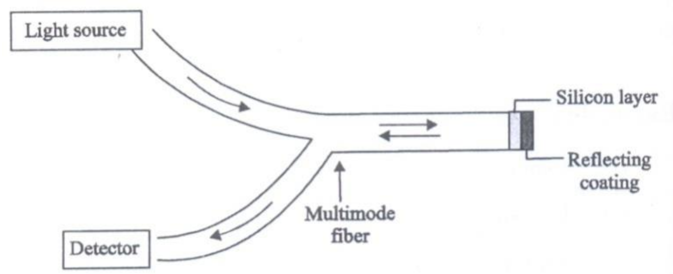
Answer : Page: 4.31-Dr.P.MANI

- **Fiber optic sensor** (2M)

Sensor is transducer- converts any form of Signal into an optical signal- measurable form .

Temperature sensor(or) pressure sensor

- **Diagram** (2M)



- **Construction** (2M)

Beam splitter - Reference fiber - Test fiber - Inclined angle 45° - Reference fiber - Separate lens systems.

- **Working** (2M)

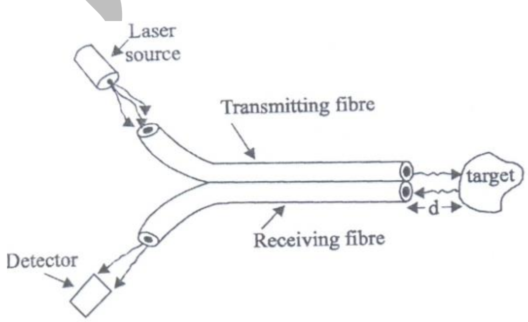
Monochromatic laser to fall on 45° inclined beam splitter- divided two parts - Reference beam - Splited beam - Main beam passed(L_1)-reference beam passed(L_2)-Splitted beam passed lens(L_3)-Interference pattern occurs-change in pressure calculated.

Displacement Sensor

- **Construction** (2M)

Transmitting fiber-Receiving fiber-moving target.

- **Diagram** (2M)



➢ **Working** (4M)

Laser transmitted - made to fall on moving target - reflected back from target - made to pass through receiving fiber – object movement detected.

11. **Distinguish step index and graded index fiber. (May 2003, May 2004, Jan. 2009) (6 M)** BTL4

Sl. No	Step index fibre	Graded index fibre
1.	n_1 is uniform throughout the core and undergoes abrupt change at the core cladding interface.	n_1 varies gradually as a function of radial distance from the axis of the fibre being maximum at the fibre axis.
2.	Attenuation is more for multimode step index and very less for single mode step index fiber	Attenuation is less
3.	Numerical Aperture is more for multimode step index and very less for less for single mode step index fiber	Numerical Aperture is less
4.	N.A. is more for multi-mode fiber but it is less for single mode fiber.	N.A. is less
5.	Intermodal dispersion occurs	No intermodal dispersions.
6.	It has lower bandwidth	It has higher bandwidth
7.	Light propagates in the form of meridonal rays. It crosses the fiber axis.	Light propagates in the form of skew rays. It never crosses the fiber axis.
8.	Light propagation is in zig-zag manner	Light propagation is in helical manner

UNIT-III-THERMAL PHYSICS

Transfer of heat energy-thermal expansion of solids and liquids-expansion joints-bimetallic strips-thermal conduction, convection and radiation-heat conduction in solids-thermal conductivity-Forbe's and Lee's disc method: theory and experiment-conduction through compound media (series and parallel)-thermal insulation-application-heat exchangers- refrigerators, ovens and solar water heaters.

PART * A

Q.No.	Questions
1.	**Define heat conduction. (A.U. Jan 2011)** BTL1 Conduction is the process of transmission of heat from one point to another through Q substance without the actual motion of the particles of the substances.
2	**Define coefficient of thermal conductivity and mention its unit. (A. U. Dec., 2010)** BTL1 It is defined as the quantity of heat conducted per second normally across unit area of cross-section per unit temperature difference per unit length of the material.
3	**Derive the unit in which thermal conductivity is measured. (A.U. April 2009)** BTL3 Thermal conductivity of material

$$K = \text{joule} \times \text{metre}/(\text{metre})^2 \times \text{kelvin} \times \text{second}$$
$$K = \text{Joule} / \text{second} \times \text{metre} \times \text{Kelvin}$$
$$\text{W m-1K}^{-1}$$

4 **What is basic principle behind Lee's disc method in determining thermal conductivity of bad conductor? (A.U.Jan.,2012)** BTL4

The given bad conductor is taken in the form of disc is placed in between the metal disc and steam chamber. The steam is passed through the steam chamber. Heat conducted through bad conductor per second is calculated. Amount of heat lost per second by disc is also calculated.

At steady state

Heat conducted through the bad conductor per second = Amount of heat lost per second by the disc.

From this, thermal conductivity of the bad conductor is calculated.

5 **How are heat conduction and electrical conduction analogous to each other?(A.U.,Dec 2008)** BTL4

S.NO	HEAT CONDUCTION	ELECTRICAL CONDUCTION
1.	Heat is conducted from a point of higher temperature to a point of lower temperature.	Electricity is conducted from a point at higher potential to a point at lower potential.
2.	In metals, heat conduction is mainly due to free electrons.	In metals, electrical conduction is due to free electrons.
3.	The ability to conduct heat is measured by thermal conductivity.	The ability to conduct electricity is measured by electrical conductivity.

6 **Distinguish between Good conductors and Bad conductors. (A.U.Nov.,2011)** BTL4

S.NO	**GOOD CONDUCTORS**	**BAD CONDUCTORS**
1.	They have high electrical and thermal conductivity.	They have very low electrical and thermal conductivity.
2.	They can be easily heated or cooled.	They cannot be easily heated or cooled
3.	Examples : Metals like iron, copper etc.	Examples: Non metals like glass, wood etc.

7 **What is thermal resistance? (A.U. Jan2012)** BTL2

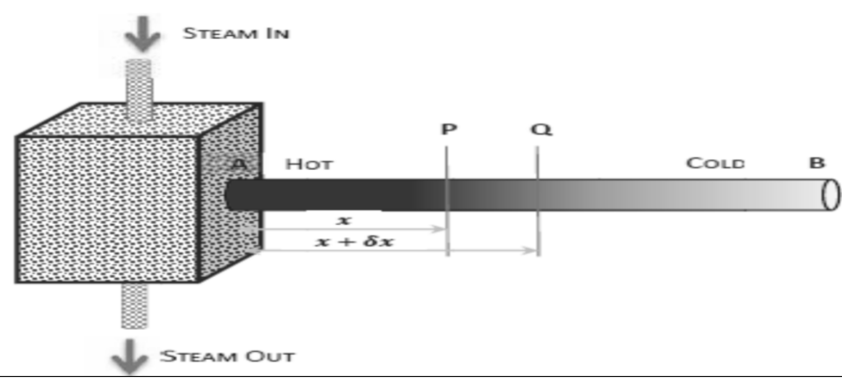
The thermal resistance of a body is a measure of its opposition to the flow of heat through it.

8 **Mention the methods to determine thermal conductivity of good and bad conductors.(A.U.Jan.,2011)** BTL2

- Searle's method – for good conductors like metallic rod.
- Forbe's method – for determining the absolute conductivity of metals.

	➢ Lee's disc method – for poor conductors. ➢ (iv) Radial flow method- for bad conductors.
9	**What are the basic entities responsible for thermal conduction of a solid? (Dec 1997)**BTL2 ➢ Area of cross section (A) ➢ Temperature difference between the hot and cold layer of the solid. ➢ Time of conduction (t) ➢ (iv)Thickness of the solid (x)
10	**Mention four factors to be considered for providing good thermal effect for buildings. (or) What is need for thermal insulation in buildings? (Nov. 2002, Dec 2017)** BTL2 ➢ Thermal Insulation ➢ Thermal Comfort ➢ Thermal Regulation ➢ Thermal Resistivity
11	**Mention the properties of thermal insulating materials. (or) List the important characteristic of a material to be a thermal insulator. (May 2003, Jan. 2019)** BTL4 ➢ The material should be fire proof. ➢ It should have high volumetric specific heat. ➢ It should have low thermal conductivity. ➢ It should be a poor absorber of moisture. ➢ It should withstand for any environmental conditions.
12	**What is meant by Thermal expansion in liquids?** BTL2 We know when as ordinary alcohol-in-glass thermometer (or) mercury –in-glass thermometer is kept in the temperature bath, the alcohol (or) mercury rises, due to thermal expansion. In this case it should be noted that the temperature rises not because of the expansion of liquid but it is only due to the volume expansion of the liquid.
13	**What do you understand by the term "Bimetallic Strip"? Give its use. (or) State the function of bimetallic strip. (Dec 2017)** BTL2 A bimetallic strip is used to convert a temperature change into mechanical displacement. The strip consists of two strips of different metals which expand at different rates as they are heated, usually steel and copper, or in some cases steel and brass.
14	**What is meant by Heat exchanger? How the heat is measured using Heat exchanger?** BTL2 A heat exchanger is a device that is used to transfer the heat between a solid and liquid (or) between two (or) more liquid, without mixing and is used to reduce the heat produced by a device (or) machine.
15	**Mention any two applications of heat exchanger?** BTL2 Heat exchangers have a wide range of applications. Some of them are detailed below. ➢ They are used in Refrigerators, air conditioners etc.

	➢ Heat exchangers are often used in power plants (or) Engines to cool the exhaust hot Gases. ➢ They are widely used in petroleum refineries, Petro-chemical Plants etc.
16	**What is meant by solar power? How will you estimate it?** BTL2 Solar Power is the process of converting (or) utilizing the abundantly available solar energy Either directly as heat (or) indirectly by converting it into electrical power using photo voltaic Cells.
17	**Mention any two applications of solar power.** BTL2 The Solar energy can be utilized in two ways. ➢ Active systems. ➢ Passive systems.
18	**Give the principle of solar water heater.** BTL2 Solar water heater is based on the principle of converting solar energy into electrical energy and then into heat energy, using solar electric panels, so called solar cells (or) Photo voltaic cells. Nowadays, solar thermal panels were widely used, which converts the solar energy directly into Heat energy.
19	**Define thermal diffusivity.** BTL1 It is defined as the ratio of thermal conductivity to the thermal capacity per unit volume of the material. Thermal diffusivity (h) = $\frac{\text{Thermal conductivity}}{\text{Thermal capacity}}$
20	**A 30 cm length of iron rod is heated at one end to 100^0C, while the other end is kept at a temperature of 35^0C. The area of cross section of the iron rod is 0.725 cm^2. Assume that the iron rod is thermally insulated. Calculate the amount of heat conducted through the rod in 8 minutes along the way. Given the thermal conductivity of iron K=62 $Wm^{-1}K^{-1}$.** BTL1 $Q= KA(\Theta_1-\Theta_2)T/X$ $Q = 62x0.725x10^{-4}x(373-308)x480/0.3$ $Q= 467.48J$
21	**By means of an electric heater of 12 kW, the temperature in a room with 6.0 m^2 of windows is to be maintained so that the inner surface of the glass is 10^0C above the outer surface. Ignoring the heat losses through the walls of the room and assuming that heat is lost through the window glass of thickness 6mm, what is the coefficient of thermal conductivity of glass. (Jan. 2012)** BTL4 Heat generated by the electric heater = 12 kW = $12x10^3$ watt = $12x10^3$ joule /second Area of the window(A) =6 m^2 Temperature difference = 10 K Thickness of glass window = $6x10^{-3}$ m Heat conducted through the window glass $Q= KA(\theta_1-\theta_2)t/x$ $Q/t = KA(\theta_1-\theta_2)t/x$

	$K= (Q/t)\, x/ \theta_1-\theta_2)$ $K= 12x10^3x6x10^{-3}/10$ $K= 1.2\ W\ m^{-1}K^{-1.}$
22	**What is expansion joint?** BTL2 An expansion joint or movement joint is an assembly designed to safely absorb the heat induced expansion or contraction of a pipeline, duct or vessel. It helps to hold parts together.
23	**Define radiation.** BTL1 It is the process in which heat is transmitted from one place to the other directly, without the agency of any material medium.
24	**What are the three modes of transferring heat?** BTL2 ➢ Conduction ➢ Convection ➢ Radiation
25	**Define oven.** BTL1 An oven is a thermally insulated chamber used for heating, baking or drying of a substance and most commonly used for cooking. Kilns and furnaces are special-purpose ovens, used in pottery and metalworking, respectively.
26	**Comment on thermal behaviour of Invar. (Jan 2019)** BTL4 ➢ Invar is a 36% nickel iron alloy which has the lowest thermal expansion among all metals and alloys in the range from room temperature up to approximately 230°C. ➢ The Invar alloy is ductile and easily weldable, and machinability is similar to austenitic stainless steel. ➢ It does not suffer from stress corrosion cracking. **Applications** Used in thermostat, Cathode Ray Tube, telecommunications, aeronautical and aerospace engineering, cryogenic engineering (liquefied natural gas tankers) etc.
	PART * B
1	**Describe Forbes method to determine the thermal conductivity of a conductor in the form of a long bar. (April 1997, Dec.1997, Apr.1998, Dec.1999) (16 M)** BTL2 **Answer : Refer: Page: 5.27-Dr.P.MANI** ➢ **Diagram** (4M) 

- **Working**

  Steam chamber-one end of rod heated- turns into steady state.

$$K = \frac{\rho S \int_B^C \frac{d\theta}{dt}}{\left(\frac{d\theta}{dx}\right)} dx \qquad \text{(4M)}$$

- **Static Experiment:**

  Steam chamber-one end rod heated- Records temperature at different points- Plotted steady state-graph for fall in temperature.

$$\left(\frac{d\theta}{dx}\right) = \frac{AB}{BC} = \tan\alpha \qquad \text{(2M)}$$

- **Dynamic Experiment:**

  Heated piece rod- suspended air-allowed to cool-regular interval temperature noted-graph plotted.

$$K = \frac{\rho Sx(Area\ of\ the\ shaded\ portion)}{\tan\alpha} \qquad \text{(2M)}$$

- **Merits:** (2M)

  Determine-Thermal conductivity.

- **Demerits:** (2M)

  Takes long time-not proper temperature distribution.

2

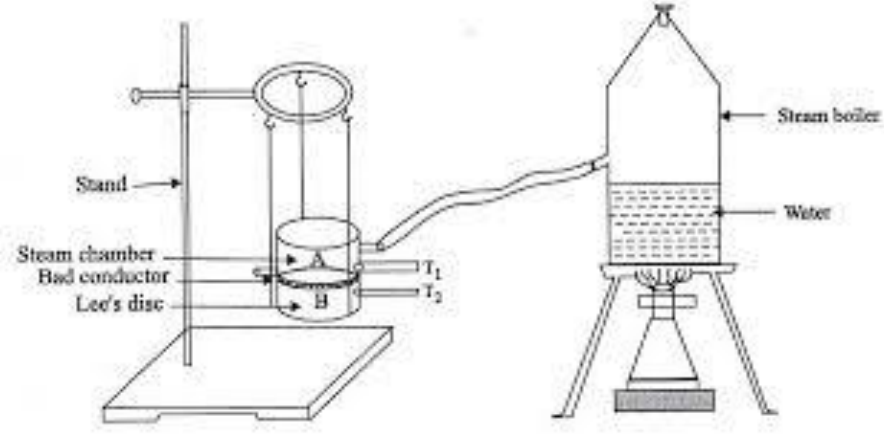
Describe Lee's disc method to find the co-efficient of thermal conductivity of a bad conductor. (or) Describe the relevant theory and method of determining the co-efficient of thermal conductivity of a bad conductor by Lee's disc method (or) How will you determine the thermal conductivity of a poor conductor using Lee's Disc method. Give the necessary theory. (16 M) (May 2003, Dec 2017, Jan 2018) BTL2

Answer : Page: 5.33-Dr.P.MANI

- **Construction** (3M)

Bad conductor, placed in between metallic disc and steam chamber- thermometer inserted –record temperature.

- **Diagram** (4M)



- **Working**

Steam passed steam chamber-temperature noted(T_1,T_2)-parameters measured.

$$K = \frac{MSRd}{\pi r^2(\theta_1 - \theta_2)} wm^{-1}K^{-1} \qquad (5M)$$

- **Determination of rate of cooling R**

Bad conductor removed, directly placed. Steam chamber on slab-slab heated (up to 5C)-steam chamber removed-cool to slab-temperature noted-graph plotted.

$$K = \frac{MSd(r+2h)\left(\frac{d\theta}{dt}\right)}{\pi r^2(\theta_1 - \theta_2)(2r+2h)} \qquad (4M)$$

3 **What is meant by heat exchanger? Detail the different modes in which the heat is exchanged though it.(12M)**BTL2

Answer : Page: 5.41-Dr.P.MANI

- **Heat Exchanger:** (2M)

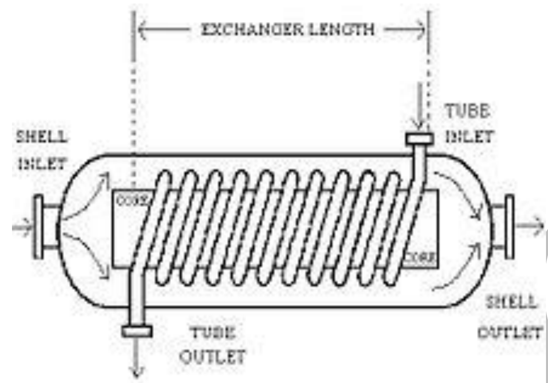
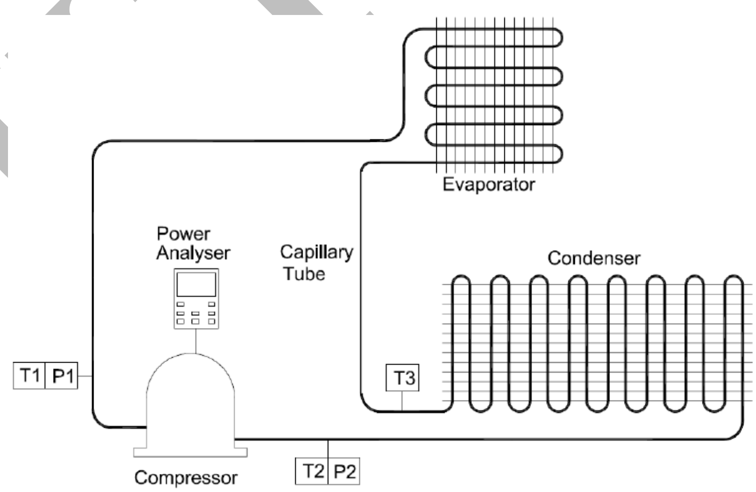
Heat exchangers devices - Transfer heat between two or more fluid - Different temperatures.

- **Types of heat exchanger:** (3M)

- **Nature of heat exchange process**
  (i)Direct contact heat exchanger
  (ii)Indirect contact heat exchanger

- **Relative direction of fluid motion**
  (i) Parallel flow
  (ii) Counter flow
  (iii) Cross flow

- **Design and constructional features**
  (i) Concentric tubes
  (ii) Shell method

	(iii) Compact heater exchanger ➢ **Diagram** (4M)  ➢ **Working** (3M) **S**team mixes with cold water-latent heat to water- gets condensed.
4	**Write short notes on Refrigerator. (16M)(Dec 2017, Jan 2018)** BTL3 **Answer : Page: 5.46-Dr.P.MANI** ➢ **Refrigerator** (3M) It is a machine which produces cold. It maintains the temperature below the surrounding atmosphere. ➢ **Principle** (2M) It works by passing a cool refrigerant gas around food items which heat from them. Then it loses that heat to the cooler surroundings on the outside. ➢ **Diagram** (3M)  ➢ **Construction** (4M) 1. Expansion valve controls the flow of the liquid refrigerant in to the evaporator.

2. The compressor sucks the liquid refrigerant from the evaporator and compresses it in a cylinder to make hot, high pressure gas.
3. The evaporator absorbs heat from the stuff kept inside.
4. This heat changes the liquid refrigerant into vapour.
5. The condenser absorbs the heat from the vapour and expels to the surroundings.
6. As the heat is removed, the vapour changes into liquid.
7. Refrigerant keeps the refrigeration cycle going.

➢ **Working** (4M)

1. The liquid refrigerant is passed into expansion valve.
2. It turns into cool gas in the expansion valve due to the sudden drop in pressure.
3. The cool gas flows through the chiller cabinet.
4. The evaporator absorbs the heat from the food items and vapourizes.
5. The vapour flows in to the compressor.
6. The compressor compresses the molecules to make it into hot, high pressure gas.
7. This gas transports to the condenser.
8. The condenser converts the gas into liquid again.
9. Then this liquids travel back to the expansion valve and becomes a cool gas.
10. By this way, the whole cycle repeats.

5

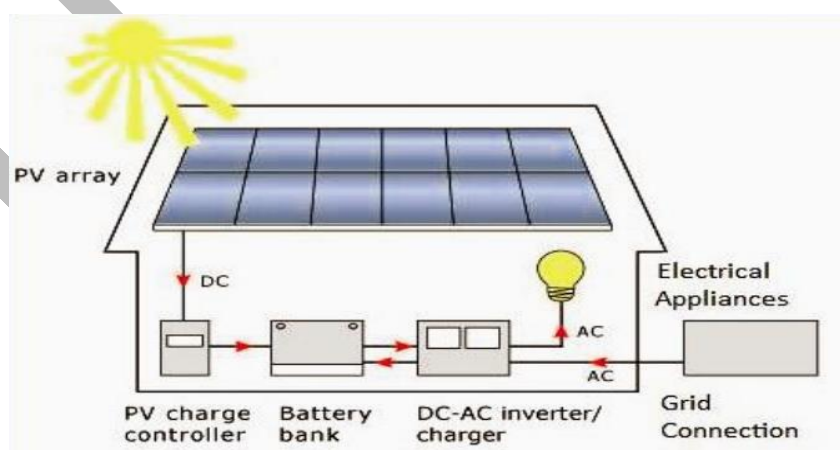
Describe the principle, construction and working of solar water heater. Mention any two advantages and disadvantages of it. (Jan 2018) (16M) BTL2

Answer : Page: 5.54-Dr.P.MANI

➢ **Principle** (2M)

Solar water heater is based on the principle of converting solar energy into electrical energy and then into heat energy using solar cells.

➢ **Diagram** (2M)



➢ **Construction** (4M)

1. The roof of solar water heater contains a thermal panel and collector.
2. The collector is used to collect, capture and retain heat radiations from the sun.
3. A heat exchanger is kept inside the water tank.

4. The heat exchanger is used to transfer the heat between hot water in the pipeline and coldwater in the water tank.
5. An electric pump is used to pump the cold water from heat exchanger to collector.
6. The controller is used to fill the water tank.
7. The controller is also used to switch ON/OFF the electric pump.

- **Working** (4M)

1. Initially, the cold water is pumped by the electric pump to the collector.
2. Due to heat radiations from the sun, the water is heated up.
3. The hot water is passed to the water tank by the heat exchanger.
4. The heat exchanger transfers the heat from the hot water in the pipeline to the water tank.
5. Now the cold water in the tank becomes hot.
6. The water coming out from the heat exchanger become cold water and enters into the electric pump again.

- **Advantages** (2M)

1. Solar energy is free and abundant.
2. Solar panel occupy less space.
3. 80% of heat radiation is converted into heat energy by solar panels.
4. The electricity will be less.
5. It does not pollute air.
6. It is an Eco friendly way to heat water.

- **Disadvantages** (2M)

1. Capital investment and installation cost is high.
2. Annual maintenance is required to check the working of panel.
3. It is not useful during rainy days.
4. Energy cannot be stored in batteries.
5. Air pollution and weather will affect the production of electricity.

6

Derive an expression for flow of heat through compound media. (or) Derive an expression for thermal conductivity through compound media in series and parallel. (Dec 2017) (16M) BTL3

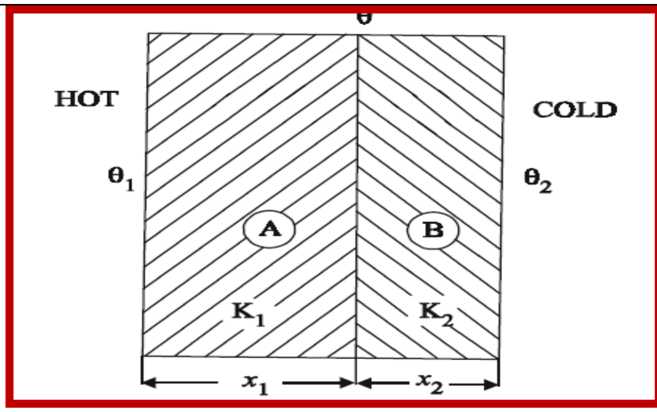
Answer : Page: 5.23-Dr.P.MANI

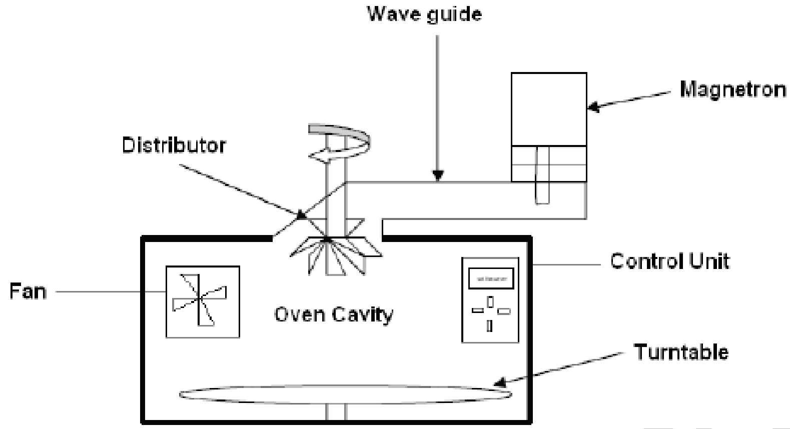
Material bars in series

- **Construction** (2M)

Different material(A-B)-Thermal conductivity(K_1-K_2)-Temperature $(\theta_1 - \theta_2)$

- **Diagram** (2M)

	 $$Q = \frac{A(\theta_1 - \theta_2)}{\Sigma(\frac{x}{K})}$$ (4M) ➢ **Material in parellel** **Q=** $Q = (\theta_1 - \theta_2)(\frac{A_1K_1}{X_1} + \frac{A_2K_2}{X_2})$ (4M) $Q = (\theta_1 - \theta_2)\Sigma\frac{KA}{x}$ (4M)
7	**Write notes on oven. (12M) (Jan 2018** BTL4 **Answer : Page: 5.49-Dr.P.MANI** ➢ **OVEN** (2M) An oven is a thermally insulated chamber used for heating, baking or drying of a substance and most commonly used for cooking. **PRINCIPLE** It works on the principle of fine gravity air convection in a highly heated electrical chamber. ➢ **Diagram** (2M)



➢ **Construction** (3M)

1. The apparatus consists of a large, rectangular and copper base.
2. It is covered with asbestos sheets.
3. It is provided with a door and kept on a four legged stand.
4. The roof has a hole for inserting a thermometer. It records temperature.
5. The electric heater fitted at the base is used to heat the oven.
6. The electric heater fitted at the base is used to heat the oven.
7. The regulator is used to control the inside temperature.

➢ **Working** (3M)

1. Before sterilization, the glassware are dried properly.
2. It is kept at hot air inside the oven.
3. After loading of glassware the oven is switched ON.
4. The temperature is increased gradually till the steady state is reached.
5. At 160 degree, the oven is kept for an hour.
6. The, the temperature is decreased gradually and sterilization is complete.

➢ **Advantages** (1M)

1. This instrument kills the bacterial endotoxin.
2. It does not leave ant chemical residue.

➢ **Disadvantages** (1M)

1. Plastic and rubber items cannot be dry heat sterilized because of too high temperature.
2. Dry heat penetrate the materials slowly and unevently.
3. It requires a continous source of electricity.

8

Explain the concept of thermal insulation. (8M) BTL2

Answer : Page: 5.37-Dr.P.MANI

Thermal insulation

It is a method of minimizing the heat transfer between outside and inside the building, to maintain the constant temperature in the interior. Due to thermal insulation, the building remains cool in summer and warm in winter.

General principles of thermal insulation

	1. The thermal resistance of the insulating material is directly proportional to its thickness. 2. The provision of an air gap is an important insulating agent. 3. Heat is transferred from one region to another because of the temperature difference between them. 4.The heat is transferred by conduction, convection and radiation. ➢ **Thermal insulation in walls** (2M) 1. The walls should be constructed by light weight materials. 2. The hallow wall or cavity wall construction may be adopted. 3. The low thermal conductivity material may be used as bridging material. 4. The inner surface of the walls should be made of wooden plaster and card board. ➢ **Thermal insulation in doors and windows** (2M) ➢ 1. Double glazed window should be placed in the window for better air spacing instead of single glazed window. ➢ 2. The ventilators should be designed inside and outside of the room. ➢ 3. The artificial cooling system like fan, AC, air coolers et, should be used for supplying fresh air inside the rooms. ➢ **Thermal insulation in floors and ceilings** (4M) Vermiculite mixed flooring walls-proper insulating material-constructed greater height.
	UNIT IV QUANTUM PHYSICS
	Black body radiation – Planck‘s theory (derivation) – Compton effect: theory and experimental verification – wave particle duality – electron diffraction – concept of wave function and its physical significance – Schrödinger‘s wave equation – time independent and time dependent equations – particle in a one-dimensional rigid box – tunneling (qualitative) - scanning tunneling microscope.
Q.No.	**Questions**
1.	**Define black body and its radiation. Give examples.** BTL1 A perfect black body is the one which absorbs and also emits the radiations falls on it. The radiation emitted by a black body is called as black body radiation. There is no perfect black body in nature. Eg. Stars, (Sun), Lamp black coated copper spherical shell.
2	**State Planck's quantum theory (or) State Planck's hypothesis (or) What are the postulates of Planck's quantum theory? (or) What are the assumptions of quantum theory of black body radiation? (or) Give the special features of Quantum theory.** BTL1 ➢ The black body is not only filled with the radiations but also with a large number of atomic oscillators or plank oscillators. ➢ The frequency of radiation emitted by an oscillator is the same as the frequency of its vibration. ➢ The oscillator cannot absorb or emit energy in a continuous manner. ➢ It can absorb energy in the multiples of small unit called quantum or photon. ➢ The energy of a photon is given by $E= h\nu$ or $E_n = nh\nu$ where 'n' is called as quantum number (n=0,1,2,3,4..)

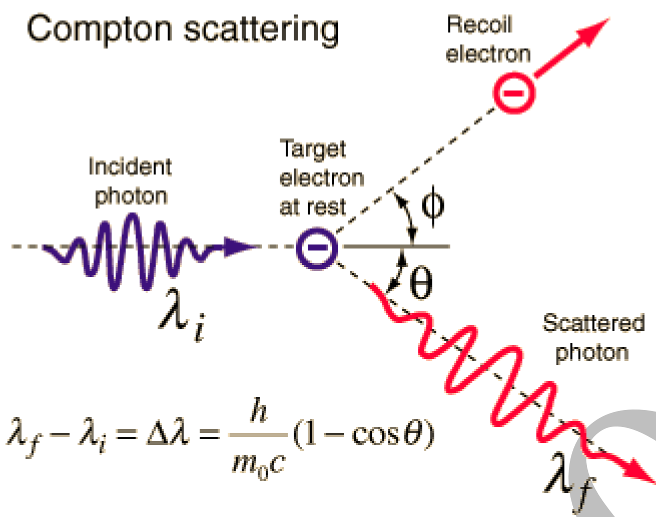
3	**State Planck's law of black body radiation or Write the equation for Planck's law of black body radiation.** BTL1 Energy density of radiation emitted by a black body is inversely proportional to fifth power of its wavelength. $E_\lambda = \dfrac{8\pi hc}{\lambda^5 (e^{\frac{h\upsilon}{KT}} - 1)}$
4	**What is Compton Effect and Compton shift?** BTL2 When a beam of high frequency radiation (X-ray or γ –ray) is scattered by a low atomic substance, the scattered radiation consists of two components, one has the same wavelength λ as that of the incident radiation and the other has a slightly longer wavelength λ'. The phenomenon is called as Compton effect. The change in wavelength between the scattered photon and incident photon is called as Compton shift. $d\lambda = \dfrac{h}{m_0 c}(1 - \cos\theta)$
5	**What is Compton wavelength? Calculate its value. (Jan 2008)** BTL2 The Compton shift corresponds to angle of scattering 90° is called Compton wavelength. $Compton\ Shift\ \Delta\lambda = \dfrac{h}{m_0 c}(1 - \cos\theta)$ When θ = 90^0, cos θ = 0 $Compton\ Shift\ \Delta\lambda = \dfrac{h}{m_0 c}$ $Compton\ Shift\ \Delta\lambda = \dfrac{6.625 \times 10^{-34}}{(9.11 \times 10^{-31}) \times (3 \times 10^5)}$ $\boxed{\Delta\lambda = 0.02424\ \text{Å}}$
6	**Define De- Broglie wave or matter wave. Give examples. (Jan 2010, Dec. 2012)** BTL1 The wave associated with moving particle is called as de-Broglie wave or matter wave. Examples: Electron wave, proton wave etc.
7	**List the properties of matter wave. (Jan 2012)** BTL4 ➢ It is the wave associated with particle. ➢ It is charge independent and it is not electromagnetic wave. ➢ If the particle is lighter, λ is longer. ➢ Wave length is inversely proportional to the velocity of the particle. ➢ Velocity (v) is not constant for de-Broglie waves. ➢ If v=0, then λ =∞ and if v= ∞, then λ =0, indicates that de-Broglie waves are generated by the motion of particles. ➢ De-Broglie wave equation connects the particle and its associated waves.

8	**State de-Broglie hypothesis (or) Explain the concept of wave nature (or) Give the origin of concept of matter waves. (May 2004, May 2012)** BTL1 The light exhibits the dual nature. It can behave as a particle and wave. De-Broglie suggested that particle can also behave as a wave and exhibits the dual nature. Thus the wave associated with a material particle (electron) is called as matter or de-Broglie wave.
9	**Write an expression for the wavelength of matter waves. (or) What is de-Broglie's wave equation?** BTL1 Wavelength of matter wave is given by $\lambda = \frac{h}{mv}$ Where h – Planck's constant p – Momentum of particle m – Mass of electron v – Velocity of particle V – Voltage applied e – Charge of electron E – Kinetic energy of electron.
10	**What is electron diffraction? (or) Prove the wave nature of electron?** BTL2 G.P. Thompson made investigations with high speed electrons, accelerated by a potential difference ranging from 10,000 to 50,000 volts and studied the electron diffraction effects by gold foil. He found the electron diffraction patterns exactly analogous to X-ray patterns. Thus it is proved that the electron also exhibit wave nature. Moreover, he was able to determine the wavelengths associated with electrons.
11	**What is wave function? Mention the physical significance of wave function. (Dec 2002, Nov 2003, May 2004, Jan 2006, Jan 2007, Jan 2009, Jan 2010, Jan 2011, Jan 2013, Dec 2017, Jan 2019)** BTL2 The quantum mechanical function which describes the wave motion of a particle (de-Broglie wave) is known as wave function and the symbol is ψ. **<u>Physical Significance of (ψ)</u>** ➢ The wave function $(\psi = \psi e^{-i\omega t})$ is a variable quantity associated with a moving particle ➢ Ψ is a complex quantity and has no physical significance by itself ➢ ψ connects the particle and ant it associated wave nature statistically. ➢ Probability density = $\lvert \Psi (r, t) \rvert^2 = \psi^* \psi$. ➢ The quantity $\psi \psi^*$ is positive and real. Ψ^* is the complex conjugate of ψ ➢ If $\iiint \psi^* \psi \, d\tau = 1$, then particle is present. ➢ If $\iiint \psi^* \psi \, d\tau = 0$, then particle is not present
12	**What is Schrödinger wave equation? Give its types. (Jan. 2011)** BTL2 The wave equation which describes the wave nature of a particle in mathematical form is called as Schrodinger wave equation. Types : Schrodinger time-independent wave equation Schrodinger time-dependent wave equation

13	**Write Schrödinger's time-independent and time dependent wave equations. (Jan 2011)** BTL2 Time independent wave equation $$\nabla^2\Psi + \frac{2m}{\hbar^2}(E-V)\Psi = 0$$ Time dependent wave equation $$H\Psi = E\Psi$$
14	**For a free particle moving within a one dimensional potential box, the ground state energy cannot be zero. Why? (Jan 2011)** BTL4 Energy Eigen value in 1 D box $E_n = \frac{n^2h^2}{8ma^2}$ Hence, for a free particle moving within a one dimensional potential box, the ground state energy cannot be zero.
15	**Define Eigen values and Eigen function? (Jan. 2013)** BTL2 Energy of a particle moving in one dimensional box of width "a" is given by $$E_n = \frac{n^2h^2}{8ma^2}$$ For each value of n, there is an energy level. Each value of E_n is called as Eigen value. For each E_n, there is a corresponding energy Eigen function Ψ_n. this wave function is called as Eigen function.
16	**State the principle of Scanning Tunneling Microscope. (or) Brief about the tunneling phenomenon. (Jan 2019)** BTL1 Tunneling of electron through the gap between the metal needle and the surface of the sample leads a tunneling current. This tunneling current is used to obtain the surfaces of atom.
17	**What are the advantages and disadvantages of STM?** BTL2 **<u>Advantages:</u>** ➢ No damage to the sample ➢ Vertical resolution is superior to SEM ➢ Gives the spectroscopy of atom ➢ Relatively low cost **<u>Disadvantages:</u>** ➢ A small vibration, even a sound could smash the tip and the sample together. ➢ A single dust particle, for example, could damage the needle.
18	**List the applications of STM.** BTL2 ➢ Used to show the position of atoms, electron ➢ Used to study metals and semiconductor surface ➢ Used in manipulation of atoms ➢ Used to analyze the electronic structure of the active sites at catalyst surfaces ➢ Used to study the structure, growth, morphology, electronic structure surface, thin films, and nanostructure.
19	**Write the applications of Schrödinger wave equation.** BTL4 Schrodinger wave equations are used to find the energy, momentum and wave function of a particle in matter wave. It is also used in the designing of electron microscope.

20	**What is quantum physics?** BTL2 Quantum physics is the studies of miniature i.e. study of micro level particle.
21.	**What is scanning electron microscope (SEM)? (Dec 2017)** BTL1 A scanning electron microscope (SEM) scans a focused electron beam over a surface to create an image. The electrons in the beam interact with the sample, producing various signals that can be used to obtain information about the surface topography and composition.
	PART * B
1	**State Planck's Hypothesis for black body radiation. Derive Planck's law for black body radiations hence deduce Wien's displacement law and Rayleigh-Jeans law. (May 2008, May 2013, Jan. 2014, June 2014, Jan 2016, Dec 2017)(16M)**BTL1 **Answer : Page: 6.6-Dr.P.MANI** ➢ **Postulates of Planck's theory** (2M) ➢ Black body radiator contains electrons or atomic oscillators or plank oscillators. ➢ Frequency of radiation emitted by an oscillator = the frequency of its vibration. ➢ Oscillators absorb or emit energy in a discrete manner. ➢ The energy of a photon is given by E= h ν or E_n = nh ν where 'n' is called as quantum number (n=0,1,2,3,4..) ➢ **Derivation** $N=\frac{N_0}{(1-x)}$ $E=\frac{h\upsilon}{e^{h\upsilon/kT}-1}$ (8M) $E_\lambda=\frac{8\pi hc}{\lambda_5(e^{h\upsilon/kT}-1)}$ (2M) ➢ **Wien's Displacement law** $E_\lambda=\frac{8\pi hc}{\lambda_5(e^{h\upsilon/kT}-1)}$ (2M) ➢ **Rayleigh Jean's law** $E_\lambda=\frac{8\pi kT}{\lambda^4}$ (2M)
2	**What is Compton Effect? Derive the equation for Compton shift in terms of frequency. Also briefly explain its experimental verification. (or) What is Compton effect? Give the theory of Compton effect and show that the Compton shift is** $\lambda=\frac{h}{m_0c}(1-\cos\theta)$ **(May 2007, May 2009, Jan 2010, Jan 2011, Dec. 2014, Dec. 2015, Jan 2018) (16M)** BTL2 **Answer : Page: 6.15-Dr.P.MANI** ➢ **Compton effect** (2M) High frequency radiation-X-rays-scattered beam-same wavelength-higher wavelength.

➢ **Diagram** (2M)

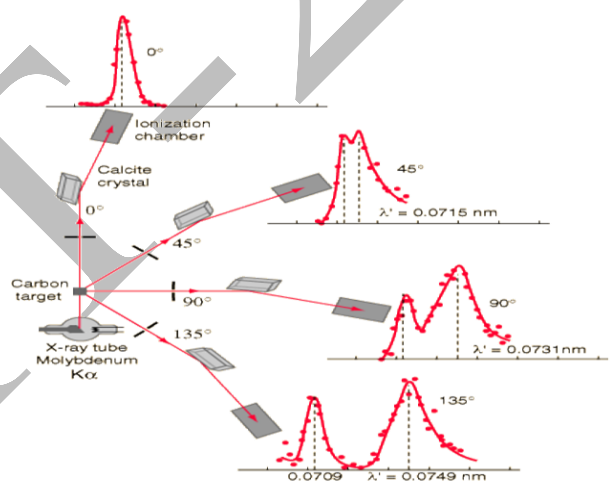


➢ **Compton wavelength**

$$d\lambda = \frac{h}{m_0 c}(1-\cos\theta)$$ (8M)

➢ **Experimental verification**

➢ **Diagram** (2M)



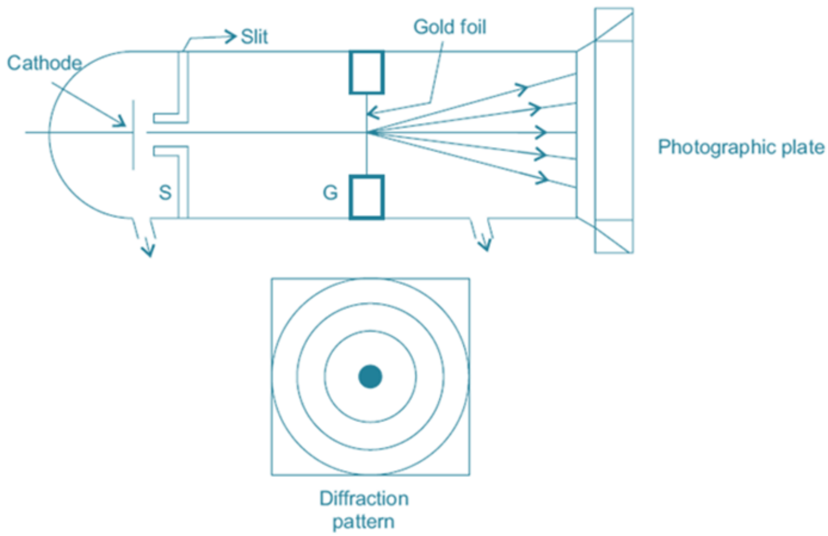
Producing x-rays-scattering substance-Bragg spectrometer used to receive x-rays-experiment repeated various angle. (2M)

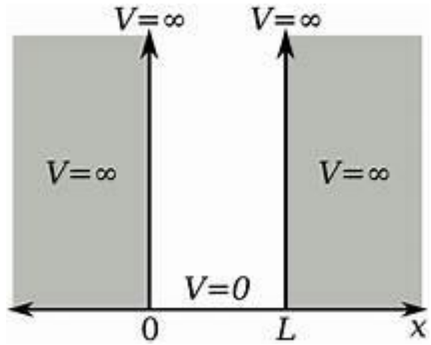
3 **Derive the different forms of de – Broglie wave equations. (May 2015) (16M)**BTL2

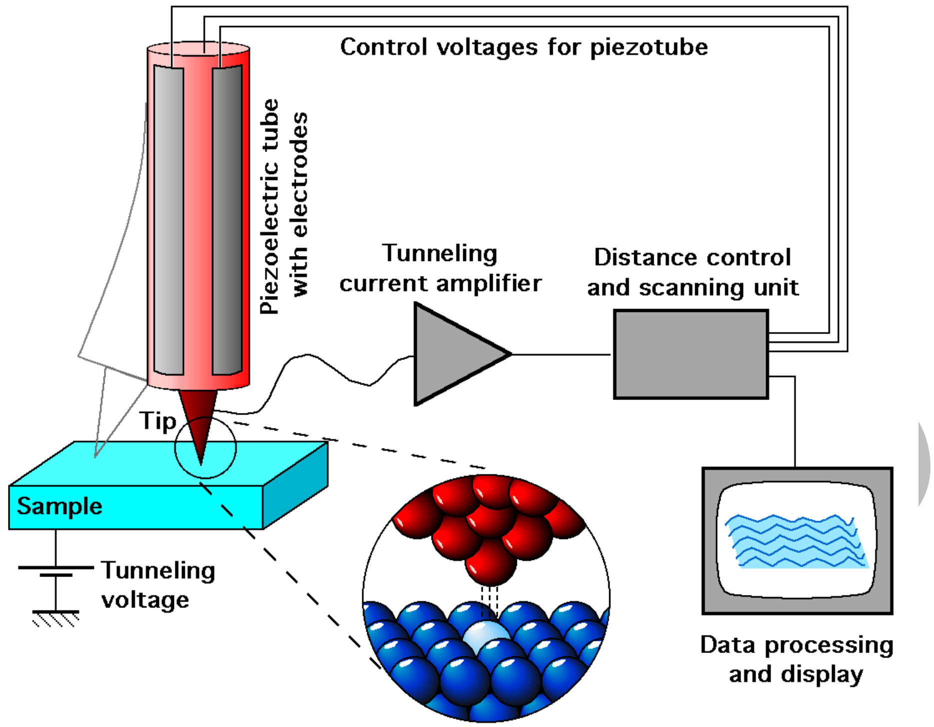
Answer : Page: 6.26-Dr.P.MANI

De-Broglie waves and its wavelength

$$\lambda = \frac{h}{mv}$$ (6M)

	➢ **De-Broglie wavelength in terms of energy** $\lambda = \dfrac{h}{\sqrt{2mE}}$ (4M) ➢ **De-Broglie's wavelength in terms of accelerating potential associated with electrons** $\lambda = \dfrac{h}{\sqrt{2meV}}$ (6M)
4	**Describe the electron diffraction experiment to verify the wave nature of particle by G.P. Thomson experiment. (May 2015) (8M)**BTL2 **Answer : Page: 6.33-Dr.P.MANI** **Diagram** (2M)  ➢ **Procedure** (6M) Electrons produced-electrons accelerated up to 50,000-accelerated electrons passed to slit-thickness 10^{-6}cm-diffraction pattern photographed by photographic plate.
5	**What is Schrodinger's wave equation? Derive Schrödinger's time dependent wave equation in three dimensions and one dimension. (May 2005, Jan 2007, Jan 2010, Jan. 2011, June 2014, Dec. 2014, Jan. 2016, Jan 2018) (16 M)** BTL2 **Answer : Page: 6.36-Dr.P.MANI** ➢ **Schrödinger time-dependent wave equation** $\nabla^2\Psi + \dfrac{2m}{h^2}(E-V)\Psi = 0$ (8M) ➢ **Time-dependent wave equation** $\mathrm{H}\Psi = E\Psi$ (8M)
6	**Derive the expression for energy Eigen values and Eigen function of a particle enclosed in one-dimensional potential box of width "a" and infinite height. (May 2005., Jan.2009, May 2015) (or) Obtain the eigen value and eigen function for a electron enclosed in one-dimensional potential box. (Dec 2017) (16M)** BTL3 **Answer : Page: 6.44-Dr.P.MANI**

	➢ **Diagram** (2M)  ➢ **Eigen value and Eigen Function** $E_n = \frac{n^2h^2}{8ma^2}$ (8M) ➢ **Normalization of wave function** $\psi_n = \sqrt{\frac{2}{a}} \sin \frac{n\pi x}{a}$ (6M)
7	**Define tunneling. Describe the principle, construction and working of Scanning Tunneling Microscope with neat sketch. (16M)** BTL1 **Answer : Page: 6.54-Dr.P.MANI** ➢ **Tunneling** (2M) ➢ **According to Classical Mechanics** Probability to cross the barrier zero-particle K.E less than potential barrier. ➢ **According to Quantum Mechanics** Incident wave region(I)-Region (2)-process of tunneling. ➢ **Construction** (4M) Probe has only one atom-tip moves towards single atom-tip connected to scanner-tip placed below sample-air gap maintained. ➢ **Diagram** (2M)



- **Working** (4M)
  Circuit switched ON-given biasing voltage-electron tunnel tip to sample-produced small Current amplified- based on distance current increases (or) decreases-tip scans atom by atom.

- **Advantages** (2M)
  Scans atom by atom-very accurate measurement-Magnification up to Nano scale.
- **Disadvantages** (2M)
  Very small vibration gives disturbance-cost high-more complexity-single dust particle will damage.

UNIT- V – CRYSTAL PHYSICS

Single crystalline, polycrystalline and amorphous materials- Single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices-inter planar distances-coordiantion number and packing Factor for SC,BCC,FCC,HCP and diamond structures-crystal imperfections: point defects, line defects-Burger vectors, stacking faults-role of imperfections in plastic deformation-Growth of single crystals: soloution and melt
Growth techniques.

PART * A

Q.No.	Questions
1.	**Define the terms lattice points, lattice plane and basis. (May 2003, May 2004, June 2005, Jan 2009, Jan 2013, Dec 2015)** BTL1 Lattice points The points in which atoms are located are called lattice points. Lattice plane

	The plane containing the lattice points is called as lattice plane. It is also called as atomic plane. Basis The unit assembly of atoms associated with every lattice point is called basis. Crystal structure The space lattice combines with basis gives the crystal structure. Space lattice + Basis →Crystal
2	**Define the terms unit cell. (May 2003, Nov 2003, May 2004, Jan 2010, Jan 2011, Jan 2012, Jan 2014)** BTL1 Unit Cell: The unit cell is the smallest geometric figure or volume of the solid from which the entire crystal structure can be built by translational repetition in three dimensions.
3	**Define the terms co- ordination number, number of atoms per unit cell. (Dec 2010)** BTL1 Coordination number:It is the number of nearest equidistant neighboring atoms directly surrounding to an atom in an unit cell. (SC- 6; BCC- 8; FCC- 12; HCP-12. DIAMOND – 4; NaCl - 6) Number of atoms per unit cell :It is the total number of atoms possessed or shared by an unit cell. (SC- 1; BCC- 2; FCC- 4; HCP-6; Diamond – 8; NaCl- 4)
4	**Define the terms nearest neighboring distance, atomic radius and atomic packing factor. (Apr 2011, May 2012, May 2013)** BTL1 Neighboring distance :It is the distance between the centers of the two nearest neighboring atoms in a unit cell. Atomic radius :It is half of the nearest neighboring distance. Atomic packing factor or density of packing : It is the ratio of volume (v) occupied by all the atoms in unit cell to the volume of the unit cell. $APF = \frac{No.of\ atoms\ present\ in\ a\ unit\ cell \times Volume\ of\ one\ atom}{Volume\ of\ the\ unit\ cell}$ i.e. Atomic packing factor = v / V
5	**Differentiate crystalline solid and amorphous solid. (Jan 2015)** BTL4
6	**What are Miller indices? Give the procedure to find Miller indices. (Apr 2002, May 2003, May 2004, Jan 2009, Jan 2010, May 2010, Jan 2010, Jan 2011, Dec 2014)** BTL2

Table for question 5:

S. No	Crystalline solids	Amorphous solids
1.	Atoms or molecules are arranged in a regular and orderly manner in a three dimensional pattern	Atoms or molecules are arranged in an irregular manner
2.	Posses internal spatial symmetry	Do not posses any spatial symmetry
3.	Have directional properties	Have no directional properties
4.	Also called as anisotropic substances	Also called as isotropic substances
5.	Broken pieces have regular shapes	Broken pieces irregular in shape
6.	Egs : Cu, Ag, Au, Si,Ge,NaCl, Quartz etc.	Plastic, Glass, Rubber Etc.

The miller indices are the three smallest possible integers which have the same ratios as the reciprocals of the intercepts of the plane concerned on the three axes.

- ➢ The intercepts made by the plane on the reference are to be found. Let these be X', Y', Z' along x, y, z axes respectively.
- ➢ Reciprocal of these intercept are taken.
- ➢ Take LCM and the reciprocals are reduced into whole numbers.
- ➢ Write the integers in parentheses without coma ( ) to get the miller indices.

7 **Defects in crystals are not always harmful. Justify. (Jan 2012)** BTL1

Some properties of crystals are structure insensitive. ie., Stiffness and density are not affected by the presence of defects. Hence defects in crystals are not always harmful.

8 **Name the Crystal structure of the following. (Dec 2003, Dec 2008)** BTL2

Gold -	Face centered cubic	Sulphur	- Orthorhombic
Germanium -	Diamond cubic	Indium	- Tetragonal
Barium -	Body Centered cubic	Calcite	- Trigonal
Zinc -	Herxagonal close packed	Quartz, Tourmaline	- Herxagonal close packed

9 **Name the seven crystal systems. (Jan 2010)** BTL3

- ➢ Cubic
- ➢ Tetragonal
- ➢ Orthorhombic
- ➢ Monoclinic
- ➢ Triclinic
- ➢ Rhombohedral
- ➢ Hexagonal

10 **Mention the various crystal growing techniques.** BTL1

- ➢ Melt Growth
- ➢ Low temperature solution growth
- ➢ High temperature solution growth (flux growth)
- ➢ Hydrothermal growth
- ➢ Gel growth
- ➢ Growth from vapour

11 **State the conditions imposed on the cell parameters for crystal systems having the least number of bravais lattices and the least number of nearest neighbours. (Jan 2005)** BTL1

Crystal with least number of nearest neighbors is simple cubic structure. (6 neighbors)
Crystal system with large number of Bravais Lattices is Orthorhombic (4 Bravais Lattices)
Therefore the cell parameters for orthorhombic is $a \neq b \neq c$, $\alpha=\beta=\gamma=90°$

12 **Give the comparison chart for SC, BCC, FCC, HCP and Diamond structures. (Jan 2008, Jan 2009)** BTL1

S. No.	SYSTEM	SC	BCC	FCC	HCP	Dia Mond
1.	Atoms per unit cell	1	2	4	6	8
2.	Atomic radius	$\frac{a}{2}$	$\frac{a\sqrt{3}}{4}$	$\frac{a\sqrt{2}}{4}$	$\frac{a}{2}$	$\frac{a\sqrt{3}}{8}$

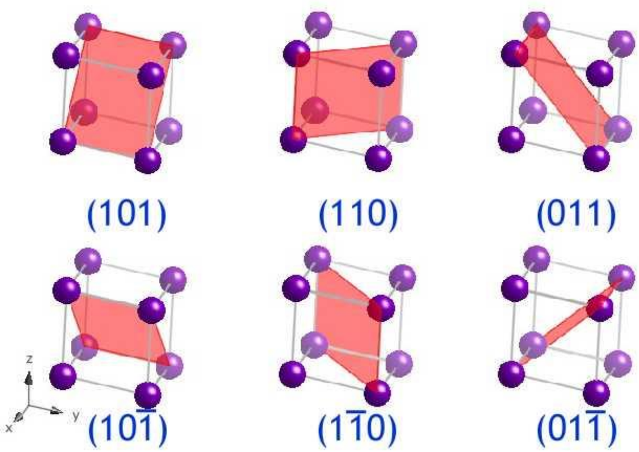
	3.	Co-ordination number	6	8	12	12	4
	4.	Atomic packing factor	$\frac{\pi}{6}=0.52$	$\frac{\pi\sqrt{3}}{8}=0.68$	$\frac{\pi\sqrt{2}}{6}=0.74$	$\frac{\pi}{3\sqrt{2}}=0.74$	$\frac{\pi\sqrt{3}}{16}=0.34$
	5.	Packing density	52%	68%	74%	74%	34%
	6.	Example	Polonium	Cr,Fe, Na, Ba, Tungsten	Pb, Ni, Ag, Cu, Al	Mg, Co, Ti, Zn, Quartz	Ge, Si, Carbon

13 **What are the differences between edge and screw dislocations? (Jan 2011)**BTL2

S.No.	Edge dislocation	Screw dislocation
1.	These dislocations arise due to introduction or elimination of extra atoms.	Screw dislocation results from a displacement of atoms in one part of a crystal relative to the rest of crystals forming a spiral ramp around the dislocation line.
2.	Region of lattice disturbance extends along an edge inside a crystal.	Region of lattice disturbance extends in two separate planes at right angles to each other.
3.	An edge dislocation can glide and climb.	A screw dislocation can glide only.
4.	Burger vector is always perpendicular to the dislocation line.	Burger vector is parallel to the dislocation line.

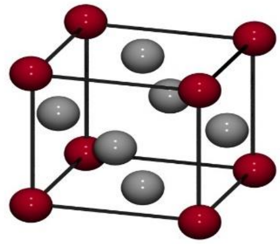
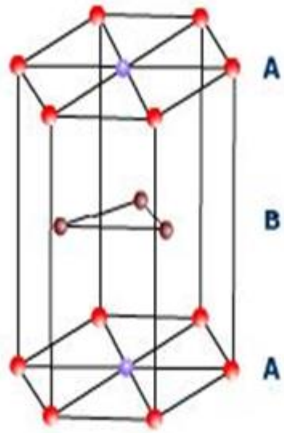
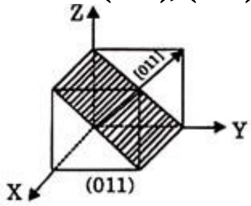
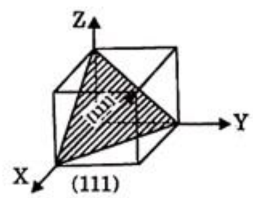
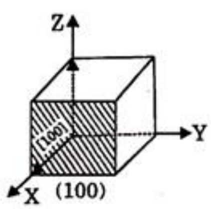
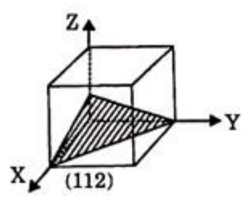
14 **What are the various types of defects in crystals?** BTL2

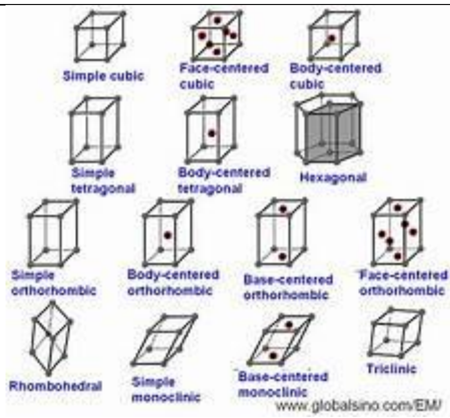
- Point defects
- Impurity defects
  - Substitutional impurity defect
  - Interstitial impurity defect
- Vacancies
  - Frenkel defect
  - Schottky defect
- Line defects
  - Edge dislocation
    Screw dislocation
- Surface defects
  - Grain boundaries
  - Twin boundaries
  - Tilt boundaries
  - Stacking faults
- Volume defects

	Cavities or voids Cracks and holes
15	**What is Frenkel defect, Schottky defect and and Burger's vector in crystal defects? (Jan 2009, Jan 2010, Jan 2011, Dec 2017, Jan. 2019)** BTL2 **Frenkel defect:** A vacancy associated with interstitial impurity is called Frenkel defect. **Schottky defect**: If an atom is missing its lattice site, the vacancy is called Schottky defect. **Burger's vector**: The magnitude and the direction of the displacement due to edge dislocation are defined by a vector called Burger's vector.
16	**Draw (101), (110), (011), (10 ī), (1 ī0), (01 ī) planes in a crystal.** BTL1 
17	**Calculate the packing factors of BCC and FCC unit cell. (May 2013)** BTL1 In the body – centered Cubic Structure, The number of atoms per unit cell = 2 $\therefore$ Volume of 2 atoms (spherical) 2 x $\frac{4}{3}\pi r^3$ We know the radius of atom in BCC is r = $\frac{a\sqrt{3}}{4}$ $\therefore$ Volume occupied by the atoms per unit cell (v) $= \frac{8\pi}{3}\left[\frac{a\sqrt{3}}{4}\right]^3$ $V = \frac{8\pi}{3}\left[\frac{a^3\ 3\sqrt{3}}{4\times 4\times 4}\right]$ $\therefore$ Volume occupied by the atoms per unit cell (v) = $\pi a^3 \frac{3\sqrt{3}}{8}$ Volume of the unit cell for a Cubic System (v) = a^3

	$\therefore$ Atomic packing factor (APF) = $\dfrac{\pi a^3 \sqrt{3}/8}{a^3}$ (or) APF = $\pi \dfrac{\sqrt{3}}{8}$ $\therefore$ APF = 0.68. In face – centered cubic Structure, The number atoms per Unit cell = 4 $\therefore$ Volume of 4 atoms = 4 x $\dfrac{4}{3}\pi r^3$ We know the radius of the atom is FCC $r = \dfrac{a\sqrt{2}}{4}$ $\therefore$ Volume occupied by the atoms per unit cell $(v) = \dfrac{16\pi}{3}\left(\dfrac{a\sqrt{2}}{4}\right)^3$ $v = \dfrac{16\pi}{3}\left(\dfrac{a^3 2\sqrt{2}}{4\times 4\times 4}\right)$ $\therefore$ Volume occupied by the atoms per unit cell $v = \dfrac{\pi a^3\sqrt{2}}{6}$ Volume of the unit cell for a Cubic System (v) = a^3 $\therefore$ Atomic packing factor (APF) = $\dfrac{\pi a^3 \frac{\sqrt{2}}{6}}{a^3}$ (or) APF = $\pi\dfrac{\sqrt{2}}{6}$ = 0.74 APF = 0.74
18	**Obtain Miller indices of a plane whose intercepts are a, b/2, 3c in a simple cubic unit cell. (Jan 2010)** BTL1 Actual intercepts are a, b/2, 3c Numerical parameters are 1, 1/2, 3 Reciprocals of the above 1, 2, 1/3 3, 6, 1 Miller indices of the plane is (361).
19	**Define the term space lattice. (May 2003, May 2004, June 2005, Jan 2009, Jan 2013, Dec 2015)** BTL1

	Space lattice is defined as an array of points in three dimensional space in which the environment about each point is the same. i.e. every point has identical surroundings to that every other point in the array.
20	**Define the term Bravais lattice. (May 2003, May 2004, June 2005, Jan 2009, Jan 2013, Dec 2015)** BTL1 Bravais lattice There are only fourteen ways are arranging points in space such that the environment looks same from each point. i.e. there are fourteen possible type of space lattices out of the seven crystal systems. These fourteen space lattices are called Bravais lattices.
21	**Lattice constant of a BCC crystal is 0.36 nm. Find its atomic radius.(Jan.2013)** BTL1 **$a=0.36\times10^{-9-}$ m** **For BCC, $r=a\sqrt{3}/2$** **$r=0.36\times10^{-9}\times\sqrt{3}/4$ nm =0.16nm**
22	**Copper is FCC whose atomic radius is 1.26×10^{-10} m. Calculate its lattice constant.(May.2012)** BTL1 **$r=1.26\times10^{-10}$m** **For FCC, $r= a\sqrt{2}/4$** **$a = 4r/\sqrt{2}$** **$4\times1.26\times10^{-10/}\sqrt{2}$** **$a= 3.56\ A^0$**
23	**Alpha iron of atomic weight 55.85 solidifies into BCC structure and has a density 7860 kgm^{-3}. Calculate the radius of an atom.** BTL1 Atomic weight M= 55.85 Density = 7860 kg m^{-3} Number of atoms per unit cell for BCC=2 Avagadro's number N= 6.023×10^{26} mol^{-1} $\rho = nM/Na^3$ $a^3=nM/N\rho$ $a= (nM/N\rho)^{1/3}$ $a= 2\times55.85/6.023\times10^{26}\times7860)^{1/3}$ $a=2.869\times10^{-10}$m Atomic radius for BCC = $a\sqrt{3}/4$ $r= 2.869\times10^{-10}\times1.732/4$ $r= 1.242A^0$
24	**Define the terms Primitive cell. (May 2003, Nov 2003, May 2004, Jan 2010, Jan 2011, Jan 2012, Jan 2014)** BTL1 Primitive cell:The unit cell which is formed by the primitives a, b and c with only one lattice point is called as primitive cell. It is represented by the letter P. E.g. SCC
25	**Define the terms Non-Primitive cell. (May 2003, Nov 2003, May 2004, Jan 2010, Jan 2011, Jan 2012, Jan 2014)** BTL1 Non-primitive cell :The unit cell which is formed by the primitives a, b and c with more than one lattice point is called as non primitive cell. E.g. BCC, FCC
26	**Show the atomic positions in fcc and hcp crystal structures in a sketch. (Jan 2019)** BTL4

	  **FCC-Lattice Structure** **HCP-Lattice - Structure**
27	**Sketch (011), (111) plane for a cubic structure. (Dec 2017)** BTL4  
28	**Sketch (100), (112) plane for a cubic structure.** BTL4  
	PART * B
1	**Explain the various types of crystal systems with a neat sketch and example. Describe the 14 types of Bravais lattice three dimensions with suitable diagrams. (Jan 2009, Jan 2011) (16M)** BTL2 **Answer : Page: 7.15-Dr.P.MANI** ➢ **Bravais lattice** (2M) Fourteen possible ways - arranging points in space -Environment looks same from each point. ➢ **Diagram** (6M)



- **Types of seven crystal systems** (8M)
  - Cubic
  - Tetragonal
  - Orthorhombic
  - Monoclinic
  - Triclinic
  - Rhombohedral
  - Hexagonal

2

Define the terms "Coordination number", "number of atoms per unit cell", "atomic radius" and "atomic packing factor" Calculate the above for SC, BCC structures. (Jan 2011, Dec 2012, Dec 2013, Dec 2017)(16 M) BTL1

Answer : Page : 7.23-Dr.P.MANI

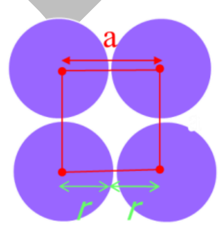
- **Simple cubic structure**
- **Arrangement of atoms** (2M)

  Simple cubic-8 corner atoms-Easiest structure.
- **Number of atoms per unit cell** (2M)

  8*I/8=1atom per unit cell
- **Atomic radius** (2M)

$$a = 2r$$

$$r = \frac{a}{2}$$



- **Packing factor** (2M)

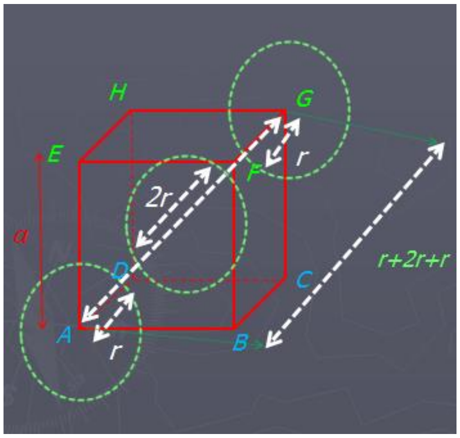
$$\text{APF} = \frac{\pi}{6} \text{ (or) APF} = 0.52$$

- **Body centre cubic structure**
- **Arrangement of atoms** (2M)

  Body centre atom(1)-8 corner atoms-centre atoms touch corner atom.
- **Number of atoms per unit cell** (2M)

  Body centre atom(1)+ Corner atom (8*I/8)=2 atoms per unit cell

➢ **Atomic radius** (2M)



$$r = \sqrt{\frac{3a}{4}}$$

➢ **Packing Factor** (2M)

$$\text{APF} = \pi \frac{\sqrt{3}}{8}$$

3

Define the terms "Coordination number", "number of atoms per unit cell", "atomic radius" and "atomic packing factor" Calculate the above for FCC structure. (Apr 2003, Jan 2010, Jan 2011, Dec 2013, Dec 2017) (12 M) BTL1

Answer : Page : 7.33-Dr.P.MANI

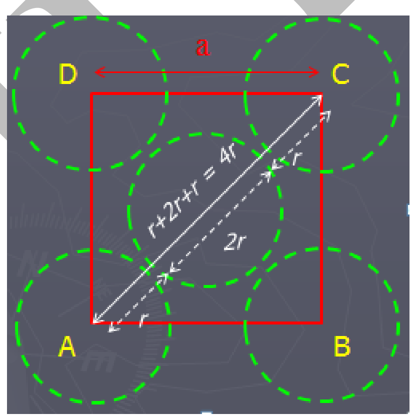
➢ **Arrangement of atoms** (2M)

Face centre atom(6)-8 corner atoms- face centre atoms do not touch corner atom.

➢ **Number of atoms per unit cell** (2M)

Face centre atom(6*I/2)+ Corner atom (8*I/8)= 4 atoms per unit cell

➢ **Atomic radius** (2M)



$$r = \frac{\sqrt{2}a}{4}$$

➢ **Packing Factor** (6M)

<table>
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$$\text{APF} = \pi\frac{\sqrt{2}}{6} = 0.74$$

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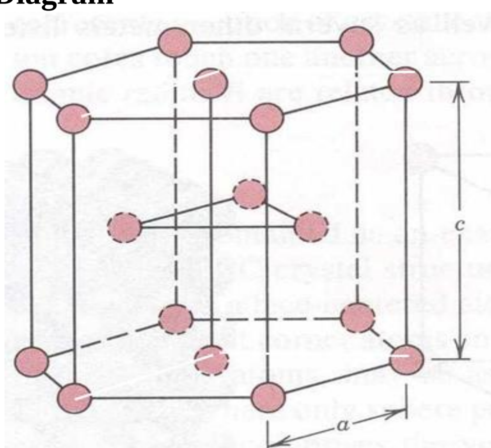
Describe the structure of HCP crystal. Give details about its coordination number, number of atoms per unit cell, atomic radius, axial ratio and atomic packing factor. (Apr 2003, Jan 2010, Jan 2011, Dec 2013)(16 M)BTL2

Answer : Page : 7.38-Dr.P.MANI

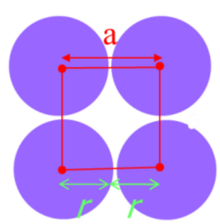
- **Description** (2M)
- **1.Top Layer**
  6corner atom-centre atom(1)-side(a)
- **2.Middle Layer**
  Individual atom(3)-height(c)
- **3. Bottom Layer**
  6corner atom-centre atom(1)-side(a)
- **Diagram** (2M)



- **Atomic radius**

$$a = 2r$$

$$r = \frac{a}{2}$$



- **Calculation of c/a ratio** (8M)

$$\frac{c}{a} = \sqrt{\frac{8}{3}} = 1.633$$

- **Packing Factor** (4M)

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$$APF = \frac{2\pi}{3\sqrt{3}}\left(\frac{3}{8}\right)^{1/2} (or) APF = \frac{2\pi\sqrt{3}}{3\sqrt{3}2\sqrt{2}}$$

$$APF = \frac{\pi}{3\sqrt{2}} (or) APF = 0.74$$

5

Explain the structure of diamond crystal and prove that it is loosely packed structure. (Apr 2003, Jan 2005, Jan 2009, Jan 2010, Jan 2011, Dec 2014, Dec 2015, Jan 2016)(16 M) BTL2

Answer : Page: 7.46-Dr.P.MANI

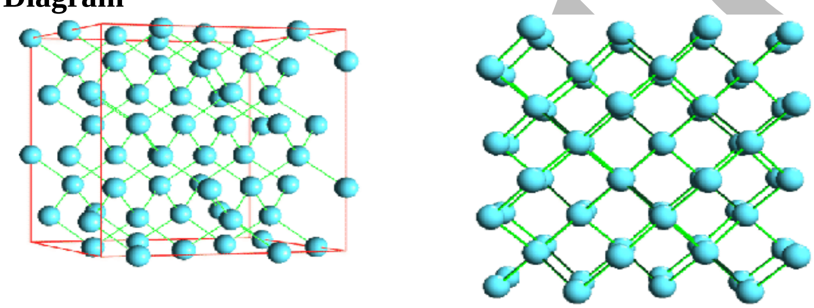
- **Arrangement of atoms** (2M)

  Important crystal structure-two interpenetrating FCC sub lattices-one origin(0,0,0)-another origin($\frac{a}{4}, \frac{a}{4}, \frac{a}{4}$)-loosely packed structure.

- **Number of atoms per unit cell** (2M)

  Corner atoms(1)-Face center atoms(3)- inside four atoms=8 atoms.

- **Diagram** (2M)



Diamond lattice

- **Atomic radius** (4M)

$$r = \frac{\sqrt{3}a}{8}$$

- **Packing Factor** (6M)

$$PF = \frac{\pi\sqrt{3}}{16}$$

  Atomic Packing Factor is 0.34.

6

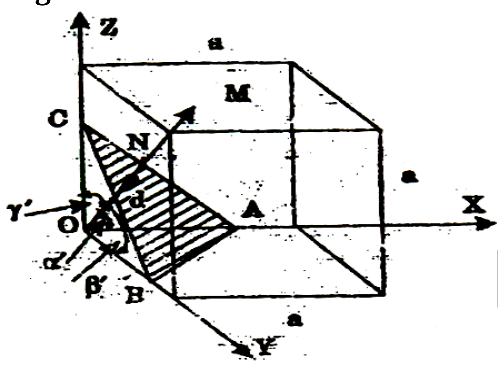
Show that the packing factors of FCC and HCP are equal. (BTL1)**(10M)**

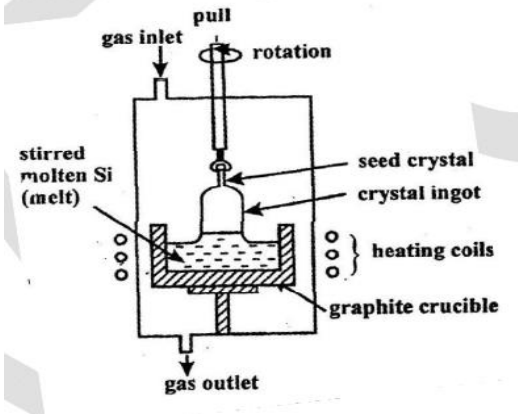
Answer : Page : 7.37-7.44-Dr.P.MANI

- **Packing Factor (FCC)** (5M)

$$\text{APF} = \pi\frac{\sqrt{2}}{6} = 0.74$$

- **Packing Factor (HCP)** (5M)

	$APF = \frac{2\pi}{3\sqrt{3}}\left(\frac{3}{8}\right)^{1/2} (or) APF = \frac{2\pi\sqrt{3}}{3\sqrt{3}2\sqrt{2}}$ $APF = \frac{\pi}{3\sqrt{2}} (or) APF = 0.74$
7	**What are Miller indices? Derive an expression for d – spacing of a cubic crystal in terms of lattice constant and miller indices. (Jan 2010, Dec 2017)(8M)**BTL2 **Answer : Page : 7.59-7.101-Dr.P.MANI** ➢ **Miller Indices** (2M) Three smallest possible integers- same ratios- reciprocals of intercepts of plane -concerned on three axes. ➢ **Diagram** (2M)  ➢ **Derivation** (4M) $\mathcal{NM} = d = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$
8	**Explain the principle, construction and working of Czochralski and Bridgmancrystal growth techniques. (Jan 2014, Dec 2015, Dec 2017)(16 M)** BTL2 **Answer : Page: 7.83-Dr.P.MANI** ➢ **Czochralski Method** ➢ **Principle** (2M) Crystal pulling method-mono crystalline seed-used pull rod-melt freezes-crystal grows. ➢ **Diagram** (2M)



- **Construction& Working** (3M)

Crystal pulling technique - growing a crystal gradually- condensing melt- liquid-solid phase transition-seed crystal-heater switched ON.

- **Advantages** (1M)

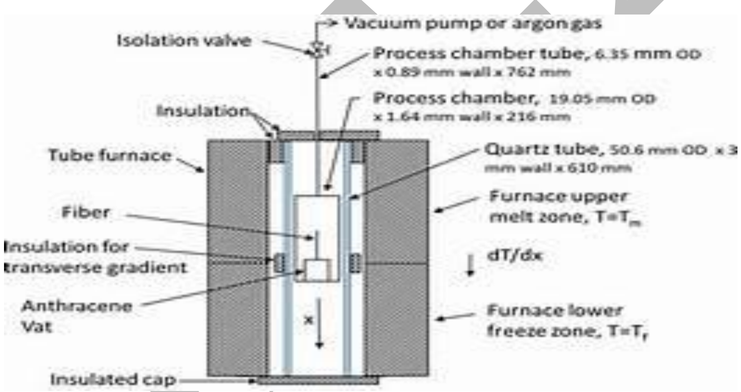
Produce large crystal-easy control-free from crystal growth.

- **Bridgmann Method**

- **Principle** (2M)

Material heated-molten state-temperature gradient-crystal growth.

- **Diagram** (2M)



- **Construction& Working** (3M)

Crystal taken crucible-vertical container-Hot furnace(1)- Cold furnace(2)-material heated-molten state-crystalline starts-crystal growth.

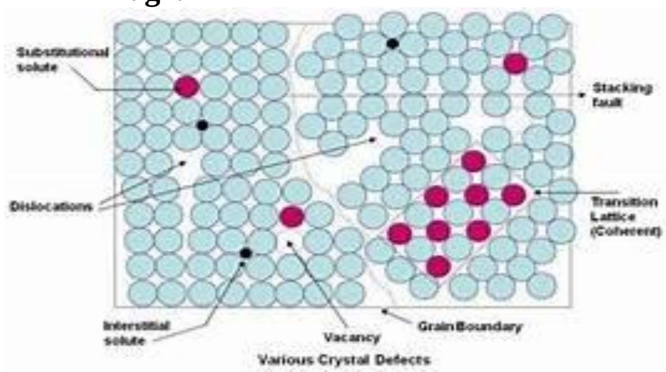
- **Advantages** (1M)

Cheaper-Easy method-Good crystal formed.

9	**Give an account of point and line defects in crystals. (Jan 2009, Jan 2010, Jan 2011) (12M)**BTL3

Answer : Page :7.65-Dr.P.MANI

- **Diagram** (2M)



Various Crystal Defects

- **Types of point defects** (5M)

- **Interstitial defect**

  Extra atom positioned-voids between regular atomic sites-atom occupies interstitial position -without replacing parent atom.
- **Vacant**

  Missing of an atom
- **Types of line defects** (5M)
- **Edge dislocation**

Lattice disturbance extending upto the edge- extra plane of atoms-elimination of an extra plane of atoms-Burger's vector perpendicular to dislocation line-speed movement is high.

- **Screw dislocation**

One part of a crystal relative to rest of crystal-Burger's vector parallel to dislocation line-speed movement is low.

10

Give an account of surface and volume defects in crystals and role of imperfection in plastic deformation. (Jan 2009) (12M) BTL3

Answer : Page 7.77-Dr.P.MANI

- **Types of surface defects** (5M)
- **Grain Boundaries**

  Grains of different orientations-general pattern of atoms-two growing grain surfaces meet-solidification of liquid metal.
- **Tilt and twist Boundaries** (5M)

  Another surface imperfection-arranged one above-low angle boundary.

  $$\tan\theta = \frac{b}{D}$$
- **Twist Boundaries**

  Low angle boundary-two sets of parallel screw dislocation.
- **Twin Boundaries**

  Atomic arrangement in mirror image.
- **Role of imperfections in plastic deformations** (2M)

  Application of stress crystal deformed-removal of stress comes original shape called elastic-removal of stress does not comes original shape called plastic-presence of dislocation slip formed.

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"Self-Belief | Self Discipline | Self Respect"

CY8151 – ENGINEERING CHEMISTRY

QUESTION BANK

I YEAR – 01st SEMESTER

DEPARTMENT OF SCIENCE AND HUMANITIES

NAME	:
REG. NO.	:
YEAR	: FIRST YEAR (ALL BRANCHES)
SEMESTER	: 01

CY8151 ENGINEERING CHEMISTRY L T P C 3 0 0 3

OBJECTIVES:

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques.
- To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.
- Preparation, properties and applications of engineering materials.
- Types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels.
- Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.

UNIT I WATER AND ITS TREATMENT 9

Hardness of water – types – expression of hardness – units – estimation of hardness of water by EDTA – numerical problems – boiler troubles (scale and sludge) – treatment of boiler feed water – Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) external treatment – Ion exchange process, zeolite process – desalination of brackish water - Reverse Osmosis.

UNIT II SURFACE CHEMISTRY AND CATALYSIS 9

Adsorption: Types of adsorption – adsorption of gases on solids – adsorption of solute from solutions – adsorption isotherms – Freundlich‘s adsorption isotherm – Langmuir‘s adsorption isotherm – contact theory – kinetics of surface reactions, unimolecular reactions, Langmuir - applications of adsorption on pollution abatement. Catalysis: Catalyst – types of catalysis – criteria – autocatalysis – catalytic poisoning and catalytic promoters - acid base catalysis – applications (catalytic convertor) – enzyme catalysis– Michaelis – Menten equation.

UNIT III ALLOYS AND PHASE RULE 9

Alloys: Introduction- Definition- properties of alloys- significance of alloying, functions and effect of alloying elements- Nichrome and stainless steel (18/8) – heat treatment of steel. Phase rule: Introduction, definition of terms with examples, one component system -water system - reduced phase rule - thermal analysis and cooling curves - two component systems - lead-silver system - Pattinson process.

UNIT IV FUELS AND COMBUSTION 9

Fuels: Introduction - classification of fuels - coal - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum - manufacture of synthetic petrol (Bergius process) - knocking - octane number - diesel oil - cetane number - natural gas - compressed natural gas (CNG) - liquefied petroleum gases (LPG) - power alcohol and biodiesel. Combustion of fuels: Introduction - calorific value - higher and lower calorific values- theoretical calculation of calorific value - ignition temperature - spontaneous ignition temperature - explosive range - flue gas analysis (ORSAT Method).

UNIT V ENERGY SOURCES AND STORAGE DEVICES 9

Nuclear fission - controlled nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant - breeder reactor - solar energy conversion - solar cells - wind energy. Batteries, fuel cells and supercapacitors: Types of batteries – primary battery (dry cell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells – H_2-O_2 fuel cell.

TOTAL: 45 PERIODS

OUTCOMES:

The knowledge gained on engineering materials, fuels, energy sources and water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.

TEXT BOOKS:

1. S. S. Dara and S. S. Umare, ―A Textbook of Engineering Chemistry‖, S. Chand & Company LTD, New Delhi, 2015
2. P. C. Jain and Monika Jain, ―Engineering Chemistry‖ Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015
3. S. Vairam, P. Kalyani and Suba Ramesh, ―Engineering Chemistry‖, Wiley India PVT, LTD, New Delhi, 2013.

REFERENCES:

1. Friedrich Emich, ―Engineering Chemistry‖, Scientific International PVT, LTD, New Delhi, 2014.
2. Prasanta Rath, ―Engineering Chemistry‖, Cengage Learning India PVT, LTD, Delhi, 2015.
3. Shikha Agarwal, ―Engineering Chemistry-Fundamentals and Applications‖, Cambridge University Press, Delhi, 2015.

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UNIT I – WATER AND ITS TREATMENT

Hardness of water – types – expression of hardness – units – estimation of hardness of water by EDTA – numerical problems – boiler troubles (scale and sludge) – treatment of boiler feed water – Internal treatment (phosphate, colloidal, sodium aluminate and Calgon conditioning) external treatment– Ion exchange process, zeolite process – desalination of brackish water - Reverse Osmosis.

Part-A (2Marks)

Q.No.	Questions
1	**Name any two salts that cause temporary hardness. (Jan 2018)** BTL1 The salts responsible for temporary hardness are $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$.
2	**What is reverse osmosis? (Jan 2018)** BTL2 The flow of solvent from higher concentration to lower concentration through the semipermeable membrane when hydrostatic pressure in excess of the osmotic pressure is applied on higher concentration side is known as reverse osmosis.
3	**Define hardness of water. What are its types? (Jan 2013)** BTL2 The property of water which makes it not to lather with soap is called hardness. It is mainly because of hardness producing salts like $MgCO_3$, $CaSO_4$, $Mg(HCO_3)_2$, $CaCO_3$ etc., Types - i) Temporary hardness ii) Permanent hardness
4	**Mention the disadvantages of using hard water in boiler. (Nov. 2010)** BTL2 Water used for steam generation should be free from hardness, otherwise it will cause boiler problems like scale and sludge formation, priming and foaming, boiler corrosion, etc. Hence, water is softened before feeding it to boiler.
5	**List out the salts responsible for the temporary and permanent hardness of water.** BTL2 Temporary hardness: Carbonates and Bicarbonates of Ca and Mg (eg) $CaCO_3$, $Mg(HCO_3)_2$. Permanent hardness: Sulphates, Chlorides of Ca, Mg (eg)$CaCl_2$, $MgCl_2$, $CaSO_4$, Mg SO_4
6	**How is the hardness of water expressed? What are the units practiced for expressing hardness of water? (April 2005) (June 2009)** BTL2 The hardness is, usually, expressed in terms of equivalent amount of $CaCO_3$. The choice of $CaCO_3$ is due to: a) Its molecular weight is 100 (*equivalent weight = 50*) which makes calculation easy.

	b) It is the most insoluble salt that can be precipitated in water treatment. Hardness can be expressed by any of the following units ppm - mg/l - degree Clarkes - Degree French
7	**How is hardness of water detected?** **(or)** **Give the test to detect hardness of water. (April 2005)** BTL2 a) Eriochrome Black – T indicator gives wine red colour in hard water. b) With soap, hard water gives a scummy (dirty white) precipitate. $2C_{17}H_{35}COONa + CaCl_2 \rightarrow (C_{17}H_{35}COO)_2Ca + 2NaCl$ (Sodium stearate) (Scummy precipitate)
8	**What are ion-exchange resins?** BTL2 Ion-Exchange Resins are long chain, insoluble, cross linked, organic polymers which are capable of exchanging its ions with water. They are of 2 types. i)Cation exchange resins – RH^+ (e.g) Sulphonated coals , RSO_3H ii)Anion exchange resins – $R'OH^-$ (e.g) Ureaformaldehyde, Amines $R\text{-}NH_2$
9	**What are Boiler troubles? How are they caused? (May 2008); (May 2011)** BTL2 Sludge and Scale formation, Caustic embrittlement, Boiler corrosion, Priming and foaming are collectively known as boiler troubles. They are caused by the hardness causing salts present in boiler feed water.
10	**What are scales**? **How can it be prevented ? Mention its disadvantages**. **(June 2009)** BTL2 Scales are hard, thick and adherent precipitate deposited on boilers due to salts like $CaSO_4$, $Ca(HCO_3)_2$ present in water. Disadvantages: • Wastage of fuel • Decrease in efficiency of boilers • Boiler explosion Prevention: • Using scraper, wire brush etc • Thermal shocks • Using suitable chemicals like dil. Acids, EDTA with which they form suitable complexes • Internal and External treatment methods

11	**What is meant by 'internal conditioning of water'. Name any two boiler compounds used in internal conditioning of boiler feed water. (June 1994,June 2013)** BTL2 It is the process of removal of hardness producing ions by adding certain chemicals directly into the boilers. These chemicals are called boiler compounds. The boiler compounds used in the internal conditioning are • Calgon • Phosphate
12	**Justify the role of phosphates in the internal treatment of water. (May 2005)** BTL2 **(or)** **Name an internal method used for high pressure boiler and explain. (Dec 2011)** BTL1 Phosphate salts are used as boiler compounds for high pressure boilers**.** Phosphates precipitate the soluble Ca and Mg salts as their insoluble phosphates. They are also helpful in maintaining the pH of the boiler water. $3CaSO_4 + 2\ Na_3PO_4 \rightarrow Ca_3(PO_4)_2 + 3\ Na_2SO_4$
13	**Calgon treatment prevents scale formation in boilers. Give reason. (Jan 2010, June 2010,Jan 2011)** BTL4 Addition of calgon (sodium hexa meta phosphate) to boiler feed water interacts with calcium ions in $CaSO_4$ forming a soluble complex, thus preventing the precipitation of scale and sludge forming salt. $2CaSO_4 + Na_2[Na_4(PO_3)_6] \longrightarrow Na_2[Ca_2(PO_3)_6] + 2Na_2SO_4$**.**
14	**Define demineralization of water. Give its advantages and disadvantages (Dec 2016)** BTL2 Demineralization is the process of complete removal of cations and anions of water. This process makes use two columns of cation -exchange column and anion- exchange column filled with resins Advantages: i) The process can be used to soften highly acidic or alkaline waters. ii) It produces water of very low hardness (2ppm). iii) It is very good for treating water for use in high-pressure boilers. Disadvantages: i)The equipment is costly and more expensive. ii)The turbidity must be below 10 ppm.
15	**What is Desalination? Name the different methods of desalination. (May 2011,May 2014)** BTL2

	Removal of common salt (NaCl) from water is called desalination. Various methods of desalination: Reverse Osmosis, Distillation, Electro- dialysis, Freezing, Solar distillation, etc.,
16	**List the requirements(or) requisites of boiler feed water. (Jan 2016)** BTL2 Water used in boilers known as boiler feed water must be free from • Hardness producing salts like Ca^{2+}, Mg^{2+} etc • Dissolved gases like O_2, CO_2 etc, • Suspended impurities • Dissolved salts and alkalinity • Turbidity and oil • Total dissolved solids
17	**Give the differences between sludges and scales.** BTL5 Sludges: • Loose and Slimy precipitate • Due to the presence of $MgCO_3$, $MgCl_2$, $MgSO_4$ and $CaCl_2$ Scales: • Hard and adherent coating • Due to the presence of $Ca(HCO_3)_2$, $CaSO_4$, $Mg(OH)_2$
18	**Differentiate Carbonate hardness from Non-carbonate hardness.** BTL5 **Carbonate hardness (Temporary hardness)** • Due to bicarbonates of Calcium and Magnesium • Can be removed by boiling and by adding lime • Also called as alkaline hardness **Non-carbonate hardness** • Due to Chlorides and Sulphates of Calcium and Magnesium • Can not be removed by boiling but by lime soda process and zeolite process • Also called as non-alkaline hardness
19	**Zeolite softener cannot be used for softening turbid water. Why?** BTL4 The suspended matter in turbid water clogs the pores of the zeolite bed and restricts the water flow.
20	**Mention the merits of ion -exchange process.** BTL2 • Highly acidic and alkaline water can be treated. • Residual hardnesss of the water is 0-2 ppm. So it is very good for use in high pressure boilers • Resins can be regenerated.

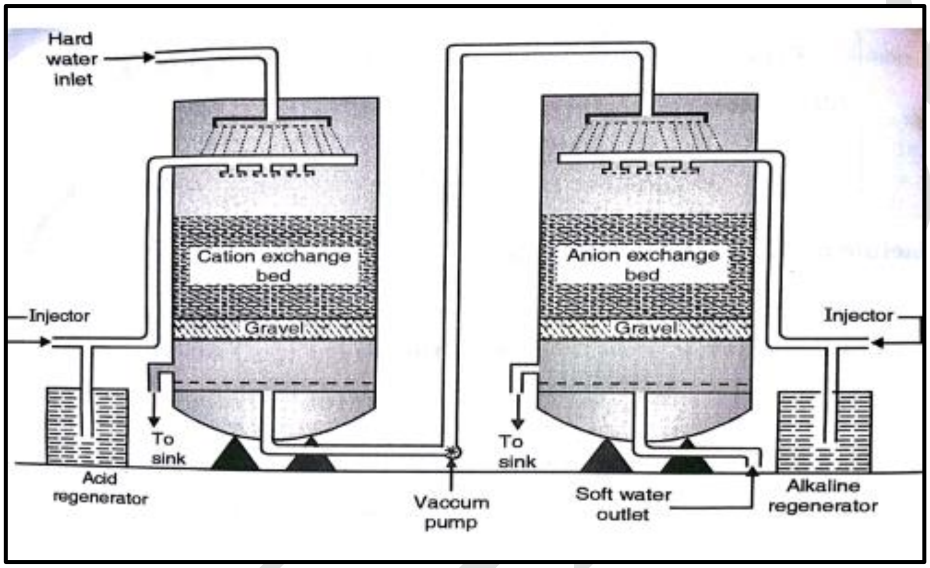
21	**Give the merits and demerits of zeolite process. (June 2015, Jan 2014)** BTL2 **Merits:** (i) The softened water has hardness between 15-50ppm. (ii) Requires less time for softening(iii) No sludge is formed during this process. **Demerits:**(i) The treated water contains more sodium salts which cannot be used as boiler feed water. (ii) Highly turbid water cannot be treated by this method.(iii) Zeolite Plant occupies more space.
22	**What is meant by colloidal conditioning?** BTL2 Formation of scale in boilers can be avoided by adding organic substances like kerosene, tannin, agar-agar, etc. These substances get coated over the scale forming precipitates thereby yielding non-sticky deposits which can be removed.
23	**What are boiler compounds? Give examples. (June 2006)** BTL2 Boiler compounds are chemicals added inside the boilers to remove scale forming substances. Ex: Calgon, Sodium Phosphate
24	**How is internal conditioning done using Sodium aluminate?** BTL2 Sodium aluminate undergoes hydrolysis in boiler water to give a white gelatinous precipitate of aluminum hydroxide and sodium hydroxide. This precipitate entrap the scale forming substances and settles down easily which can be removed by blow down operation. $NaAlO_2 + 2\ H_2O \rightarrow Al_2O_3 + NaOH$
25	**What is calgon conditioning? (June 2015, Jan 2014)** BTL2 Calgon is Sodium hexa meta phosphate. This interacts with calcium ions forming a highly soluble complex and thus prevents scale formation $Na_2[Na_4(PO_3)_6] + 2CaSO_4 \rightarrow Na_2[Ca_2(PO_3)_6] + 2Na_2SO_4$ Since, the complex formed is soluble in water, there is no problem in the disposal of sludge.
26	**How is soft water different from demineralized water? (June 2011)** BTL5 Soft water does not contain hardness causing ions like Ca^{2+} and Mg^{2+} but contains other ions like Na^+, K^+, SO_4^{2-}, Cl^- etc. whereas demineralized water does not contain both anions and cations.
27	**Why is sodium carbonate not used as a conditioning substance in high pressure boilers?** BTL4 In high pressure boilers, Sodium carbonate undergoes decomposition to give NaOH. This sodium hydroxide formed flows into the minute cracks present in the boiler and cause caustic embrittlement.
	Part-B (8 Marks)

1	**Describe how hardness is measured using EDTA. (8M) (Jan2010, Jan 2009)** BTL2 **Answer: Page 1.11-Dr. A. RAVIKRISHNAN** **EDTA**-Structure (1M) **Principle** (1M) EBT+ water sample →wine red weak EBT complex Weak EBT complex +EDTA→ stable EDTA complex Indicator set free, End point- steel blue colour. pH: 8-10 maintained using ammonia buffer. **Standardisation of EDTA** (2M) Burette-EDTA Conical flask-Standard hard water+ buffer+ indicator End point- wine red to steel blue **Determination of total hardness** (2M) Burette-Standard EDTA Conical flask-Sample hard water+ buffer+ indicator End point- wine red to steel blue Total hardness= $1000\times \frac{v2}{v1}$ ppm **Determination of Permanent and temporary hardness** (2M) Burette-Standard EDTA Conical flask-Boiled sample hard water+ buffer+ indicator End point- wine red to steel blue Permanent hardness= $1000\times \frac{v3}{v1}$ ppm Temporary hardness= Total hardness- Permanent hardness
2	**Write a note on Scales and Sludges. (8M) (June 2005, June 2009, June 2010, June 2014, May 2017)** **Answer: Page 1.24-Dr. A. RAVIKRISHNAN** BTL1 **Scales** (4M) **Definition**- Hard- adherent coating- inner walls of boiler **Salts responsible**- $Ca(HCO_3)_2$, $CaSO_4$, $Mg(OH)_2$, **Removal methods**- External and internal methods **Disadvantages-** Fuel wastage, decreases boiler efficiency, boiler explosion **Sludges** (4M) **Definition**- loose- slimy precipitate **Salts responsible**- $MgCO_3$, $MgCl_2$, $MgSO_4$, $CaCl_2$ **Removal methods**- Blow down operation **Disadvantages-** Poor heat conductors, decreases boiler efficiency

3

Describe ion-exchange method in detail. (8M)
(or)
Explain demineralization process. (8M) (Dec 2002, May 2007, May 2008, Jan 2014,June2016)
BTL2
Answer: Page No. 1.33-Dr. A. RAVIKRISHNAN

Cation exchanger (1M)
Acidic functional group, exchanges H^+ with cations, RH_2
Anion exchanger (1M)
Basic functional group, exchanges OH^- with anions, $R(OH)_2$
Diagram (2M)



Process (2M)
Cation exchanger absorbs all cations, anion exchanger absorbs all anions, demineralized water free from all minerals obtained

Reactions occurring at Cation exchange column

- $RH_2 + CaCl_2 \rightarrow RCa + 2HCl$
- $RH_2 + MgSO_4 \rightarrow RMg + H_2SO_4$
- $RH + NaCl \rightarrow RNa + HCl$

Reactions occurring at Anion exchange column

- $R'(OH)_2 + 2HCl \rightarrow R'Cl_2 + 2H_2O$
- $R'(OH)_2 + H_2SO_4 \rightarrow R'SO_4 + 2H_2O$

Regeneration (1M)

Cation exchanger by passing dil. HCl or H_2SO_4

- $RCa + 2HCl \rightarrow RH_2 + CaCl_2$

Anion exchanger by passing dil. NaOH

- $R' Cl_2 + 2NaOH \rightarrow R'(OH)_2 + 2NaCl$

Advantages and Disadvantages (1M)

Advantages- Highly acidic/ alkaline water can be treated, Water obtained has low hardness
Disadvantages - Turbid water can't be treated, Expensive equipment

4

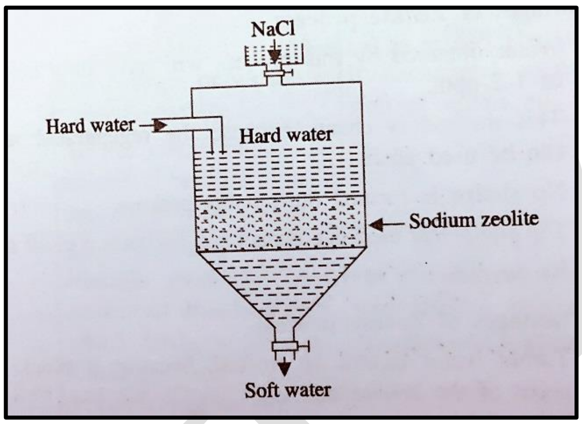
What is zeolite? How is it useful in water treatment? (8M) (May 2015, Dec 2014, June 2016) BTL3

Answer: Page No. 1.36 -Dr. A. RAVIKRISHNAN

Zeolite Definition (2M)

Naturally occurring- hydrated sodium aluminosilicate- non-porous
synthetic form- Permutit, porous, gel like structure

Diagram (2M)



Process (2M)

Hard water passed through zeolite, exchanges sodium ions with Ca^{2+}, Mg^{2+} , soft water obtained, but contains large amount of sodium.

- $Cal_2 + Na_2Ze \rightarrow CaZe + NaCl$
- $MgCl_2 + Na_2Ze \rightarrow MgZe + NaCl$

Regeneration (1M)

Exhausted zeolite treated with 10% NaCl.

- $CaZe + 2NaCl \rightarrow Na_2Ze + CaCl_2$
- $MgZe + 2NaCl \rightarrow Na_2Ze + MgCl_2$

Advantages and disadvantages (1M)

Advantages-low hardness, cheap method, no sludge formed, easy operation
Disadvantages- water with turbidity, acidity can't be treated, treated water cannot be used in boilers

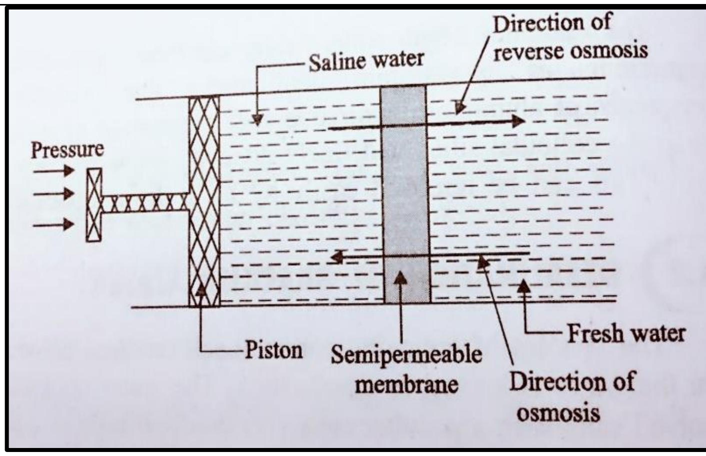
5

What is internal conditioning? Explain the various methods of internal conditioning. (8M) (June 2017) BTL2

Answer: Page No. 1.39-Dr. A. RAVIKRISHNAN

Definition (1M)

	Removal of scale by addition of chemicals directly into boiler **Phosphate conditioning** (2M) Used in high pressure boilers, converts scale into soft sludges, 3 types- trisodium phosphate for too acidic, Disodium hydrogen phosphate for weakly acidic, Sodium dihydrogen phosphate for alkaline $3CaSO_4 + 2Na_3PO_4 \rightarrow Ca_3(PO_4)_2 + 3\ Na_2SO_4$ **Calgon conditioning** (2M) Sodium hexa meta phosphate, $Na_2[Na_4(PO_3)_6]$, interacts with calcium ion forming highly soluble complex $Na_2[Na_4(PO_3)_6] + 2CaSO_4 \rightarrow Na_2[Ca_2(PO_3)_6] + 2Na_2SO_4$ **Colloidal conditioning** (1M) Used in low pressure boilers, colloidal conditioning agents, convert scale forming substance into sludge. Colloidal conditioning agents used are agar-agar gelly, Kerosene etc. **Sodium aluminate conditioning** (2M) $NaAlO_2$ undergoes hydrolysis, forms gelatinous white precipitate $Al(OH)_3$ & NaOH, NaOH precipitates Mg as MgOH, entraps finely divided solids, settles easily, removed by blow down operation. $NaAlO_2 + 2\ H_2O \rightarrow Al_2O_3 + NaOH$
6	**What is desalination? How is it carried out using Reverse Osmosis? (8M) (Jan 2010, Jan 2011,June 2011, Jan 2013, Dec2014, May2015,June 2016)** BTL2 **Answer: Page No. 1.41- Dr. A. RAVIKRISHNAN** **Desalination Definition** (1M) Removal of salt from sea water **Reverse osmosis** (1M) Solvent flow from higher concentration to lower concentration **Process** (3M) Two solutions- different concentration-separated- semi permeable membrane-hydrostatic pressure-higher concentration side-solvent flow from high concentration to low concentration-superfiltration, membranes-cellulose acetate, cellulose butyrate. **Diagram** (2M)



Advantages- (1M)
High membrane life time, low capital cost, simple

UNIT II – SURFACE CHEMISTRY AND CATALYSIS

Adsorption: Types of adsorption – adsorption of gases on solids – adsorption of solute from solutions– adsorption isotherms – Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – contact theory – kinetics of surface reactions, unimolecular reactions, Langmuir - applications of adsorption on pollution abatement.

Catalysis: Catalyst – types of catalysis – criteria – autocatalysis – catalytic poisoning and catalytic promoters - acid base catalysis – applications (catalytic convertor) – enzyme catalysis– Michaelis – Menten equation.

Part-A (2Marks)

Q.No.	Questions
1	**List out any four characteristics of enzyme catalysis. (Jan 2018)** BTL1 • Highly specific in nature • Requires optimum temperature and pressure • Activity is enhanced by activators • Activity is reduced by Poisons
2	**What is known as auto-catalysis? Give example. (Jan2018)** BTL2 The type of reaction in which one of the products itself acts as a catalyst is known as auto-catalysis. Eg. The oxidation of oxalic acid by acidified $KMnO_4$ becomes much more rapid due to the presence of manganese (II) ions which are formed in the reaction.
3	**Define adsorption. (Dec 2006)** BTL1 The phenomenon of higher concentration of any molecular species at the surface than in the bulk of a solid is known as adsorption. E.g. (i) Silica and alumina gel adsorbs moisture. (ii) Carbon cartridges in water filters adsorb contaminants.
4	**Define adsorbent and adsorbate. (June 2006)** BTL2 The solid that takes up a gas or vapour or a solute from a solution is called the adsorbent. E.g. Silica gel, Charcoal. The gas or vapours are the solute which is held to the surface of the solid is called the adsorbate. E.g. All gases, solid contaminants in water.
5	**What is chemisorption?** BTL2 If the adsorbed molecules are held on the surface of the adsorbent by chemical bonds (covalent or

	ionic bond) is called chemisorption. E.g. Adsorption of H_2 on Raney Nickel.
6	**What is physisorption? (Jan 2011)** BTL2 The type adsorption caused by weak van der waal's forces between adsorbate and adsorbent is referred as physical or van der waal's adsorption. E.g. Adsorption of H_2 or O_2 on charcoal.
7	**Mention the characteristics of adsorption. (Jan 2012)** BTL2 (i) It is a spontaneous process. (ii) It is accompanied by the evolution of heat. (iii) It is a selective process. (iv) Rate of adsorption depends on temperature.
8	**What is meant by adsorption isotherm?(Jan 2011)** BTL2 Adsorption isotherm is a relationship between magnitude of adsorption with pressure at constant temperature.
9	**What is negative adsorption?** BTL2 When the surface concentration of the adsorbate is less than the bulk, the process is designated as negative adsorption. E.g. dilute KCl on charcoal.
10	**Mention the factors which influence the adsorption of gases on solids.** BTL1 Pressure, temperature, nature of the gases, thickness of the adsorbed layer, nature and surface area of the adsorbent influence adsorption of gases on solids.
11	**Discuss the effect of temperature on adsorption.** BTL2 *Physisorption*: It occurs at rapidly lower temperature. It decreases with increase in temperature *Chemisorption*: It increases with increase in temperature and then decreases.
12	**Give the conditions at which Freundlich adsorption isotherm fails.** BTL3 (i) When $n = 0\ (or) 1$ $\frac{x}{m} = constant (or) \propto p$ respectively. However, it fails at high pressure. (ii) It fails when the concentration of adsorbate is very high
13	**Mention the limitations of Freundlich's isotherm.** BTL2

	(i) It is purely empirical and has no theoretical basis. (ii) The equation is valid only up to a certain pressure and is invalid at higher pressure (iii) The constants K and n are temperature dependants. (iv) The isotherm fails at higher concentration of adsorbate.
14	**What is homogeneous catalysis?** BTL2 In homogeneous catalysis, the catalyst is in the same phase as the reactants. E.g. Oxidation of SO_2 to SO with NO as catalyst $2SO_2 + 2H_2O + O_2 \xrightarrow{NO} 2H_2SO_4$
15	**What is heterogeneous catalysis?** BTL2 The reaction in which the catalyst is in a different physical phase from the reactants is termed as heterogeneous catalysis E.g. Synthesis of ammonia by Haber‘s process $N_2 (g) + 3H_2 (g) \xrightarrow{Fe(s)} NH_3(g)$
16	**How is activated carbon used in gas masks?** BTL3 Activated carbon adsorbs poisonous or foul-smelling gases more readily than air. Thus, air required for breathing gets filtered on passing thorough the activated carbon in the mask.
17	**What is a promoter? Explain its action.** BTL2 The substances which increase the catalytic activity are called promoters. Promoter increases the space between the catalyst particles thereby the adsorbed molecules are weakened and cleaved which increases the rate of reaction. In Haber‘s process, the activity of iron catalyst is increased by adding Mo.
18	**Define catalytic poison.** BTL2 Catalytic poison is defined as, a substance which occupies the active centers and destroys the catalytic activity. E.g. In contact process, the activity of platinum catalyst is decreased by adding arsenious oxide.
19	**Write the Langmuir adsorption isotherm.** BTL1 $\theta = \frac{KP}{1+KP}$ $where, \theta = fraction\ of\ the\ total\ surface\ covered\ by\ the\ adsorbed\ molecules$ $K = constant,$ P = pressure

20	**Give the expression of Freundlich isotherm.** BTL1 It is mathematical expression which relates the magnitude of adsorption with pressure at constant temperature. $\frac{x}{m} = KP^{1/n}$ where x = mass of adsorbate, m = mass of adsorbant, P = Pressure, K, n are constant.
21	**How is ion exchange adsorption used in water softening?** BTL3 Hard water contains Ca^{2+} and Mg^{2+} ions. It softened by passing through a column packed with sodium cation exchange resin ($R-Na^+$). The cations in hard water are replaced by Na^+ ions.
22	**Explain the function of activated charcoal with suitable examples.** BTL2 (i) It adsorbs colouring matter present in sugar solutions. (ii) It adsorbs the poisonous gases passing through gas masks. (iii) It adsorbs ammonia from the solution of ammonium hydroxide
23	**What is the role of adsorbent in catalysis? (Jan 2009)** BTL2 (i) Reactant molecules gets adsorbed on the adsorbent surface. (ii) Chemical reaction occurs through the formation of an activated complex. (iii) De-sorption of products from the adsorbent.
24	**Give the effect of increase in pressure on the adsorption of a gas on a solid. (Jan 2009)** BTL2 According to Le-Chatelier's principle, a dynamic equilibrium exists between the adsorbed gases and solid surfaces. Hence, an increase of pressure increases the adsorption of gases on solid surfaces whereas decrease of pressure causes desorption of gas molecules from the solid surfaces.
25	**Mention any four applications of adsorption. (Jan 2010)** BTL3 (a) In analytical techniques, adsorption is employed in chromatography to separate various components of a mixture (b) In biological systems the adsorption of atoms and molecules onto the surface of a cell membrane is the first step in molecular recognition. (c) In air pollution control, activated carbon is used as an adsorbent for the removal of gaseous pollutants (d) Charcoal is used in gas masks, because of its high porosity; it adsorbs large volumes of gases including most toxic ones and allows only pure air to pass through it.

26	**List out the postulates of Langmuir's adsorption isotherm.** BTL1 (i) The gases are adsorbed only on vacant sites of the adsorbent surface. (ii) Formation of uniform monolayer on the surface of adsorbent. (iii) The adsorbed molecules on the surface do not interact with each other. (iv)The adsorbed gas molecules do not move around on the surface
27	**What is a unimolecular surface reaction?** BTL2 A unimolecular reaction is a reaction between reactant molecule A and a vacant site on the surface S resulting in product formation. It involves adsorption, desorption, and decomposition steps. The mechanism may be represented as, $A + S \rightleftharpoons AS$ (adsorption, desorption) $AS \longrightarrow A + S$ (decomposition)
28	**What is catalyst?** BTL2 A catalyst is a substance which increases the rate of the reaction without undergoing any change and can be recovered as such at the completion of the reaction.
29	**Define acid-base catalysis.** BTL2 The reactions which are catalyzed by acids or bases or both is known as acid-base catalysis. Eg. Esterification reaction is catalyzed by acids and bases.
30	**Define enzyme catalysis.** BTL1 Rate of certain biological processes are increased by enzymes. The study of reactions in which enzymes act as catalyst is called enzyme catalysis. Eg. Maltose is converted into Glucose in the presence of enzyme *maltase*.
31	**Define turn over number.** BTL1 Turn over is defined as the number of molecules converted into products in unit time by one molecule of enzyme.
	PART-B (8 Marks)
1	**Distinguish between Physisorption and Chemisorption. (8M) (Jan2009, Jan 2010)** BTL5 **Answer: Page 2.4 -Dr. A. RAVIKRISHNAN**

S.No.	PHYSISORPTION	CHEMISORPTION
1	Formed by weak Vanderwaals force of attraction	Formed by Strong Chemical bond
2	Low heat of adsorption	High heat of adsorption
3	Reversible	Irreversible
4	Decreases with increase in temperature	Increases with temperature
5	Increases with increase of Pressure	Decreases with increase of Pressure
6	Multilayer is formed	Monolayer is formed
7	Equilibrium is established rapidly	Takes more time for the attainment of equilibrium
8	Requires small activation energy	Requires appreciable activation energy
9	No surface compound is formed	Surface compound is formed
10	Not specific in nature	Highly specific in nature
11	Ex: Adsorption of H_2 on Charcoal	Ex: Adsorption of H_2 on Nickel

2

Explain the factors affecting the adsorption of gases on solids. (8M) (Jan 2010) BTL2
Answer: Page 2.6-Dr. A. RAVIKRISHNAN

Explain the following factors (8M)

1. **Nature of gases**- easily liquefiable gases are adsorbed more readily
2. **Nature and surface area of adsorbent**- Powdered form and rough surface increases rate of adsorption
3. **Heat of adsorption-** Low for Physisorption and high for Chemisorption
4. **Reversibility-** Physisorption-reversible and Chemisorption-irreversible
5. **Effect of pressure on gas-** Physisorption increases with Pressure and Chemisorption decreases with Pressure
6. **Effect of temperature on gas-** Physisorption decreases with temperature and Chemisorption increases with temperature
7. **Thickness of adsorbed layer-** Multilayer for Physisoprtion and monolayer for Chemisorption
8. **Activation of adsorbent-** Adsorbent is activated by powdering, creating rough surface or by treating with certain chemicals.

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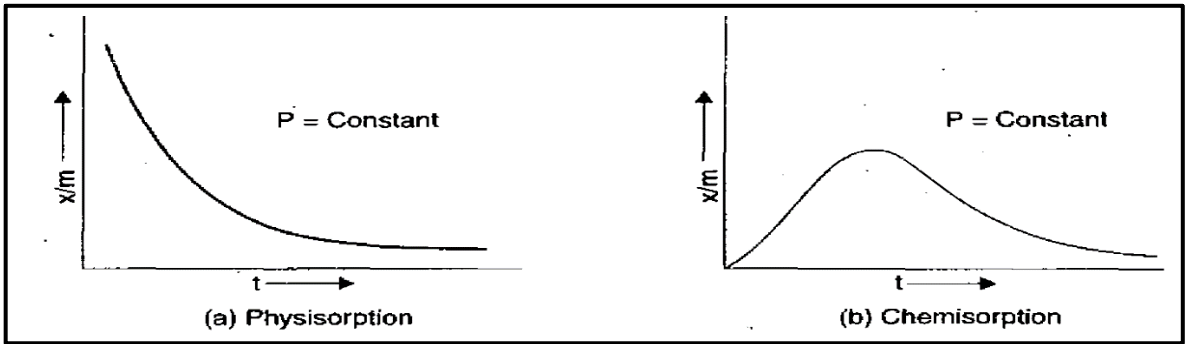
<tr><td></td><td>

(a) Physisorption (b) Chemisorption</td></tr>
<tr><td>3</td><td>Describe the adsorption of solutes from solution. (8M) BTL2
Answer: Page 2.9-Dr. A. RAVIKRISHNAN

Explanation with example (2M)
Adsorbents adsorb dissolved substances -Ex: activated charcoal
Adsorbent preferentially adsorbs one substance from solution- Ex: Charcoal adsorbs non-electrolytes in preference to electrolyte.

Factors influencing adsorption (4M)
Effect of temperature and concentration- $\boxed{\text{Log } x/m=\log K+1/n \log C}$
Where, x/m is magnitude of adsorption, K and n are constants and C is concentration
Effect of surface area- adsorption increases with increase in surface area.
Nature of solute adsorbed- adsorption is high when the molecular weight of the solute is high.

Positive and negative adsorption (2M)
Positive adsorption: solute is adsorbed by adsorbent, Adsorption increases with decrease of temperature and increase in concentration of solution.
Negative adsorption: solvent is taken up by adsorbent, Adsorption decreases with rise of temperature and decrease in concentration of solution.</td></tr>
<tr><td>4</td><td>Explain Freundlich adsorption isotherm. (8M)BTL2
Answer: Page No :2.15-Dr. A. RAVIKRISHNAN

Adsorption isotherm – Definition (2M)
Relationship between magnitude of adsorption with pressure at constant temperature

Derive the expression (4 M)
$(x / m) = k \cdot P^{1/n}$ (at constant T)

taking log on both sides,

$\boxed{\text{Log } x/m=\log K+1/n \log P}$</td></tr>
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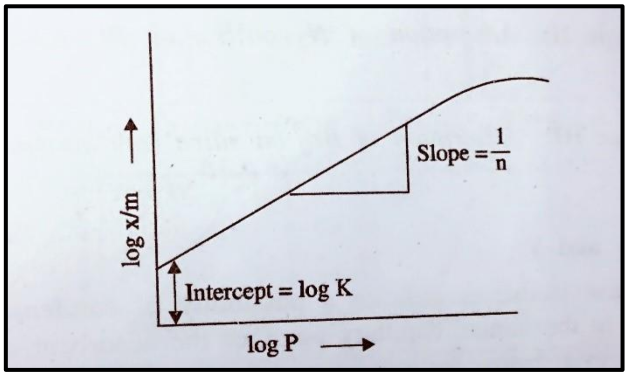


Case 1- At low pressure, adsorption is proportional to pressure.

$(x/m) \propto P$

$(x/m) = k \, . \, P^1$

Case 2 - At high pressure, adsorption is almost constant.

$(x/m) = k$

$(x/m) = k \, . \, P^0$

Case 3 - At intermediate pressure

$(x/m) = k \, . \, P^{0-1}$

$(x/m) = k \, . \, P^{1/n}$, where n is an integer

This is known as Freundlich adsorption isotherm.

Disadvantages (2M)
Purely empirical, invalid at higher pressure, constants K & n vary with temperature, invalid at higher concentration of adsorbate.

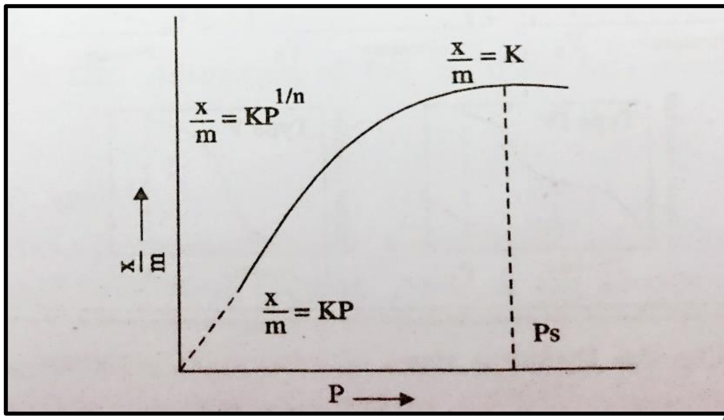
5 **Derive Langmuir adsorption isotherm. (8M) (Jan 2018, Jan 2010)** BTL3
Answer: Page 2.17-Dr. A. RAVIKRISHNAN

Five postulates (2M)
Derivation
Rate of adsorption, $R_a = K_a (1-\theta) P$

Rate of desorption, $R_d = k_d \, . \, \theta$

Rate of adsorption= Rate of desorption (1M)
$k_d \, . \, \theta = K_a (1-\theta) P$

$\boxed{x = K' \, KP/1+KP}$ Langmuir adsorption isotherm (2M)

	This can be also written as $\frac{1}{K'K} + \frac{K}{K'K}P = \frac{P}{x}$ (1M)  **Conditions** (1M) Case-1 At low pressure, adsorption increases with pressure $\boxed{x/m \propto P}$ Case-2 At high pressure, adsorption is almost constant. $\boxed{x/m = K_2}$ Case-3 At normal pressure, $x/m = k\,P^{0-1}$ $\boxed{x/m = k\,P^{1/n}}$ where n= 0 to 1 This proves that at normal pressure, Langmuir adsorption resembles Freundlich isotherm. **Limitations** (1M) Fails at high pressure, possibility of multilayer adsorption
6	**Explain the Kinetics of Surface catalyzed reactions. (8M)**BTL2 **Answer: Refer Page: 2.27-Dr. A. RAVIKRISHNAN** **Unimolecular reactions** (2M) $\text{Rate} = \frac{k_2 K P_A}{(1+KP_A)}$

At low pressure($P \to 0$)
Rate=$k2KP_A$

At high pressure($P \to 1$)
Rate= $\frac{k_2 K P_A}{K P_A}$
$= k_2$

Langmuir- Hinshelwood Mechanism (Bimolecular reactions)
Derivation (4M)
Rate (r)= $\frac{K_3 K_1 P_A K_2 P_B}{(1+K_1 P_A + K_2 P_B)^2}$
Conditions (2M)
Condition 1: Both- low adsorption
Rate= $k_3 K_1 K_2 P_A P_B$

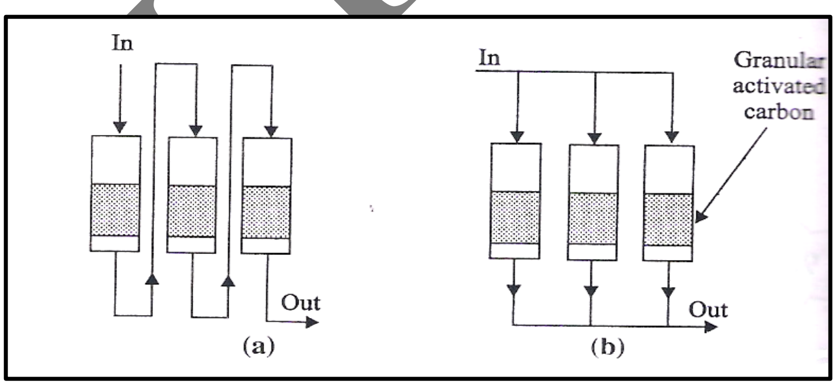
Condition 2: One - very low adsorption
Rate= $\frac{k_3 K_1 K_2 P_A P_B}{(1+K_1 P_A)^2}$
Order is one with respect to B

Condition 3: One- very high adsorption
Rate= $\frac{k_3 K_2 P_B}{K_1 P_A}$

7

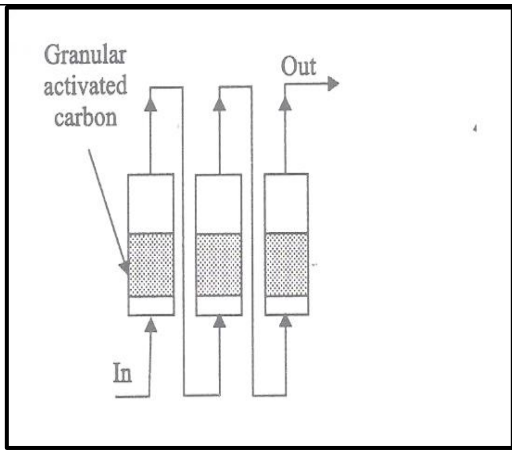
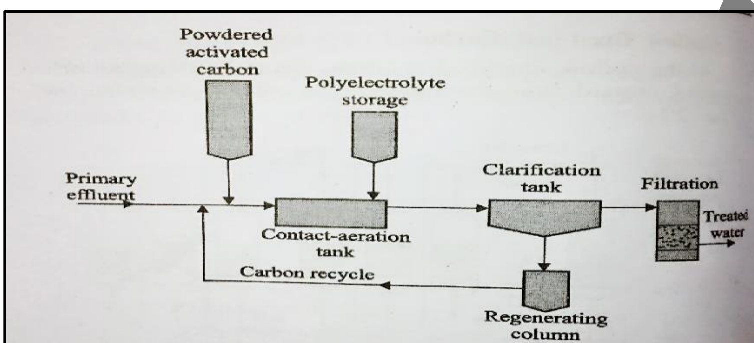
How is adsorption useful in pollution abatement? (8M) (Jan 2010, Jan 2009) BTL3
Answer: Page No.2.33-Dr. A. RAVIKRISHNAN

Using Granular activated carbon- Down flow fixed bed carbon contactors (4M)
The polluted water or air is applied to the yop of the column and withdrawn at the bottom.

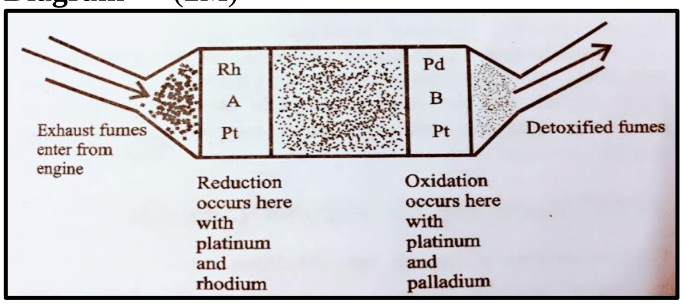


(a) & (b) Down flow fixed bed contactors in series and parallel

Upflow fixed bed contactors
The polluted water or air moves upwards from the base.

	 **Using Powdered Activated Carbon** (4M) Primary effluent + PAC + polyelectrolyte → Contact aeration tank→ Clarification tank→ Filtration→ treated water 
8	**What are the criteria of Catalysis ?** **Or** **List out the characteristics of Catalysis. (8M)** BTL2 **Answer: Page No:3.5-Dr. A. RAVIKRISHNAN** **Catalysis-Definition** (1M) Process of altering rate of chemical reaction with the help of catalyst **Eight characteristics** (7M) Catalyst remains unchanged Only small amount of catalyst is required Catalyst does not alter position of equilibrium Catalyst is specific Catalyst cannot initiate reaction Finely divided catalyst- more effective Optimum temperature Catalytic poison- decreases the activity of catalyst Catalytic promoter- increases the activity of catalyst
9	**Write a note on catalytic converter. (8M)** BTL1 **Answer: Page 3.18-Dr. A. RAVIKRISHNAN**

Definition (1M)
Device used to reduce emissions coming out from an IC engine
Construction and working (4M)
Metal housing with ceramic honey comb interior- insulating layers. Honey comb interior has thin walls coated with porous wash coat of aluminium oxide along with Pt, Rh, Pd.
Exhaust fumes→ compartment A- impurities reduced →compartment B- impurities oxidised→ outgoing fumes- no toxic byproducts
Diagram (2M)



Functions (1M)
Reduces nitrogen oxides to nitogen & oxygen, oxidises CO to CO_2, oxidises hydrocarbons to CO_2 & H_2O

10

Derive Michaelis-Menten Equation. (8M) (Jan 2018) BTL3
Or
Elucidate the kinetics of Enzyme catalyzed reaction.
Answer: Page 3.24-Dr. A. RAVIKRISHNAN
Derivation
$E + S \rightarrow X$ (k_1)
$X \rightarrow E + S$ (k_2)
$X \rightarrow P$ (k_3) (1M)
Where, E=Enzyme, S= Substrate, X= Intermediate, P=Product

Rate of formation of complex (1M)
$d[X]/dt= k_1[E][S]- (K_2+K_3)[X]$

Stationary state (2M)
$d[X]/dt=0$
so, $[X]=k_1[E_0][S]/ k_1[S]+k_2+k_3$

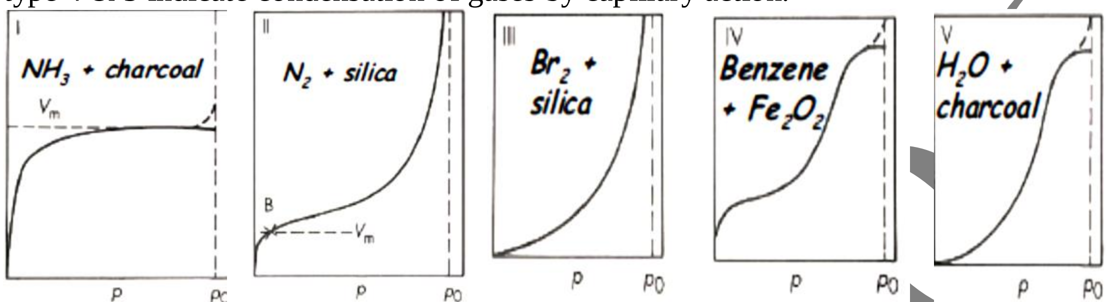
Michaelis Menten Equation
$\boxed{d[P]/dt = k_3 [E_0]/ 1+ K_m/[S]}$ (2M)

Two important cases (1M)
Low concentration: First order with respect to substrate and enzyme
High concentration: Zero order with respect to substrate
Significance (1M)
Michaelis constant: r =1/2 υ_{max}

11 **Define adsorption isotherm. Explain the various types of adsorption isotherm.(8M)(Jan 2018,**

Jan 2010) BTL1
Answer: Page 2.13-Dr. A. RAVIKRISHNAN

Definition (1M)
Relationship between magnitude of adsorption with pressure at constant temperature.
Five types (7M)
Type 1- follows monomolecular adsorption, type 2 & 3 follows the formation of additional layers, type 4 & 5 indicate condensation of gases by capillary action.



12

Explain contact theory of catalysis. (8M) (Jan 2010, May 2005) BTL2
(or)
Explain the role of adsorbents in catalysis.
Answer: Page 2.22-Dr. A. RAVIKRISHNAN

Step-1 Adsorption of reactant molecule-adsorption of gaseous reactant by Physisorption/ Chemisorption
Step-2 Formation of activated complex- unstable- intermediate complex
Step-3 Decomposition of activated complex- activated complex breaks- forms products- products bound to catalysts by partial chemical bond
Step-4 Desorption of products- Products desorb from surface- stable

Effect of Finely divided state of Catalyst- more number of free valency or active site increases thereby enhancing the activity of catalyst

Effect of rough surfaced catalyst- Rough surface increases active sites due to the presence of cracks, peaks, corners

Action of Promoters- Promoters are substances which increase the activity of a catalyst. This is due to (i) increase in lattice spacing, and (ii) increase of peaks and cracks

Action of catalytic poisons- Catalytic poisons are substance which destroys the activity of a catalyst. This is due to blocking the active sites by preferential adsorption of poisons on the catalyst surface.

13

Explain the mechanism and kinetics of acid- base catalysis. (8M)BTL2
Answer: Page 3.14-Dr. A. RAVIKRISHNAN

Mechanism (2M)
Addition and removal of protons is the important part in mechanism of acid-base catalysis.

Acid Catalysis

Step-I Addition of proton to substrate forming intermediate complex

Step- II Removal of proton from intermediate complex using water or base

Example: Keto enol tautomerism of acetone

Base Catalysis

Step- I Removal of proton from reactant forming intermediate complex

Step-II Addition of proton to the intermediate complex

Kinetics of acid-base catalysis (6M)

First mechanism

Assume,

$S + AH^+ \leftrightarrow SH^+ + A$ Step-I

$SH^+ + H_2O \rightarrow P + H_3O^+$ Step-II

where, S=Substrate, AH^+= acid

Applying steady state and solving for $[SH^+]$, the rate of formation of product is given by

$d[P]/dt = k_2[SH^+]$

$$r = d[P]/dt = \frac{k_2 k_1 [S][AH^+]}{k_{-1}[A] + k_2}$$

Two important cases

(i) When $k_2 >> k\text{-}1[A]$

$r = k_1[S][AH^+]$

(ii) When $k_{-1}[A] >> k_2$

$$r = \frac{k_1 k_2 [S][H^+]}{k_{-1} k}$$

This reaction in specifically hydrogen -ion catalyzed.

Second mechanism

Assume,

$S + AH^+ \leftrightarrow SH^+ + A$ Step-I

$SH^+ + A \rightarrow P + AH^+$ Step-II

Where, A= Base, P= Product, S= Substrate and AH^+=Acid

Applying steady state and solving for $[SH^+]$,

$$[SH^+] = \frac{k_1 [S][AH^+]}{(k_{-1} + k_2)[A]}$$

$$\text{So, } r = d[P]/dt = \frac{k_1 k_2 [S][AH^+]}{k_{-1} + k_2}$$

The reaction is generally acid catalyzed.

UNIT – III ALLOYS AND PHASE RULE

Alloys: Introduction- Definition- properties of alloys- significance of alloying, functions and effect of alloying elements- Nichrome and stainless steel (18/8) – heat treatment of steel. Phase rule: Introduction, definition of terms with examples, one component system -water system - reduced phase rule - thermal analysis and cooling curves - two component systems - lead-silver system - Pattinson process.

	Part*A
Q.No.	**Questions**
1	**Define the term annealing.** BTL2 Annealing means softening. This is done by heating the metal to high temperature followed by slow cooling in a furnace. Annealing can be done in two ways 1. Low temperature annealing (or) process annealing-below the lower critical temperature. 2. High temperature annealing (or) full annealing-above the higher critical temperature.
2	**Define heat treatment of steel.** BTL1 The process of heating and cooling of solid steel article under carefully controlled conditions. During heat treatment certain physical properties are altered without altering its chemical composition.
3	**Mention the composition and applications of nichrome. (June 2014)** BTL1 Nichrome is a type of steel, which contains 60% nickel, 12% chromium, 26% Iron and 2% Manganese. **Applications:** It finds applications in boiler parts, gas turbines, steam lines, annealing boxes and other equipment's exposed to high temperatures.
4	**What are alloys? (Jan 2014)** BTL2 An alloy is defined as homogeneous solid solution of two or more different elements, one of which at least is essentially a metal.
5	**List the objectives of heat treatment of alloys.** BTL2 Heat treatment causes, 1. Improvement in magnetic and electrical properties. 2. Refinement of grain structure. 3. Removal of the imprisoned trapped gases. 4. Removal of internal stresses. 5. Improves fatigue and corrosion resistance.
6	**Define stainless steel.** BTL2 Stainless steel is an alloy of iron and chromium along with other elements such as molybdenum, nickel etc. It is very effective against corrosion if it contains more than 16% chromium.
7	**What is the role of chromium in stainless steel?** BTL2 The presence of Chromium in stainless steel produces an exceptionally tough and coherent dense film of chromium oxide at the surface of alloy which gives complete protection against atmospheric corrosion.
8	**What is triple point? (June 2014)** BTL2 It is the temperature at which three phases (solid, liquid, vapour) are in equilibrium in a given one component system. Solid ↔ Liquid ↔ Vapour

9	**State phase rule.** BTL1 If the equilibrium between any number of phases is not influenced by gravity, or electrical, or magnetic forces but are influenced only by pressure, temperature and concentration, then the number of degrees of freedom (F) of the system is related to number of components (C) and the number of phases (P) by the following phase rule relation F = C – P + 2.
10	**What are degrees of freedom (F)? (Jan 2018**) BTL1 Degrees of freedom (F) is defined as, "the minimum number of independent variable factors such as temperature, pressure and concentration, which must be fixed in order to define the system completely".
11	**Define Phase.** BTL2 Phase is defined as, "any homogeneous physically distinct and mechanically separable portion of a system which is separated from other parts of the system by definite boundaries".
12	**Mention the merits of phase rule**. BTL3 1. It is applicable to both physical and chemical equilibrium. 2. It is a convenient method of classifying the equilibrium states in terms of phases, components, and degree of freedom. 3. It helps in deciding whether the given numbers of substances remain in equilibrium or not.
13	**List the limitations of phase rule.** BTL3 1. Phase rule can be applied only for the systems in equilibria. 2.Only three variables like P, T & C are considered, but not electrical, magnetic and gravitational forces. 3. All the phases of the system must be present under the same conditions of T and P. 4. Solid and liquid phases must not be in finely divided state, otherwise deviations willoccur.
14	**What is Eutectic mixture?** BTL2 Eutectic mixture is a unique mixture of two solids which has the lowest melting point. Since it is completely immiscible in the solid state, it is a mixture not a compound.
15	**What is a Eutectic point in a binary alloy system?** BTL2 It is the point at which two solids and one liquid phase are in equilibrium in a binary alloy system. Solid (A) ↔ Solid (B) ↔ Liquid melt (A +B)
16	**State the conditions under which two substances can form a simple eutectic**. BTL3 1. They must be completely miscible in the liquid state but completely immiscible in the solid state. 2. They should not chemically react with each other.
17	**How many phases and components are present in the following system?** BTL3 $\mathbf{CaCO_{3(s)} \leftrightarrow CaO_{(s)} + CO_{2(g)}}$ It consists of two solid phases and one gaseous phase. P = 3; C = 2, F = C – P + 2 = 2 – 3 + 2 = 1.
18	**Define Component. (Jan 2018)** BTL2 Component is defined as, "the smallest number of independent variable constituents, by means of which the composition of each phase can be expressed in the form of a chemical equation".
19	**State condensed phase rule. (Jan 2014)** BTL1 A solid – liquid equilibrium of an alloy has practically no gaseous phase and the effect of pressure is negligible. Therefore, experiments are conducted under atmospheric pressure. Thus the system in which only the solid and liquid phases are considered and the gas phase is ignored. It is called a condensed system. Since the pressure is kept constant, the phase rule becomes F' = C – P + 1. This equation is called reduced phase rule or condensed phase rule.

20	**Write the uses of phase diagram. (Jan 2018)** BTL3 1. It is possible to predict from the phase diagrams whether a eutectic alloy or a solid solution is formed on cooling a homogeneous liquid containing mixture of two metals. 2. The phase diagram is useful in understanding the properties of materials in the heterogeneous equilibrium system.
21	**Write the number of phases and components in the following heterogeneous system.** BTL3. $\mathbf{CuSO_{4(s)} + 5H_2O_{(l)} \leftrightarrow CuSO_4.5H_2O_{(s)}}$ Number of phases = 3 Number of components = 2.
22	**Calculate the number of components and degree of freedom for the following equilibrium.** $\mathbf{NH_4Cl_{(s)} \leftrightarrow NH_{3(g)} + HCl_{(g)}}$ BTL3 This system consists of two phases and one component. P = 2; C = 1; F = C – P + 2 = 1 – 2 + 2 = 1.
23	**Write the significance of Eutectic mixture.** BTL2 1. Suitable alloy composition can be predicted with the help of Eutectic systems. 2. Eutectic systems are used in preparing solders, used for joining two metal pieces together.
24	**What is metastable equilibrium?** BTL2 Sometimes water can be cooled below 0°C without the formation of ice, this water is known as super-cooled water. The equilibrium between super-cool water and the vapour is known as metastable equilibrium. Super cool water ↔ vapour
25	**Calculate the number of phases present in the following systems**. BTL3 $MgCO_{3(s)} \leftrightarrow MgO_{(s)} + CO_{2(g)}$ Ans = 3 Rhombic sulphur(s) ↔ Monoclinc sulphur(s) Ans = 2 Ice(s) ↔ Water(l) ↔ water vaour(g) Ans = 3 Emulsion of oil in water Ans = 2
	Part*B
1	**State Gibb's phase rule. Explain the terms involved in it with suitable examples. (8M) (June 2014)** BTL1 **Answer: Page: 5.1 - 5.6 - Dr. A. RAVIKRISHNAN** **Phase rule-Definition:** (1M) If the equilibrium between any number of phases is not influenced by gravity, or electrical, or magnetic forces but are influenced only by pressure, temperature and concentration, then the number of degrees of freedom (F) of the system is related to number of components (C) and the number of phases (P) by the following phase rule relation F=C-P+2 (1M) **Phase-Definition:** (1M) Any homogeneous physically distinct and mechanically separable portion of a system which is separated from other parts of the system by definite boundaries. **Examples**: (1M) (a) $MgCO_3(s) \leftrightarrow MgO(s) + CO_2(g)$ Ans: 3 (b) Rhombic sulphur(s) ↔ Monoclinc sulphur(s) Ans: 2

Degree of freedom-Definition: (1M)
The minimum number of independent variable factors such as temperature, pressure and concentration, which must be fixed in order to define the system completely.

Examples: (1M)

(a) $NH_4Cl_{(s)} \leftrightarrow NH_{3(g)} + HCl_{(g)}$

Two phases and One component.
P = 2; C = 1;
F = C – P + 2 = 1 – 2 + 2 = 1

(b) Ice(s) ↔ Water(l) ↔ water vapour(g)

Three phases and one component.
P = 2; C = 1;
F = C – P + 2 = 1 – 3 + 2 = 0

Component-Definition: (1M)
The smallest number of independent variable constituents, by means of which the composition of each phase can be expressed in the form of a chemical equation.

Examples: (1M)

(a) $CuSO_{4(s)} + 5H_2O_{(l)} \leftrightarrow CuSO_4.5H_2O_{(s)}$ Ans: 2 Components
(b) $CaCO_{3(s)} \leftrightarrow CaO_{(s)} + CO2_{(g)}$ Ans: 3 components

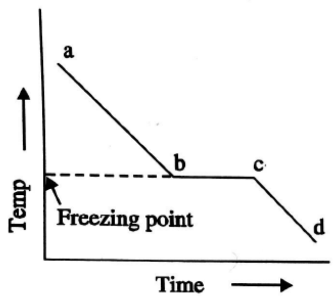
2 **What is thermal analysis? Explain how it is used for constructing a simple eutectic system. (16M) (Jan 2018)** BTL2

Answer: Page: 5.10 - 5.12 - Dr. A. RAVIKRISHNAN

Thermal analysis – Definition: (2M)
Study of cooling curves-various compositions of a system-during solidification.

Cooling curve for a pure solid-definition (2M)
Pure substance in fused state- cool slowly- temperature noted- different time interval.
Rate of cooling-continuous-point ‘b’ solid begins-temperature remains constant-liquid melt completely solidified- Solidification completes at ‘c’- horizontal line ‘bc’ - equilibrium, between solid and liquid melt.

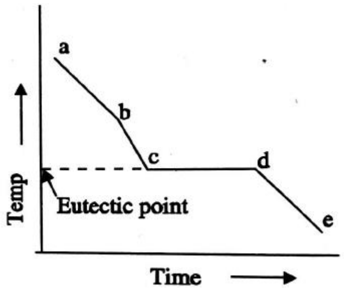
Cooling curve for pure solid-Diagram: (1M)



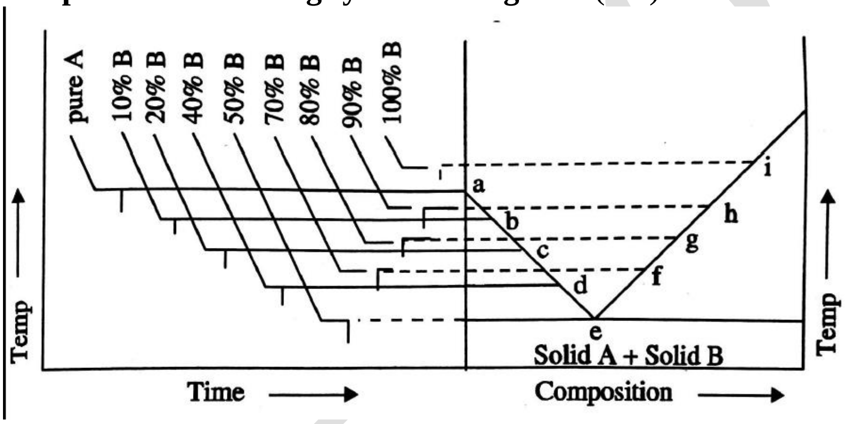
Cooling curve for a mixture (A+B) :

Explanation: (3M)
Two substances in fused state-allowed to cool slowly- rate of cooling- continuous, point ‘b’ solid begins (either A or B)- temperature remains constant-liquid melt completely solidified-Solidification completes at ‘c’,horizontal line bc - equilibrium, between solid and liquid melt.

Diagram: (1M)

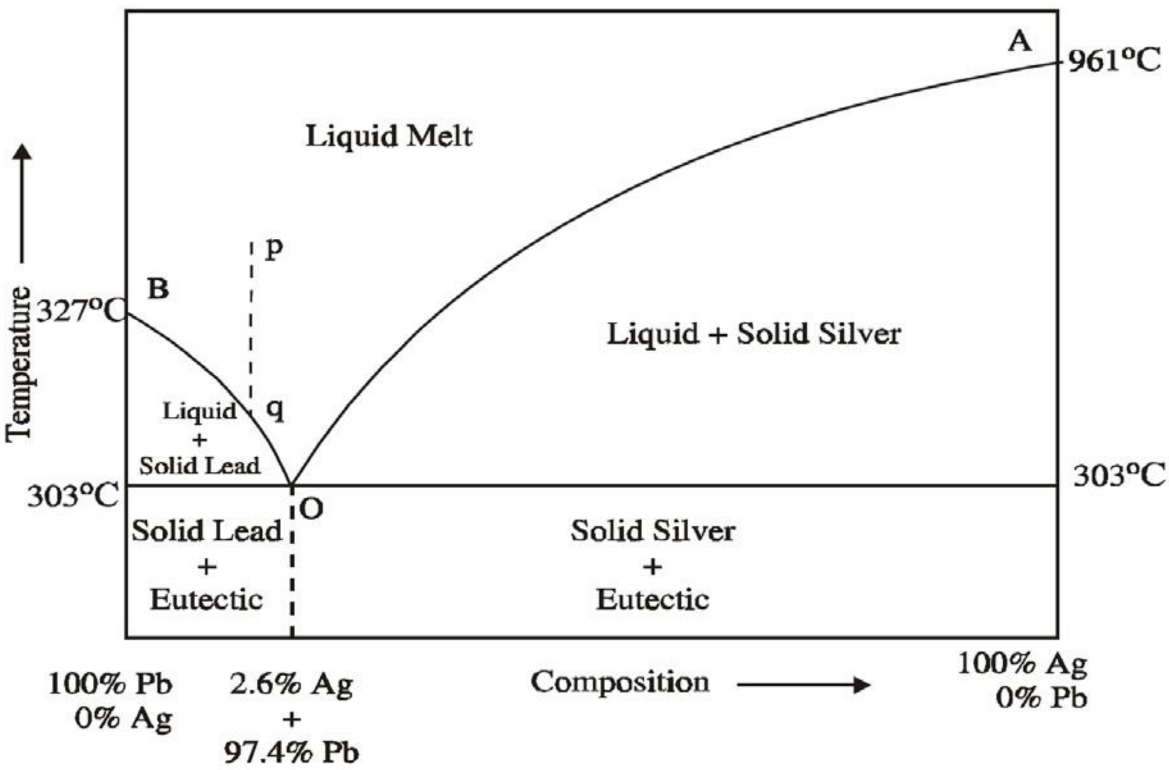


Construction of simple eutectic cooling system – Explanation: (4M)
Rate of cooling, continuous-point at ‘b’ solid begins, temperature remains constant- liquid melt- completely solidified. Solidification completes at ‘c’- horizontal line bc – equilibrium- between solid and liquid melt- Experiment is repeated, different compositions of A and B, various cooling curves, various compositions, diagram drawn, composition in X-axis, temperature in Y-axis.
Construction of simple eutectic cooling system – Diagram: (3M)

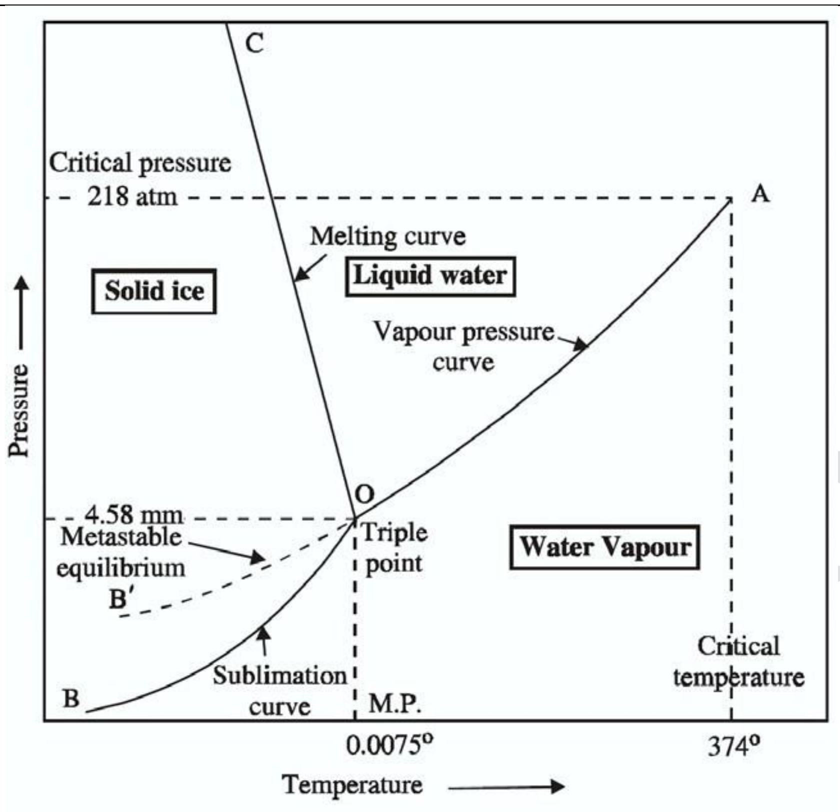


3 **Draw the phase diagram for Pb-Ag system and explain the application of this system to de-silverisation of lead. (16M) (June 2014) (Jan 2018)** BTL2
Answer: Page: 5.13 - 5.16 - Dr. A. RAVIKRISHNAN
Pb-Ag System explanation:
System is studied at constant pressure, the vapour phase is ignored.
The condensed phase rule is used. F’=C-P+1 (1M)
Curves OA-Freezing point curve of silver: (1M)
At Point ‘A’ – Melting point of pure silver (961^{O}C)
Solid Ag ↔ Melt
F’=C-P+1; F’=2-2+1=1
Univariant system.
Curves OB-Freezing point curve of lead: (1M)
At Point ‘B’ – Melting point of pure lead (327^{O}C)
Solid Pb ↔ Melt
F’=C-P+1; F’=2-2+1=1
Univariant system.
Point ‘O’ – Eutectic point: (2M)
Eutectic temperature (303^{O}C) and Eutectic mixture (97.4% Pb + 2.6%Ag)

Solid Pb ↔ Solid Ag ↔ Melt
F'=C-P+1; F'=2-3+1=0
Invariant system.
Area above AOB: (1M)
Molten Pb+Ag
F'=C-P+1; F'=2-1+1=2
Bivariant system.
Area below AO: (1M)
Solid Ag ↔ Melt
F'=C-P+1; F'=2-2+1=1
Univariant system.
Area below BO: (1M)
Solid Pb ↔ Melt
F'=C-P+1; F'=2-2+1=1
Univariant system.
Area below O: (1M)
Eutectic compound + solid Ag or Pb
F'=C-P+1; F'=2-2+1=1
Univariant system.
Pattionson's process: (3M)
The process of raising the relative proportion of Ag in the alloy is known as Pattinson's process. and the explanation. Silver proportion increases from 0.1% to 2.6% along the curve 'OB' to point 'O'.
Diagram: (4M)



4	**Draw and explain the phase diagram for water system and calculate the degrees of freedom along the curves, in areas and at triple point. (16M) (Jan 2014**) BTL2 **Answer: Page: 5.7 - 5.10 - Dr. A. RAVIKRISHNAN** **Water system explanation:** (2M) Solid ↔ Liquid Liquid ↔ Vapour Solid ↔ Vapour Water exists in three phases and it is a one component system so we can apply the phase rule F=C-P+2 (1M) **Curve: OA -Vaporization curve:** (1M) Critical temperature (374ºC) Water ↔ Water vapour F=C-2+2; F=1-2+2; F=1 Univariant system. Equilibrium extend upto line OA. **Curve: OB - Sublimation curve:** (1M) Critical temperature – (-273ºC) Ice ↔ vapour F=C-2+2; F=1-2+2; F=1 Univariant system. Equilibrium extend upto line OB. **Curve: OC – Melting point curve:** (1M) Ice ↔ Water F=C-2+2; F=1-2+2; F=1 Univariant system. OC curve slightly inclined towards pressure axis. **Point 'O' - Triple point:** (1M) Temperature - 0.0075ºC and Pressure - 4.58mm F=C-3+2; F=1-3+2; F=0 Invariant system. **Curve: OB' – Metastable equilibrium:** (1M) Super cool water ↔ vapour F=C-3+2; F=1-3+2; F=0 Invariant system. Super cooled water – unstable-converted into solid by seeding. (1M) **Areas AOC, BOC, AOB:** (2M) F=C-P+2; F=1-1+2; F=2 Bivariant system. **Diagram:** (5M)

	
5	**What is heat treatment of steel? Discuss the different methods of heat treatment of steel? (8M) (Jan 2014)** BTL2 **Answer: Page: 4.9 - 4.12 - Dr. A. RAVIKRISHNAN** **Heat treatment of alloys definition: (**1M) Process of heating and cooling- solid steel – under controlled conditions. **Annealing:** (2M) Annealing- softening- heating metal to high temperature, followed by slow cooling. **Types:** Low temperature annealing (or) process annealing-below the lower critical temperature. High temperature annealing (or) full annealing-above the higher critical temperature. **Purpose:** Increases machinability, removes imprisoned gases**.** **Hardening:** (1M) Heating- steel beyond the critical temperature -suddenly cooling it either in oil, brine water, some other fluid. **Purpose**: Making cutting tools, cut other metals. **Tempering:** (1M) Heating- already hardened steel - temperature lower than its own hardening temperature -cooling it slowly. **Purpose:** Removes stress, strain-reduces brittleness- increases toughness, ductility. **Normalizing:** (1M) Heating steel - temperature above its higher critical temperature - cool gradually in air. **Purpose:** Refines grains, recover homogeneity-remove internal stress. **Carburizing:** (1M)

	Mild steel article -small piece of charcoal- heated 900-950^{O} C - keep it as such for a sufficient time- carbon absorbed to a required depth- article - cool slowly within the iron box- outer skin of the article -converted into high carbon steel containing about 0.8 to 1.2% of carbon. **Purpose**: Produce hard-wearing surface. **Nitriding:** (1M) Heating metal alloy -presence of ammonia - temperature 550^{o} C-nitrogen obtained - dissociation of ammonia- to form hard nitride. **Purpose:** Get super hard surface.
6	**Explain in detail about the Nichrome. (8M)** BTL1 **Answer: Page: 4.5 - 4.6 - Dr. A. RAVIKRISHNAN** **Nichrome:** **Composition:** (2M) 60% nickel, 12% chromium, 26% iron, 2% manganese. **Properties:** (3M) Good resistance to heat and oxidation, possesses high melting point, electrical resistance, withstand heat upto 1000 to 1100^{O}C**.** **Uses:** (3M) Making resistance coils, heating elements in stoves, electrical irons, household electrical appliances, High temperature equipment.
7	**Evaluate the composition, properties and uses of heat treatable and non-heat treatable stainless steel. (8M)** BTL4 **Answer: Page: 4.6 - 4.8 - Dr. A. RAVIKRISHNAN** **Definition of Stainless steel:** (2M) Alloy-iron and chromium- with molybdenum, nickel etc- very effective against corrosion -contains more than 16% chromium. **Types:** **Heat treatable stainless steel.** (3M) **Composition:** 1.2% carbon, less than 12%-16% chromium. **Properties:** Magnetic-tough-worked in cold conditions. **Uses:** Used upto 800^{O}C-resistance towards weather and water-making surgical instruments-scissors, blades, etc. **Non-heat treatable stainless steel**: (3M) **Magnetic type:** **Composition:** 12-22% chromium, 0.35% carbon. **Properties:** Forged, rolled-corrosion resistance. **Uses:** Making chemical equipment, automobile parts. **Non-Magnetic type:** **Composition:** 18-26% chromium, 0.15% carbon, 8-21% nickel. 18/8 stainless steel:

	18% chromium, 8% nickel. **Properties:** By adding molybdenum corrosion resistance increases. **Uses:** Making household utensils, sinks, dental, surgical instruments.
8	**What are the main purpose of alloying steel? (8M)** BTL1 **Answer: Page: 4.1 - 4.3 - Dr. A. RAVIKRISHNAN** **Purpose with explanation:** (6M) 1.To increase the metal hardness. Example: Gold and silver alloyed with copper to make hard. 2.To lower the metal melting points. Example: Wood's metal (an alloy of lead, bismuth, tin and cadmium) melts at 60.5 ^{o}C- constituents metals have higher melting point. 3.To resist the metal corrosion. Example: Pure iron undergo corrosion in faster rate than it is alloyed with carbon and chromium. 4.To modify the metal colour. Example: Brass (white colour) an alloy copper (red) and zinc(silver-white). 5.For metal casting. Example: An alloy of lead (5% tin + 2% antimony) used for casting printing type. 6.To modify the metal chemical activities. Example: Sodium amalgam is less active than Sodium.

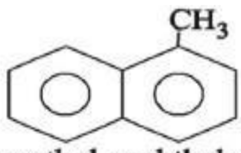
UNIT IV - FUELS AND COMBUSTION

Fuels: Introduction - classification of fuels - coal - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum - manufacture of synthetic petrol (Bergius process) - knocking - octane number - diesel oil - cetane number - natural gas - compressed natural gas (CNG) - liquefied petroleum gases (LPG) - power alcohol and biodiesel. Combustion of fuels: Introduction - calorific value - higher and lower calorific values- theoretical calculation of calorific value - ignition temperature - spontaneous ignition temperature - explosive range - flue gas analysis (ORSAT Method).

PART * A

Q.No.	Questions
1	**What is a calorie? Give the different units of calorific values. (Jan 2018)** BTL2 It is defined as, 'the amount of heat required to raise the temperature of 1gram of water through 1^oC (15 to $16^o C$). 1. Calorie. 2. Kilocalorie. 3. British Thermal Unit (B.T.U). 4. Centigrade Heat Unit (C.H.U).
2	**Define gross calorific value (GCV).** BTL2 Gross calorific value is the total amount of heat produced, when a unit quantity of fuel is completely burnt and the products of combustion are cooled to room temperature.
3	**Define Net calorific value (NCV).** BTL2 The net heat produced, when a unit quantity of the fuel is completely burnt and the products of combustion are allowed to escape. NCV = GCV – Latent heat of condensation of steam produced.
4	**List the various determinations of proximate analysis.** BTL1 It involves the determination of percentage of 1. Moisture content. 2. Volatile matter. 3. Ash content. 4. Fixed carbon in coal.
5	**How coals are classified? (Jan 2018)** BTL3 Wood→ Peat→ Lignite →Bituminous coal→ Anthracite.
6	**Justify coke is superior than coal. (JUNE-2013)** BTL5 1. Coke is stronger and more porous than coal. 2. By coking, much of undesirable sulphur is removed. 3. Coke does not contain much volatile matter than coal. 4. Coke burns with a small flame and without smoke.
7	**Define octane number of a petrol. How can it be improved?** BTL1 The octane number is defined as the percentage of iso-octane present in a mixture of iso-octane and n-heptane.
	Improving the octane number of a fuel: **1.The addition of anti- knock compounds like TEL** **2.Low octane petrol is blended with high octane compounds like alcohol. Ex: straight – run petrol is mixed with reformed petrol or benzol and alcohol.**

8	**What is meant by carbonization of coal? BTL2** **When coal is heated strongly in the absence of air, it is converted into a substance of lustrous, dense, porous, coherent mass called coke. The process of preparing coke from coal is known as carbonization of coal.**
9	**Differentiate Caking coals and coking coals. BTL4** **When coals are heated strongly, the mass becomes soft, plastic and fuses to give a coherent mass. Such type of coals are called Caking Coals. But if the mass so produced is hard, porous and stronger than the coals are called Coking Coals.**
10	**What is meant by hydrogenation of coal? BTL2** **If coal is heated with hydrogen under high pressure, it is converted into gasoline. This method of preparing liquid fuels from solid coal is called hydrogenation of coal.**
11	**What is knocking? (JUN-2013) BTL1** **Knocking is a kind of explosion occurs in IC engines due to sudden increase of pressure developed by spontaneous combustion of fuel and air mixture.**
12	**Give the anti-knocking property of Hydrocarbon based on their chemical structure. BTL2** **The knocking tendency of fuel hydrocarbons mainly depends on their chemical structures. The knocking tendency decreases in the following order.** **Straight chain paraffins>Branched chain Paraffins>Cycloparaffins>Olefins > Aromatics.** **Thus, olefins of the same carbon chain length possess better anti knock properties than the corresponding paraffins.**
13	**Why should leaded petrol not to be used? BTL3** **1. Lead deposits on the spark plug and on cylinder walls, which is harmful to engine life.** **2. This creates atmospheric pollution.**
14	**List out demerits of sulphur in coal. (June 2009) BTL5** **1. The harmful gases SO2 and SO3 will create air pollution.** **2. Sulphur containing coal is not suitable for the manufacture of metallurgical coke.**
15	**Write the action of TEL in internal combustion engines? BTL3** **Tetra ethyl lead is converted into finely divided lead oxide particle in the cylinder and these particles react with any hydrocarbon peroxide molecules formed, thereby slowing down the chain oxidation reaction and thus decreasing the chances of engine life.**
16	**List out the advantages of gaseous fuels over solid and liquid fuels. BTL2** **1. Gaseous fuels can flow through pipes and hence it can be easily transported to the place of need without any manual labour.** **2. It can be lighted at a moment's notice.** **3. It burn with high efficiency and a high temperature flame fastly.** **4. It does not produce any smoke and ash and it burns freely in the presence of air.**
17	**Define cetane number/ How are diesel oil rated? How are they improved? How can the cetane number of a fuel be improved? BTL2** **The cetane number is defined as "the percentage of hexadecane present in a mixture of**

<table>
<tr><td></td><td>hexadecane and α-methyl naphthalene, which has the same ignition lag as the fuel under test".
$CH_3-(CH_2)_{14}-CH_3$
n – cetane (hexa decane)
(cetane number = 100)

α-methyl naphthalene
(cetane number = 0)
Cetane number improvement: The cetane number of a diesel oil can be increased by adding additives called dopes.
Important dopes: Ethyl nitrate, Iso-amyl nitrate.</td></tr>
<tr><td>18</td><td>Write the significance of flue gas analysis? (Nov 2011) BTL2
1. Flue gas analysis gives an idea about the complete or incomplete combustion process.
2. If the flue gases contain considerable amount of CO, it indicates that incomplete combustion is occuring and it also indicates that the short supply of O_2.
3.If the flue gases contain considerable amount of O_2, it indicates that complete combustion is occuring and also it indicates that the excess of O_2 is supplied.</td></tr>
<tr><td>19</td><td>Define the term ignition temperature. BTL1
It is defined as the lowest temperature to which the fuel must be heated, so that it starts burning smoothly. In the case of liquid fuels, the ignition temperature is called flash point.</td></tr>
<tr><td>20</td><td>State the characteristics of a good fuel. (July 2010) BTL2
1. It should have a high calorific value.
2. It should be cheap and readily available.
3. It should undergo spontaneous combustion.</td></tr>
<tr><td>21</td><td>Define bio-diesel. BTL2
Vegetable oils comprise of 90-95% triglycerides with small amount of diglycerides, free fatty acids, phospholipids etc. are known as bio-diesel. The viscosities of vegetable oils are higher and their molecular weights are in the range of 600-900 which are about three times higher than those of the diesel fuels.</td></tr>
<tr><td>22</td><td>What do you mean by power alcohol? BTL2
When ethyl alcohol is blended with petrol at concentration of 5-10%, it is called power alcohol. In other words, absolute alcohol (100% ethyl alcohol) is also called as power alcohol. Addition of ethyl alcohol to petrol increases its octane number.</td></tr>
<tr><td>23</td><td>Mention the advantages and disadvantages of power alcohol. BTL1
Advantages:
1. Blending increases the octane number of the fuel.
2.Blend petrol shows less starting problems as compared to pure petrol.
3.It shows better anti knock properties.
Disadvantages:
1. Blended petrol has lower CV than pure petrol.
2. Alcohol is easily oxidized to organic acids, which can cause corrosion.</td></tr>
<tr><td>24</td><td>Define the term explosive range of a fuel. BTL2
In the process of burning a gaseous fuel, a particular range (minimum and maximum) of concentration of fuel is required in gas air mixture. The concentration range of gas – air is called the explosive range or limits of inflammability.</td></tr>
<tr><td>25</td><td>Differentiate between proximate and ultimate analysis. BTL 4
<table><tr><td>S.No</td><td>Proximate analysis</td><td>Ultimate analysis</td></tr></table></td></tr>
</table>

		1.	It involves the determination of physical constituents like moisture, volatile, ash and fixed carbon contents in coal.	It involves the determination of chemical constituents like carbon, hydrogen, nitrogen and sulphur and oxygen contents in coal.
		2.	It gives the approximate composition.	It gives the exact composition of the elementary constituents of coal.

	PART * B
1.	**How is proximate analysis carried out? Write its significance. (8M) (Nov 2011)** BTL2 **Answer: Page: 6.5 - 6.7 - Dr. A. RAVIKRISHNAN** 1. **Moisture content**: **Experiment:** (1M) 1g air dried coal-heated at 100-105^{O}C-one hour in an electrical oven. % of Moisture content = (Loss in weight of coal /Weight of air-dried coal) x 100. **Significance:** (1M) Reduces calorific value-transport cost increases. **2. Volatile content:** **Experiment:** (1M) Residual sample covered with a lid - heated at 950 $\pm$ 20^{o}C -7 mins in muffle furnace. % of Volatile matter = (Loss in weight of the coal / Weight of air-dried coal) x100 **Significance:** (1M) Reduces calorific value-burns with long smoke. **3. Ash content:** **Experiment:** (1M) Residual coal heated without lid - 700 $\pm$ 50^{o} C for half hour- muffle furnace. % of ash content = (Weight of ash formed /Weight of air-dried coal) x 100 **Significance:** (1M) Reduces calorific value-block the air supply. **4. Fixed carbon content:** **Experiment:** (1M) % of fixed carbon= 100-% of (moisture content + volatile matter + ash content) **Significance:** (1M) Greater calorific value-helps in designing furnace.
2.	**How is ultimate analysis carried out? Write its significance. (16M) (Jan 2018)** BTL2 **Answer: Page: 6.7 - 6.13 - Dr. A. RAVIKRISHNAN** **5. Carbon and Hydrogen content:** **Experiment:** (3M) Coal burnt– C and H converted into CO_2 and H_2O. CO_2 absorbed in known weight of KOH tube - H_2O absorbed in anhydrous $CaCl_2$ tube. $2KOH + CO_2 \rightarrow K_2CO_3 + H_2O$

$$CaCl_2 + 7H_2O \rightarrow CaCl_2 . 7\,H_2O$$
$$C + O_2 \rightarrow CO_2$$
$$\%\ of\ C = \frac{\text{Weight gain in KOH tube x 12 x 100}}{\text{Weight of coal sample taken x 44}}$$

$$H + \tfrac{1}{2}\, O_2 \rightarrow H_2O$$

$$\%\ of\ H = \frac{\text{Weight gain in } CaCl_2 \text{ tube x 2 x 100}}{\text{Weight of coal sample taken x 18}}$$

Significance: (1M)

Higher calorific value-helpful in classification of coal.

2.Nitrogen Content:

Experiment: (2M)

Carried out by Kjeldhal method – known amount of coal heated with conc. H_2SO_4- presence of K_2SO_4 (Nitrogen in coal converted into $(NH_4)_2SO_4$ and clear solution obtained).

$$(NH_4)_2SO_4 + NaOH \rightarrow NH_3 + Na_2SO_4 + H_2O.$$
$$NH_3 + HCl \rightarrow NH_4Cl$$

The amount of acid neutralized by liberated ammonia from coal is determined.

$$\%\ of\ N = \frac{\text{Volume of acid used x Normality x 1.4}}{\text{Weight of coal taken}}$$

Significance: (1M)

Undesirable-coal quality increases with little Nitrogen.

3.Sulphur content:

Experiment: (2M)

Coal burn in bomb calorimeter-Sulphur converted into SO_4 extracted with H_2O - treated with $BaCl_2$ - $BaSO_4$ precipitate filtered-dried and weighed.

$$\%\ of\ S = \frac{\text{Weight of } BaSO_4 \text{ obtained x 32 x 100}}{\text{Weight of coal sample taken in bomb x 233}}$$

Significance: (1M)

Corrosion effects on equipment-metal properties affected.

4.Ash content:

Experiment: (2M)

Residual coal heated without lid - 700 $\pm$ 50ºC for half an hour- muffle furnace.

% of ash content = (Weight of ash formed /Weight of air-dried coal) x 100

Significance: (1M)

Reduces calorific value-block the air supply.

5.Oxygen Content: (2M)

% of O = 100 – % of [C + H + S + N + Ash] found above

Significance: (1M)

Reduces calorific value- moisture holding capacity increase.

3. **How is metallurgical coke manufactured by Otto-Hoffman's method? What are the important by products recovered from coke oven gas? (16M) (May 2011)**
BTL2 **Answer: Page: 6.16 - 6.19 - Dr. A. RAVIKRISHNAN**

Objectives and advantages: (2M)

1. By products recovery (Coal gas, ammonia, benzol oil,etc.)
2. Increasing thermal efficiency by carbonization process.

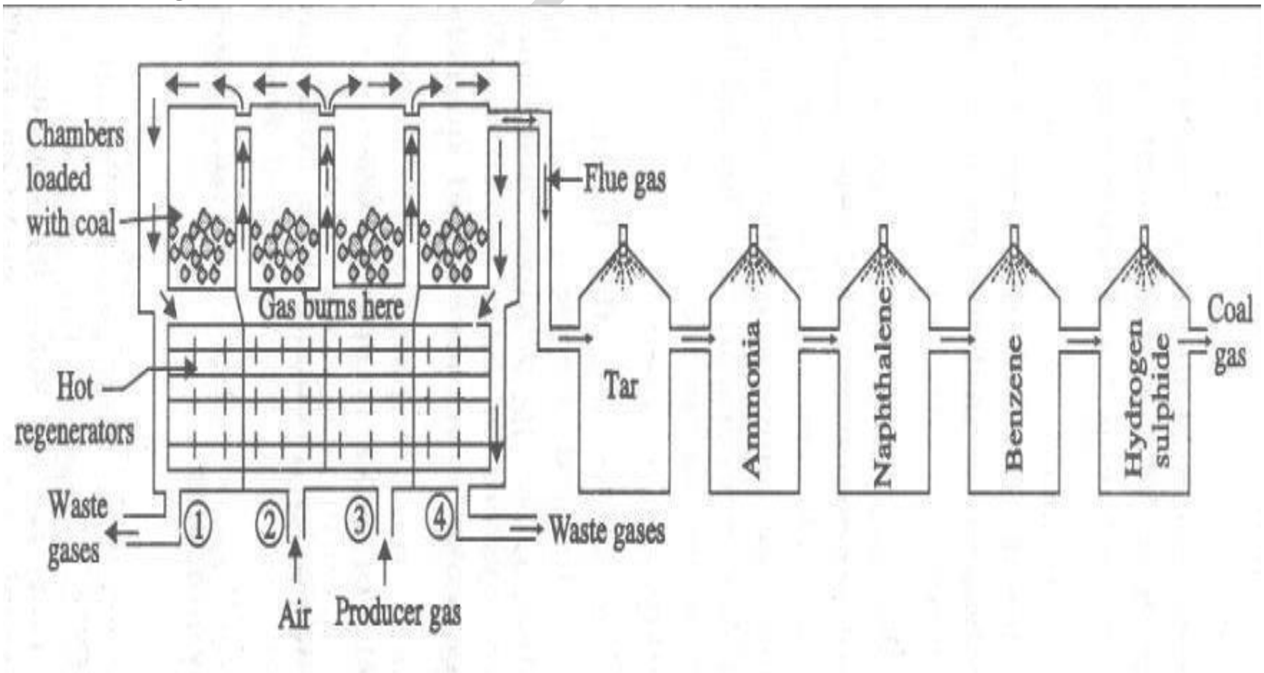
Design of chamber and working: (6M)

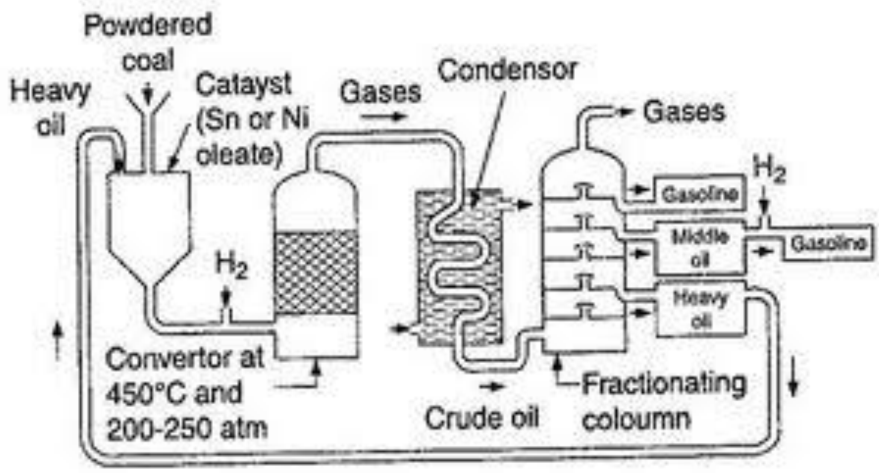
Consists of a number of silica chambers - 10-12 m long, 3-4 m tall and 0.4-0.45 m wide. Coal - heated at 1200°C – by preheated air and producer gas through 2^{nd} and 3^{rd} hot regenerators. During combustion- coal produces flue gas - hot flue gas-sent through 1^{st} and 4^{th} regenerators - temperature raises to 1000°C - direction of inlet gases and flue gases are changed frequently called heat economical regenerative system- carbonization completed in 12 -20 hours with 70% yield of coke – finally flue gases are sent to by-product recovery chamber.

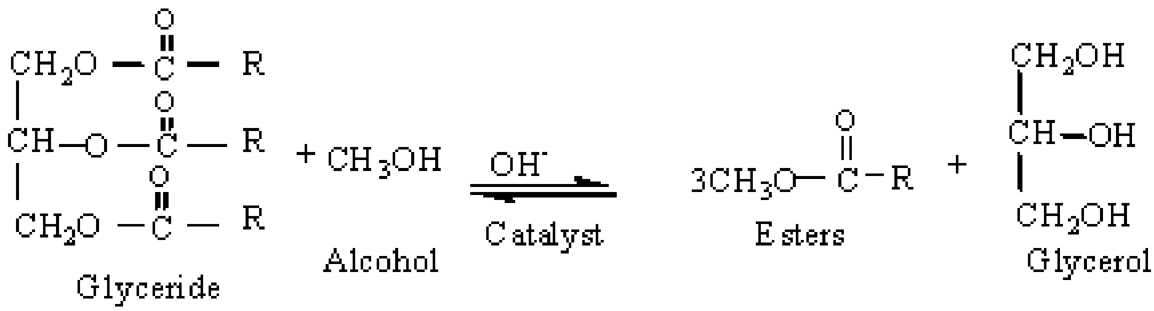
By product recovery: (3M)

No	By product	Recovered by
1	Tar	By spraying Liquid Ammonia to dissolve tar. NH_3 is again recovered by the heating the solution.
2	Ammonia	By spraying water. Here ammonia is converted as ammonium hydroxide.
3	Naphthalene	By spraying cold water.
4	Benzene	By spraying petroleum
5	Hydrogen sulphide	By moist Fe_2O_3 purifier.

Diagram: (3M)



	Advantages: (2M) Valuable by products-less carbonisation-heating done externally.
4	**What is synthetic petrol / cracked gasoline / hydrogenation of coal? How is it manufactured by Bergius process with a neat diagram? (8M) (May 2011)** BTL2 **Answer: Page: 6.23 - 6.25 - Dr. A. RAVIKRISHNAN** **Hydrogenation of coal definition** (1M) The preparation of liquid fuels from solid fuel. **Bergius method explanation:** (4M) Powdered coal- catalyst such as Tin or Nickel Oleate with heavy oil- make a paste-heated about 400-450^{O}C - pressure of 200-250atm. Depending upon the boiling points-fractions separated-Higher boiling fractions- separated at the bottom, lower boiling liquids at the top. The crude oil fraction contains, 1.Gasoline 2. Middle oil 3. Heavy oil Yield of gasoline -60%. **Diagram:** (3M) 
5	**Explain trans- esterification and advantages of bio-diesel. (8M)** BTL1 **Answer: Page: 6.36 - 6.37 - Dr. A. RAVIKRISHNAN** **Trans-esterification definition**: (2M) Reduced viscosity of vegetable oils. **Manufacture:** (2M) Treatment of vegetables oil-with excess of methanol-presence of catalyst gives glycerine (bio-diesel). **Equation:** (2M)

	 **Advantages:** (1M) Biodegradable-prepared from renewable resources-lesser gaseous pollutants-less smoke emission. **Disadvantages:** (1M) Gels in cold weather-hygroscopic-absorb water from atmosphere-engine horse power decreases.
6	**Explain the manufacture and properties of power alcohol. (8M)** BTL2 **Answer: Page: 6.33 - 6.35 - Dr. A. RAVIKRISHNAN** **Power alcohol:** **Definition:** (2M) Ethyl alcohol blended with petrol (concentration of 5-10%) or 100% alcohol. **Manufacture:** (3M) **Manufacture of Ethyl alcohol:** Fermentation of carbohydrates yields 20% ethyl alcohol-Concentration increased upto 97.6% by fractional distillation. $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ **Conversion of ethyl alcohol into power alcohol:** Removed last traces of water by 1) Distilled with benzene 2) distilled with dehydrating agent. **Properties:** (2M) Lower calorific value-high octane number- good anti-knocking property-higher compression ratio. **Uses:** (1M) Very good fuel in motors.
7	**Write short notes on CNG and LPG? (8M)** BTL2 **Answer: Page: 6.31 - 6.33 - Dr. A. RAVIKRISHNAN** **CNG definition:** (1M) Compressed natural gas- primary component methane- derived from natural gas. **Composition:** (1M) 88.5%Methane, 5.5%Ethane,3.7%propane, 1.8%Butane,0.5%pentane **Properties:** (1M) Cheapest, cleanest, least environmentally impacting alternative fuel-less CO, HC emission-less expensive than diesel, petrol. **Advantages:** (1M) Run automobile vehicles. **LPG definition:** (1M)

Obtained by-product during fractional distillation of crude petroleum oil - by cracking of heavy oil -contains propane and butane.

Composition: (1M)

38.5% n-Butane, 37% Iso butane, 24.5% propane.

Calorific Value: 25000Kcal/cm^3

Advantages over gaseous fuels: (1M)

Easy to manipulate-burns cleanly without residue-higher calorific value-higher thermal efficiency-less health hazard-free from CO.

Uses: (1M)

Domestic and industrial fuel- motor fuel.

8 **Explain the analysis of flue gas by Orsat apparatus and mention the precautions to be followed during the analysis with a neat diagram. (16M) (Jan 2018)** BTL2

Answer: Page: 7.10 - 7.13 - Dr. A. RAVIKRISHNAN

Description and Working: (8M)

Mixture of gases CO_2, O, CO called flue gases- coming out from combustion chamber -idea about complete & incomplete combustion process**.**

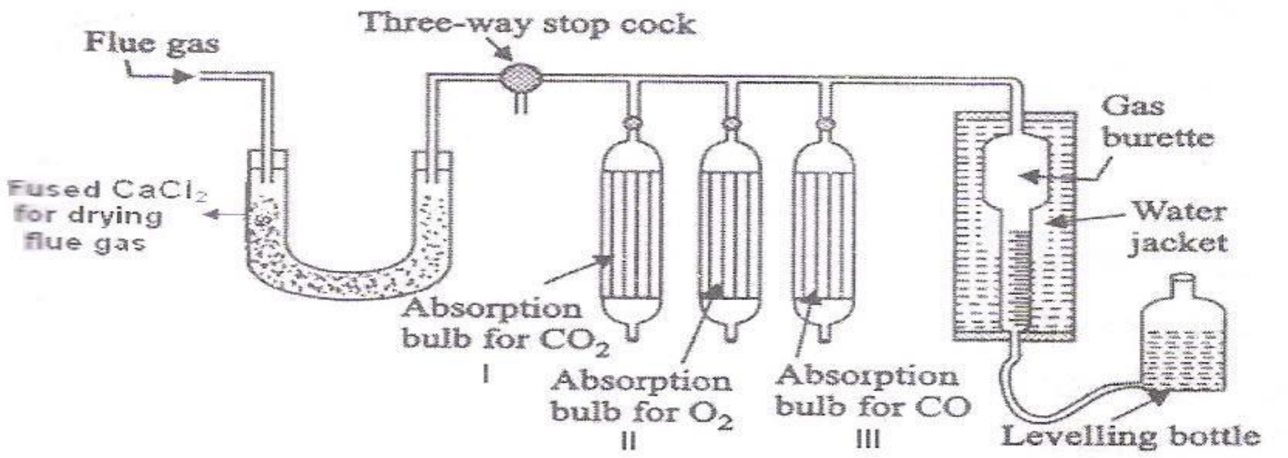
Burette filled with water -to expel the gases to the atmosphere-flue gas sent through U-tube-volume of flue gas adjusted to 100cc- adjusting the reservoir. (The 3 way stop cock is closed)

Step-1: Absorption of CO_2- bulb contains KOH & absorbs only CO_2

Step-2: Absorption of O_2- bulb contains alkaline pyrogallol & absorbs O_2,CO_2

Step-3: Absorption of O_2-bulb contains ammonical cuprous chloride solution & absorbs only CO,O_2.

Diagram: (4M)



Significances: (2M)

Idea about complete and incomplete combustion-considerable amount of CO-indicates incomplete combustion-considerable amount of Oxygen- indicates excess oxygen supply**.**

Precautions: (2M)

Order of analysis i.e CO_2, O_2 , CO should not be changed-needs special care if CO amount is very small-air from burette must be thoroughly expelled before experiment carried out.

9	**Write a detailed account on petroleum refining and fractions? (8M) (June 2009)** BTL2

Answer: Page: 6.20 - 6.22 - Dr. A. RAVIKRISHNAN

Refining of petroleum:

Definition: (1M)

Process of removing- impurities and separating crude oil – various fractions having different boiling points.

Process: (2M)

1) Separation of Water: using highly charged electrodes.
2) Removal of Sulphur: treating with copper oxide.
3) Fractional distillation: purified crude oil- heated to $400^{O}C$- crude oil gets vaporized-passed into fractionating column-straight run gasoline obtained.
4) Depending upon the boiling points-fractions separated.
5) Higher boiling fractions- separated at the bottom, lower boiling liquids at the top.

Diagram: (2M)

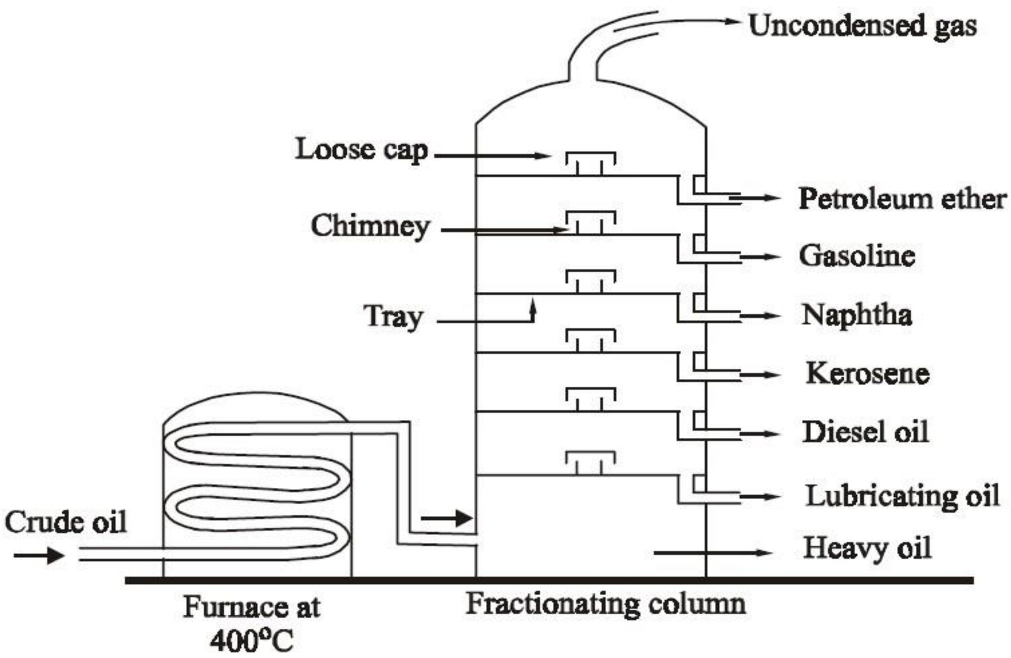


Fig 4.2 Fractional distillation of crude petroleum

Various fractions, Compositions and their uses: (3M)

No	Name	Boiling point	Number of Carbon atoms	Uses
1	Uncondensed gases	Below 30	C_1-C_4	As LPG
2	Petroleum Ether	30-70	C_5-C_7	Solvent
3	Petrol or Gasoline	40-120	C_5-C_9	Fuel in IC engine

	4	Spirit or Naphtha	120-180	C_9-C_{10}	Solvent , Paint industry ,dry cleaning
	5	Kerosene	180-250	C_{10}-C_{16}	Fuel for stoves, jet engines
	6	Diesel	250-320	C_{15} - C_{18}	Diesel engine fuel
	7	Heavy oil	320 - 400	C_{17} - C_{30}	Fuels for ships and undergoing further cracking.

10 **Calculate the gross calorific and net Calorific values of coal having the following compositions, Carbon=85%, Hydrogen=8%, Sulphur=1%, Nitrogen=2%, Ash=4%,Latent heat of Stream=587cal/gm. (8M) (June 2007)** BTL3

Answer: Page: 7.4 - Dr. A. RAVIKRISHNAN

1. **Gross calorific value:** (4M)

GCV/ HCV = 1/100 [8080C + 34500 { H- O/8} + 2240 S] kcal / kg

= 1/100 [8080(85) + 34500 { 8- 0/8} + 2240 (1)] kcal / kg

= 9,650.4 kcal/kg

2. **Net calorific value:** (4M**)**

NCV/ LCV = [HCV - 9/100 H X 587] kcal / kg

= 9227.76 kcal/kg

UNIT V – ENERGY SOURCES AND STORAGE DEVICES

Nuclear fission - controlled nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant - breeder reactor - solar energy conversion - solar cells - wind energy. Batteries, fuel cells and supercapacitors: Types of batteries – primary battery (dry cell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells – H_2-O_2 fuel cell.

PART –A (2 MARKS)

Q.No.	Questions
1.	**What is meant by multiplication factor in a fission reaction?** BTL1 Every fission reaction produces two or three neutrons. The number of neutrons, resulting from a single fission reaction is known as the multiplication factor.
2	**Write the role of moderators in nuclear reactor.** BTL1 The substances used to slow down the neutrons are called Moderators. When the fast-moving neutrons collide with moderators, they lose kinetic energy and gets slow down. Example; Ordinary water, Heavy water, graphite and Beryllium.
3	**State critical mass.** BTL2 The minimum amount of fissionable material (U^{235}) is required to continue the nuclear chain reaction which is called critical mass. Minimum mass of a lump of uranium-235 which will undergo fission in a chain reaction is called critical mass. Critical mass of U^{235} lies between 1 kg to 100 kg.
4	**Define breeder reactor.** BTL4 Breeder Reactor is the one which converts non-fissionable material [U^{238}, Th^{232}] into fissionable material [U^{235}, Pu^{239}] $U^{238} + n_0^1 \rightarrow Pu_{94}{}^{239} + 2e^-$ $Pu_{94}{}^{239} + n_0^1 \rightarrow$ Fission products $+ 3n_0^1$
5	**What is nuclear chain reaction? How it is controlled?** BTL4 (i) A fission reaction, where the neutrons from the previous step continue to propagate and **repeat** the reaction is called nuclear chain reaction. (ii) Nuclear chain reaction is an autocatalytic reaction in which the number of neutrons keeps on multiplying rapidly till the whole of fissionable material is disintegrated. (iii) Control rods are used control and regulate the number of neutrons that can cause fission.
6	**What is a battery? How does it differ from cell? (A.U. June 2016)** BTL1 i. A battery is an arrangement of several electrochemical cells connected in series that can be used as a source of direct electric current. It contains several anodes and cathodes. **CELL:** **i.** A cell contains only one anode and cathode. **ii.** Any redox reaction occurring at an appropriate electrode can be employed to generate electricity in such cell.

7	**What are primary batteries? Give an example. (A.U. June 2016)** BTL4 Primary cells are cells in which the electrode and the electrode reactions cannot be reversed by passing an external electrical energy. The reactions occur only once and after use they become dead. Therefore, they are not chargeable. **Ex.** Leclanche`s cell, Dry cell, Mercury cell.
8	**Name the electrodes used in fuel cells. (AU. Apr 2009)** BTL3 Compressed carbon containing a small amount of catalyst like Pt, Pd and Ag are used in the fuel cells porous.
9	**List the advantages of Li battery. (Jan 2012)** BTL1 (i) Its cell voltage is high, 3V. (ii) Lithium is a light-weight metal. (iii) Li has the more negative E° value and therefore generates a higher voltage than the other types of cells. (iv) All the constituents of the battery are solids and, therefore there is no risk of leakage from the battery.
10	**Write the applications of solar cells.** BTL2 Solar energy is made use in the electrification of rural areas of tropical region where the sunlight is effective during daytime. Solar cells are useful in refrigerator, water heater, water pump and cooker.
11	**What is a fuel cell or flow battery?** BTL4 Fuel cell is a voltaic cell, which converts the chemical energy of the fuels directly into electrical energy without combustion. $\text{Fuel + Oxygen} \longrightarrow \text{Oxidation Products + Electricity}$ **Example:** Hydrogen- oxygen fuel cell, Methyl alcohol – oxygen fuel cell
12	**List the advantages of fuel cells.** BTL4 (i) High efficiency of energy conservation (chemical to electrical energy). (ii) No emission of gases and pollutants. (iii) It emits only water and its vapour. (iv) Easily transportable. (v) Efficiency is more than 75%.
13	**Write the uses of lead storage battery.** BTL2 (i) Lead storage cell is used to supply current mainly in automobiles. (ii) It is also used in gas engine ignition, telephone exchanges and power stations etc.
14	**List the characteristics of fuel cells.** BTL1 (i) They do not store chemical energy. (ii) The efficiency of a fuel cell is about twice that of a conventional power plant of generating electricity. **(iii)** Fuel cell generators are free of the noise, vibration, heat transfer, thermal pollution and other problems normally associated with conventional power plants
15	**What are fissile and fertile nucleides? (Jan-2013)** BTL1 (i) **Fissile nucleides:** The materials which undergo fission by slow moving neutrons are called as fissile materials. Examples: U^{235}, Pu^{239}, U^{233}, Pu^{241}.

(ii) **Fertile nucleides:** The materials which do not undergo fission easily but may be made by bombardment with fast moving neutrons are called as fertile materials. Example: U^{238}, Th^{232}.

16 **How the non-conventional energy sources are regenerated? (June-2012)** BTL4

Renewable energy sources also called as non-conventional energy sources that are continuously regenerated by natural processes.

Example: solar energy, wind energy.

17 **Define Nuclear fission reaction. Give any one nuclear fission reaction as an example.** BTL2

The process of splitting of a heavy nucleus by a slow moving neutron into two or more lighter nuclei of almost equal size with the liberation of large amount of energy is called as nuclear fission or atomic fission reaction.

$$\mathbf{{}_{92}U^{235} + {}_{0}n^{1} \rightarrow [{}_{92}U^{236}] \rightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3\,{}_{0}n^{1} + Energy}$$

18 **List the characteristics of nuclear fission process.** BTL2

(i) Breaking of heavy nucleus by a slow moving neutron gives two or more lighter nuclei.
(ii) The fission of each nucleus generates two or more neutrons.
(iii) Large amount of energy is liberated during fission.
(iv) All the fission products are radioactive, and emit beta and gamma radiations.

19 **Write the significance of reproduction factor in nuclear chain reaction.** BTL2

K = number of neutrons generated / number of neutrons disappeared.

(i) If $k > 1$, the nucear chain reaction will lead uncontrolled growth of the neutrons and cause an atomic explosion.
(ii) If $k = 1$, the nuclear chain reaction is maintained so that at atleast only one neutron must be allowed to strike another nucleus. The chain reaction in most of reactors is controlled by means of control rods such as boron or cadmium which can absorb neutrons.
(iii) If $k < 1$, no more nuclear chain reaction occurs and the reactor stops working.

20 **Define nuclear fusion reaction. Give any one nuclear fusion reaction as an example.** BTL1

Nuclear fusion is a process in which two or more lighter nuclei combine to form one single heavier nucleus.

Example: The combination of various isotopes of hydrogen to form helium.

$$\mathbf{{}_{1}H^{2} + {}_{1}H^{2} \rightarrow {}_{2}He^{4} + {}_{0}n^{1} + 17.6\ MeV\ (Energy)}$$

21 **Distinguish between nuclear fission and nuclear fusion.** BTL4

S.No.	Nuclear Fission	Nuclear fusion
1.	A heavy nuclei split into two or more nucleus.	Two lighter nuclei combine together to form a heavier nuclei.
2.	Enormous amount of energy is liberated.	Enormous amount of energy is liberated.
3.	The process is possible at room temperature.	Process is possible only at very high temperatures.
4.	It is a chain process.	It is not a chain process.

5	It emits neutrons.	It emits positrons.

22

What is Nuclear reactor? BTL2

Nuclear reactor is an arrangement or equipment used to carry out nuclear fission in a controlled manner to release nuclear energy. The main purpose of a reactor is to produce electrical power.

In nuclear reactors, the heat generated during fission is used to produce steam. The steam is used to drive the turbines which produce electricity.

23

What are the advantages of nuclear power generation? BTL4

Nuclear power generation emits relatively lower amounts of greenhouse gases.

It is possible to generate a high amount of electrical energy in one single plant.

24

Explain the function of control rods. BTL4

Control rods absorb neutrons and regulate the number of neutrons that can cause fission Ex: Boron, Cadmium.

Cd_{43}

25

Write about the purpose of a coolant in a nuclear reactor. Name the various coolants used in nuclear reactors. BTL4

Coolants are used to carry away the heat produced inside the reactor to heat exchanger where it transfers heat to water and produces steam which is utilized for power generation.

Ex: Water (light water or heavy water), Gases (He, Co, Air), Molten Na, Molten alloy of Na and K.

26

Compare light water reactor and breeder reactor. BTL4

S.no.	Light water reactor	Breeder reactor
1.	Fissile materials like U^{235} is used as fuel	Fertile materials like U^{238} is used as fuel
2.	During fission, no radioactive emission occurs	During fission, gamma and beta emission occurs.
3.	Moderators are used to slow down the neutrons	Moderators are not used.
4.	Light water is used as coolant.	Liquid sodium is used as coolant.

27

How is electricity generated from wind? (or) What is wind energy? How is it obtained? (AU Dec 2015) BTL1

Wind energy is generated by harnessing the wind with wind turbines. When the wind is passes through the turbine's rotor blades, the blades turn and convert the wind energy into kinetic energy this energy in turn spins a rotor inside a generator where the kinetic energy is converted into electrical energy.

28

Mention the advantages and limitations of wind electric power. (or) What are the merits of wind energy?(A.U. Feb 2010) BTL2

	Advantages: Renewable energy source. Available as free of cost. Can build on shore or off shore. Supply power to remote and rural areas. More economic. Pollution free. **Limitations:** Low energy density. Variable, irregular and intermittent. Design and installation of wind turbines is complex. Vast open areas are required. Turbines interfere with TV and electromagnetic communication systems. Creates noise pollution. Attacks migrating birds.
29	**How the charging and discharging process takes place in a battery?** BTL4 (i) Discharging is an electrochemical process by which a battery delivers current to an External circuit at an the cost of the consumption of electrode materials. **(ii)** Charging is an electrolytic process by which a constant current is passed through a battery in Order to regenerate the active materials back into their original form.
30	**Define super capacitors.** Super capacitor is a high capacity capacitor with capacitance value much higher than other capacitor. They store 10 to 100 times more energy per unit volume and deliver charge much faster than batteries.
31	**Will the emf of a battery vary with size? Give reason for your answer.** **(AU June 2014). (BTL 4)** No, emf of a battery will not vary with size. **Reason:** EMF of a battery depends only on concentration and nature of anode and cathode.
32	**What are secondary cells (or) storage cells (or) accumulators? List the advantages of storage batteries. (AU Jan 2013) (BTL1)** Secondary cells are cells in which the electrode reactions can be reversed by passing an external electrical energy. Therefore, they can be recharged by passing electric current and used again and again. **Advantages:** **(i)** The secondary batteries have advantages over the primary batteries in that the net cell reaction can be reversed during the charging process and the current can be drawn during the discharge process. **(ii)** Storage batteries have better cycle life and capacity, so that it can be used over and over again.
	PART * B
1	**Define Nuclear fission reaction. Explain the Mechanism and characteristics of nuclear fission reaction. (8 M)** **Answer : Refer Page No. 8.2 – A. Ravikrishnan** BTL 2 **Definition: (1 M):**

Process of splitting of heavier nucleus-into two or more smaller nuclei - with simultaneous liberation - large amount of energy.

Mechanism:

$$U^{235}_{92} + n^1_0 \longrightarrow \left[U^{236}_{92}\right] \longrightarrow \begin{cases} Ba^{140}_{56} + Kr^{93}_{36} + 3n^1_0 + \text{Energy} \\ Xe^{144}_{54} + Sr^{90}_{38} + 2n^1_0 + \text{Energy} \\ Cs^{144}_{55} + Rb^{90}_{37} + 2n^1_0 + \text{Energy} \end{cases}$$

Characteristics (7 M):

1. Heavy nucleus like $U^{235}$and/or Pu^{239} - bombarded with slow moving neutrons - splits into two or more smaller nuclei.
2. Two or more number of neutrons - produced during fission reaction.
3. Large amount of energy - released - by conversion of small mass of the nucleus into energy ($E = mc^2$).
4. Fission fragments – radioactive - giving off α, β and γ radiations.
5. Fission reaction - Self propagating chain reaction, because fission product contain neutrons called secondary neutrons which can further cause fission of other nuclei
6. Secondary neutron - does not strike nucleus - some escape into air - chain reaction cannot be maintained.
7. Nuclear chain reactions - controlled and maintained steadily by absorbing - a desired number of neutrons using Cd, B, steel.
8. Number of neutrons - from a single fission - multiplication factor. When the value of multiplication factor is less than 1, a chain reaction cannot take place.

2 **Differentiate between Nuclear fission and Nuclear fusion reaction.**

Answer: Refer Page 8.6 - A. Ravikrishnan BTL 4 **(8 M)**

(Each point 1 mark)

S. No	Nuclear fission	Nuclear fusion
1	Process-breaking a heavier nucleus.	Process - combining of lighter nuclei.
2	Emits radioactive rays.	Does not emit radioactive rays.
3	Process takes place at ordinary temperature.	Process takes place above 106 K.
4	Mass number and atomic number of new elements - lower than parent nuclei.	Mass number and atomic number - product elements - higher than parent nuclei.
5	Gives - chain reaction.	Does not give chain reaction.
6	Emits neutrons.	Emits positrons.
7	Can be controlled.	Cannot be controlled.
8	${}_{92}U^{235} + {}_{0}n^{1} \rightarrow [{}_{92}U^{236}] \rightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3{}_{0}n^{1}$ + Energy	${}_1H^2 + {}_1H^3 \rightarrow {}_2He^4 + {}_0n^1$ + Energy

3 **Describe the components of light water nuclear reactor. (or) Give an account of Light water nuclear reactor with a neat diagram. (A.U. - Jan2018)**

Answer: Refer Page 8.12 - A. Ravikrishnan BTL 2 **(10M)**

In light water nuclear power plant - U^{235} fuel rods are submerged in water. Water acts as moderator and coolant. **(1 M)**

Components of Nuclear Reactor with examples: (7 M)

1. **Fuel rods (1 M) :** Fissionable material - enriched U-235 - form of rods or strips. **Example:** U^{235}, Pu^{239}

Function: produces heat energy and neutrons - initiate nuclear chain reaction.

2. **Control rods (1 M):** Movable rods - lowered or raised. Made of cadmium or boron. Suspended between fuel rods. Control fission reaction by absorbing excess neutrons.
   If these rods are deeply inserted inside the reactor - absorb more neutrons - fission reaction becomes slow.
   If control rods are pushed outwards - absorb less neutrons - reaction will be very fast. **Example:** Cd^{113}, B^{10}

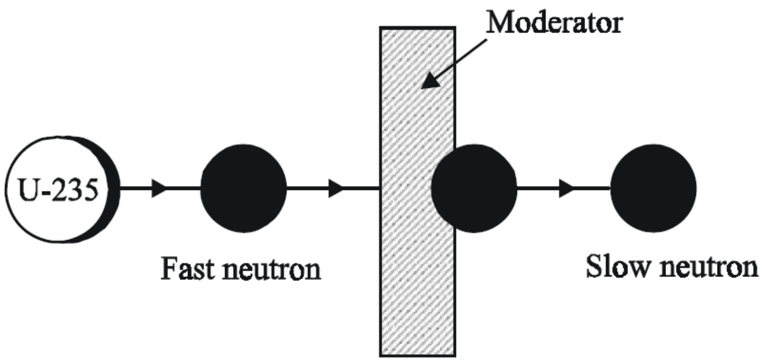
$$Cd^{113}{}_{43} + n_0{}^1 \longrightarrow Cd^{114}{}_{43} + \gamma\text{-ray}$$

$$B_5{}^{10} + n_0{}^1 \longrightarrow B_5{}^{11} + \gamma\text{-ray}$$

Function: Controls the nuclear chain reaction and avoids the damage of the reactors.

3. **Moderators (1 M):** Used to slow down the neutrons are called **moderators.**

Mechanism: Fast moving neutrons collide with moderator - lose energy - gets slow down



Example: Ordinary water, heavy water, graphite, beryllium and organic solvent.

Function: The kinetic energy of the fast neutrons (1 MeV) is reduced to slow neutrons (0.25ev)

4. **Coolants (1 M):** To absorb - heat produced during fission, a liquid called coolant - circulated in the reactor core. Enters the base of the reactor - leaves at the top. Heat carried by outgoing liquid is used to produce steam.

Example: Water and heavy water, Molten metal (Na or K), Molten salt, organic solvent, CO_2, helium and steam.

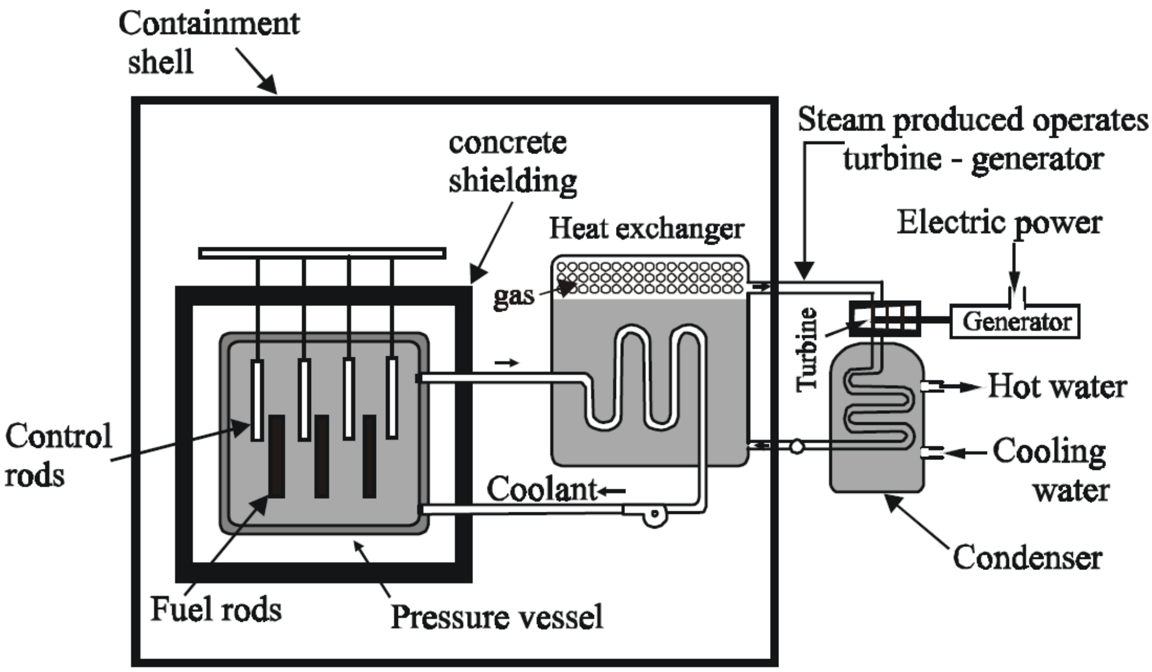
Function: It cools the fuel core.

5. **Pressure Vessel (1 M):** Encloses the core - provides - entrance and exit passage for coolant.

Function: Withstands the pressure as high as 200 kg/cm^2

6. **Protective shield (1 M):** Thick massive concrete shield of 10 meter thickness. It encloses the nuclear reactor.

Function: Environment and operating personals are protected from destruction - in case

	of leakage of radiation 7. **Turbine (1 M):** Steam generated in the heat exchanger is used to operate a steam turbine - Drives a generator to produce electricity. **Working (1 M):** Fission reaction is controlled by inserting or removing - control rods of B^{10} automatically from the spaces in between the fuel rods. Heat liberated - fission of U^{235} is absorbed by the coolant (light water). Heated coolant then goes in to the heat exchanger. Coolant here transfers heat to water - converted into steam. Steam then drives the turbine to generate electricity. **Diagram (1 M)** 
4	**Write a detailed note on breeder reactor. (Jan 2013)** **Answer: Refer Page 8.16 - A. Ravikrishnan** BTL 2 **(8 M)** **Definition: (2 M)** Converts - non fissionable materials like U^{238} and Th^{232} into fissionable materials like U^{235} and Pu^{239} **Illustration (2 M)** $U^{238}_{92} + n_0^1 \rightarrow Pu^{239}_{94} + 2e^-$ Non-fissionable → fissionable $Pu^{239}_{94} + n_0^1 \longrightarrow$ Fission products + 3 $_0n^1$ **Explanation (2 M)** Out of three neutrons emitted - only one used to propagate - fission chain with U^{235} - breeder reactor. Other two neutrons - allowed to react with U^{238}. Two fissionable atoms of Pu^{239} - produced - each atom of U^{235} consumed. Breeder reactor produces - more fissionable material than it uses. Pu^{239} - man made nuclear fuel - known as secondary nuclear fuel.

Significance (2 M)

Fissionable nucleides - U^{235} and Pu^{239} - **fissile nucleides.**

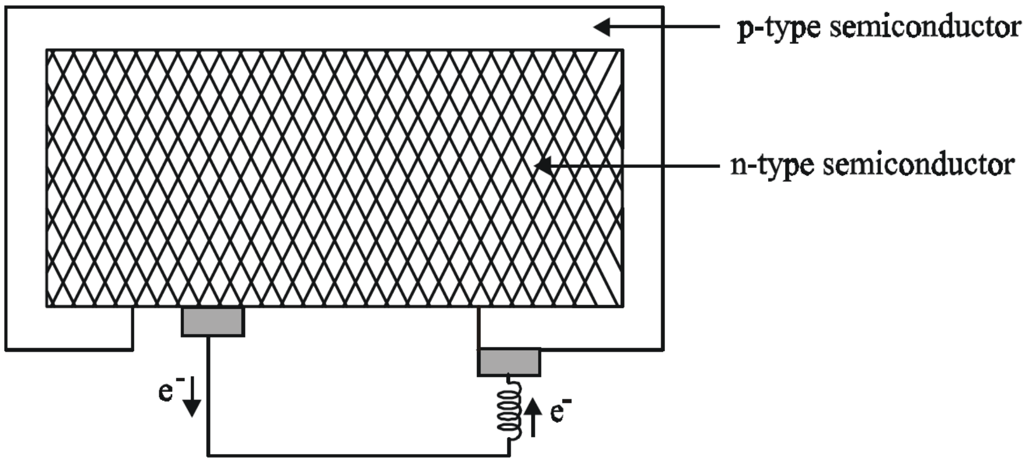
Non-fissionable nucleides - U^{238} and Th^{232} - **fertile nucleides**.

5 **Write a note on Photovoltaic cell. (or) Give an account of solar cells. (or) State the principle and application of solar batteries (NOV/DEC-2012) (Jan 2013).**
Answer: Refer Page 8.19 - A. Ravikrishnan BTL 2 **(8M)**

- **Principle (1 M)**

Solar cell consists - p-type semiconductor (such as Si doped with B) and n-type semiconductor (such as Si doped with P) - Close contact with each other, Limited number of electrons (from n-type semiconductor) and positive holes (from p-type semiconductor) - cross the junction between - two types of semiconductors. Potential difference causes flow of electrons - produces electricity.

- **Construction with diagram (2 M)**



- **Working (2 M)**
  Solar rays fall - outer layer of p-type semiconductor, the electrons in the valence band - get promoted to the conduction band - absorbing light energy. Conduction electrons - easily cross - p-n junction into n-type semiconductor, a potential difference between two layers - created. Potential difference causes flow of electrons - current is generated.

- **Applications (1 M)**
  Lighting purpose - Electrical street lights - replaced by solar street lights
  Running pumps.
  Drive vehicles.
  Power in space craft and satellites.
  Calculators, electronic watches, radios and televisions.

- **Advantages (1 M)**
  Low maintenance cost.
  Noise and pollution free.
  Long lifetime.
  Used in remote areas.
  Non-polluting and eco-friendly.

- **Disadvantages (1 M)**
  Higher capital cost
  Storage of energy - not possible.

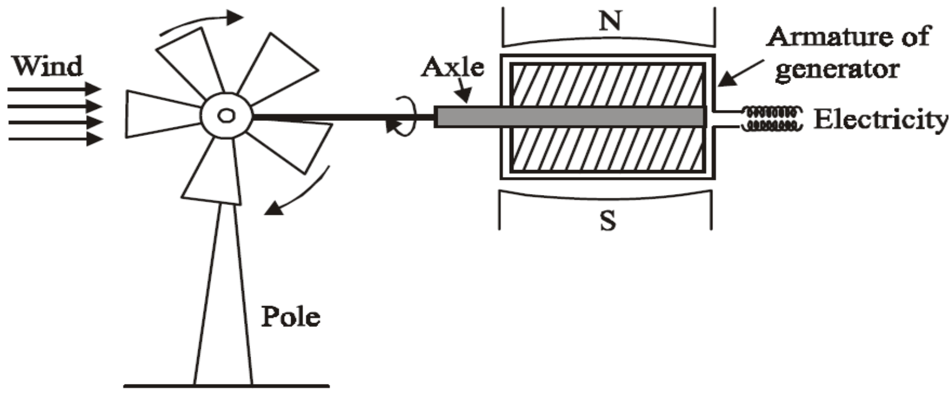
6 **Explain the methods of harnessing Wind energy by a wind mill. (June 2016)**
Answer: Refer Page 8.22 - A. Ravikrishnan BTL 2 **(8 M)**

- **Definition (1 M):** Energy recovered from the force of wind - called wind energy. Wind mill - a device used to convert wind energy into mechanical energy.

- **Construction and working of wind mill (2 M)**

Blowing wind strikes - massive size blades of wind mill - rotating continuously. Capable of generating - 100kW electricity. Minimum speed required - satisfactory working of a wind generator - 15 km/hr. Large number of wind mills - installed and joined together in a definite pattern - form wind farming. Produces large amount of electricity production.

- **Diagram (1 M)**



- **Advantages (1 M)**
  Renewable energy source.
  Available as free of cost.
  Can build on shore or off shore.
  Supply power to remote and rural areas.
  More economic.
  Pollution free.

- **Disadvantages (1 M)**
  Low energy density.
  Variable, irregular and intermittent.
  Design and installation of wind turbines is complex.
  Vast open areas are required.
  Turbines interfere with TV and electromagnetic communication systems.
  Creates noise pollution.
  Attacks migrating birds.

- **Uses (1 M)**
  Drives a number of machines - water pumps, flour mills and electric generators.

- **Harnessing of wind energy - possible by (1 M)**

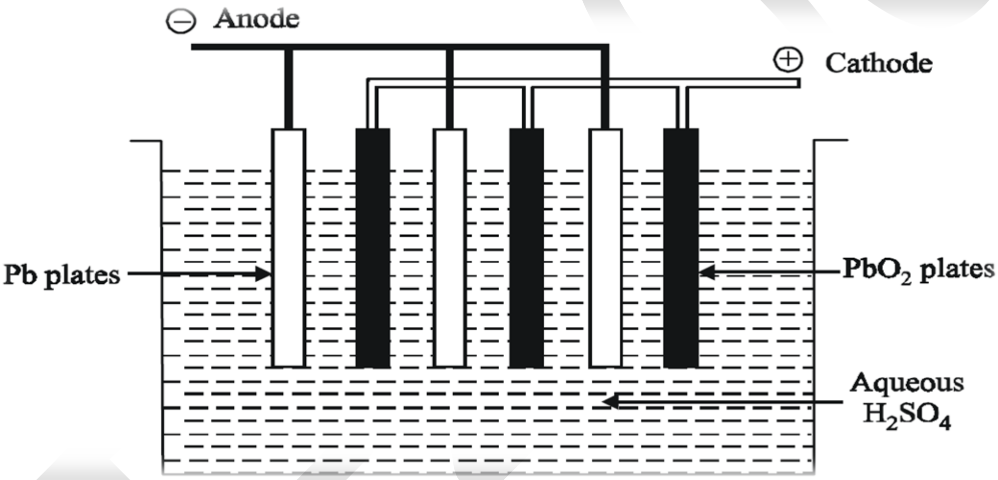
i. Sky sail
ii. Ladder mill
iii. Kite ship
iv. Sky wind power
v. Sequoia automation

7 **Describe the construction, charging and discharging of lead acid accumulator. (NOV/DEC-2016) (JAN 2018)**
Answer: Refer Page 9.5 - A. Ravikrishnan BTL 2 **(8 M)**

- **Cell description and cell representation:(1 M)**
  Anode: lead
  Cathode: lead dioxide PbO_2
  Electrolyte: H_2SO_4 of density 1.3g/l

- **Cell representation** - $Pb / PbSO_4 // H_2SO_{4\,(aq)} / PbO_2 / Pb$

- **Diagram (1 M)**



- **Working (4 M)**

i. Discharging (Anode reaction, Cathode reaction and Overall reaction)
At anode: Lead is oxidized to Pb^{2+} ions - insoluble $PbSO_4$ is formed.

$$Pb_{(s)} \xleftrightarrow[\text{Charging}]{\text{discharging}} Pb^{2+}{}_{(aq)} + 2e^-$$

$$Pb^{2+}{}_{(s)} + SO_4^{2-}{}_{(aq)} \xleftrightarrow[\text{Charging}]{\text{discharging}} PbSO_{4(s)}$$

Overall cell reaction:

$$Pb_{(s)} + SO_4^{2-}{}_{(aq)} \xleftrightarrow[\text{Charging}]{\text{discharging}} PbSO_{4(s)} + 2e^- \quad \text{--- (1)}$$

At cathode: PbO_2 gains electrons i.e., Pb undergoes reduction at the cathode. Pb^{2+} ions combines with SO_4^{2-} ions - forms insoluble $PbSO_4$

.

$$PbO_{2(s)} + 2e^- + 4H^+ \xleftrightarrow[\text{Charging}]{\text{discharging}} Pb^{2+} + 2H_2O$$

$$Pb^{2+}{}_{(aq)} + SO_4^{2-}{}_{(aq)} \underset{\text{Charging}}{\overset{\text{discharging}}{\longleftrightarrow}} PbSO_{4(s)}$$

$$PbO_{2(s)} + 4H^+ + SO_4^{2-} + 2e^- \underset{\text{Charging}}{\overset{\text{discharging}}{\longleftrightarrow}} PbSO_4(s) + 2H_2O \quad \text{-- (2)}$$

Overall cell reaction during discharging:

(1) + (2) gives

$$\boxed{Pb_{(s)} + PbO_{2(s)} + 2H_2SO_{4(aq)} \underset{\text{Charging}}{\overset{\text{Discharging}}{\rightleftharpoons}} 2PbSO_{4(s)} + 2H_2O}$$

$PbSO_4$ deposited at both the electrodes - H_2SO_4 is consumed. Concentration of H_2SO_4 decreases gradually.

ii. Charging (explanation with reaction)

Done by applying - external electricity - across the electrodes.

Overall reaction:

$$2PbSO_4 + 2H_2O + \text{Energy} \underset{\text{discharging}}{\overset{\text{Charging}}{\rightleftharpoons}} Pb + PbO_2 + 2H_2SO_4$$

Charging involves - reverse procedure - normal cell reaction.

- **Advantages, disadvantages and uses (2 M)**

Advantages:

(i) Made easily.
(ii) High current production.
(iii) Low self-discharging rate.
(iv) Used at low temperatures also.

Disadvantages:

(i) Recycling - environmental hazards.
(ii) Battery capacity - reduced - due to mechanical strain bumping.

Uses: Automobiles, gas engine ignition, telephone exchanges, hospitals, power stations.

8 **Explain charging and discharging reactions of lithium-ion cell. (Dec 2016)**
Answer: Refer Page 9.8 - A. Ravikrishnan BTL 2 **(8 M)**

- **Construction: (1 M)**
  Anode: Layers of porous carbon - Graphite
  Cathode: Layers of lithium-metal oxide – Lithium cobalt oxide ($LiCoO_2$)
  Electrolyte: Polymer gel (Separator)

- **Working: (4 M)**

  Charging:

  Lithium ion flows from $LiCoO_2$ to graphite through electrolyte.
  Electrons flow from $LiCoO_2$ to graphite through wire.
  Lithium ions combine at graphite and deposit as Lithium.

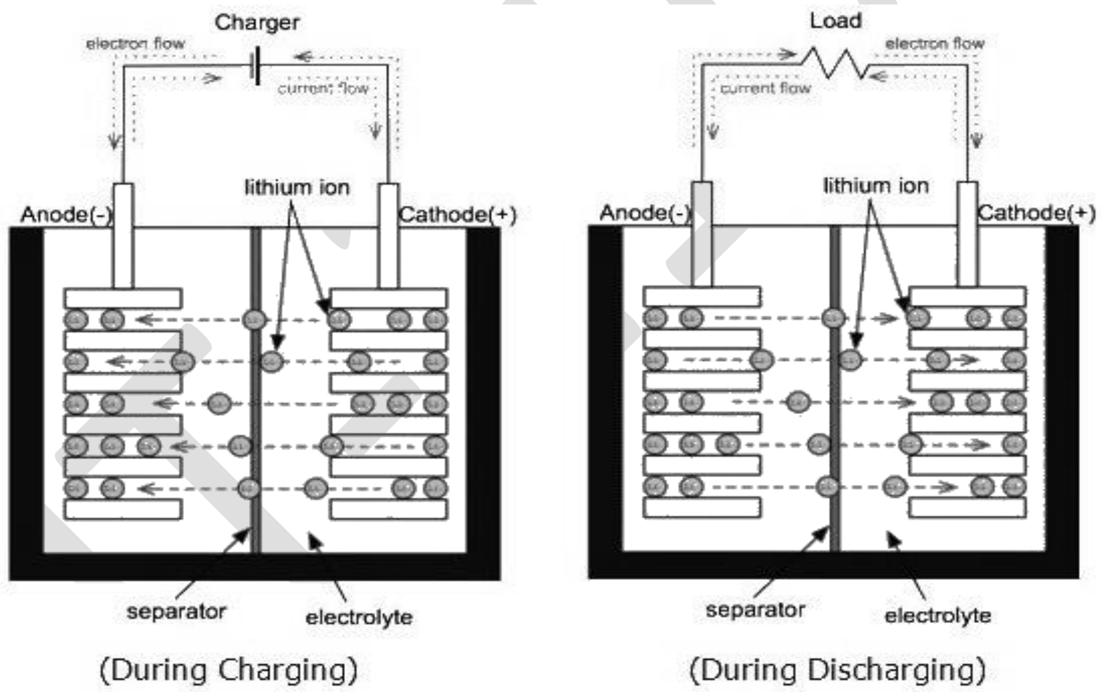
$$LiCoO_2 + C \underset{\text{discharging}}{\overset{\text{Charging}}{\rightleftharpoons}} Li_{1-x}CoO_2 + CLi_x$$

Discharging:

Lithium ion flows from graphite to $LiCoO_2$ through electrolyte.
Electrons flow from graphite to $LiCoO_2$ through wire.
Lithium ions combine at $LiCoO_2$ and deposit as Lithium.

$$Li_{1-x}CoO_2 + CLi_x \underset{\text{Charging}}{\overset{\text{discharging}}{\rightleftharpoons}} LiCoO_2 + C$$

Diagram: (1M)



Advantages: (1 M)

High voltage and light weight batteries.
Smaller in size.

Uses: (1 M)

Cellphones, Portable LCD TV, semiconductor driven audio.

9 **With a neat sketch explain the functioning of H_2O_2 fuel cell. (Jan 2017)**
Answer: Refer Page 9.11 - A. Ravikrishnan BTL 4 **(8 M)**

- **Definition: (1 M)**

  Fuel cell - voltaic cell, converts - chemical energy - fuel directly into electricity without combustion.

$$\text{Fuel + Oxygen} \longrightarrow \text{Oxidation Products + Electricity}$$

Example: Hydrogen oxygen fuel cell, Methyl alcohol – oxygen fuel cell

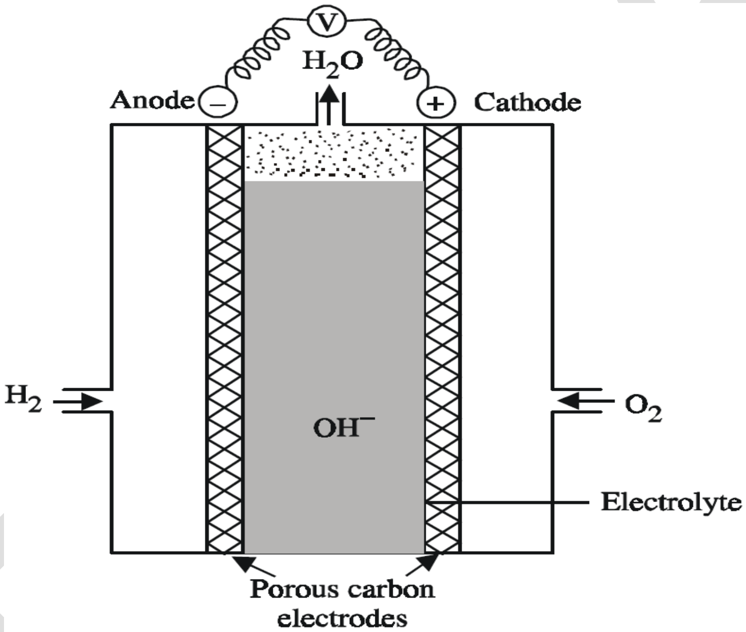
Hydrogen Oxygen fuel cell: Fuel – hydrogen (Anode)
Oxidizer – oxygen (Cathode)
Electrolyte - 25% of KOH solution

- **Description (1 M)**

Two porous electrodes anode and cathode. Porous electrodes - compressed carbon + a small amount of catalyst (Pt, Pd, Ag). Electrolytic solution - 25% KOH or NaOH. Two electrodes - connected though - Voltmeter.

- **Working (At anode, At cathode and Overall reactions) (4 M)**

Hydrogen - bubbled through - anode compartment - oxidised. The oxygen - bubbled through - cathode compartment - reduced.



At anode: $2H_2 + 4OH^- \xrightarrow{\text{discharging}} 4H_2O + 4e^-$

At cathode: $O_2 + 2H_2O + 4e^- \xrightarrow{\text{discharging}} 4OH^-$

Overall cell reaction: $2H_2 + O_2 \xrightarrow{\text{discharging}} 2H_2O$

EMF = 0.8 to 1.0V

Fuel battery: Large number of fuel cells - connected in series - forms fuel battery.

Advantages: (1 M)

1. Energy conversion is highly efficient.
2. H_2-O_2 fuel cell - produces drinking water.
3. Low noise and thermal pollution.
4. Modular and low maintenance costs.
5. Saves fossil fuels.

Disadvantages: (1 M)

1. High initial cost.

2. Pure hydrogen - costly.
3. Cannot store electrical energy.
4. Electrodes – expensive.
5. Gases - to be stored - big tanks under high pressure.

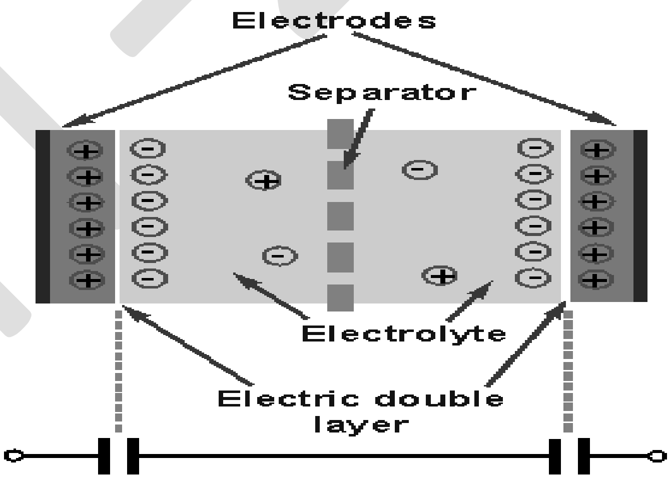
10 **Write notes on super capacitors. (BTL 2)**
Answer: Refer Page 9.14 - A. Ravikrishnan BTL 4 **(8 M)**

- **Introduction (1 M)**
  High capacity capacitor – capacitance value much higher than other capacitor. Stores 10 to 100 times more energy per unit volume – delivers charge much faster than batteries.
  Ordinary capacitors use conventional solid dielectric – super capacitors use electrostatic double-layer capacitance.

- **Design of super capacitor (2 M)**
  Super capacitor – Electro-chemical capacitor. Consists of two electrodes – made from metal coated with a porous substance like powdery activated carbon – separated by an ion-permeable membrane. Electrolyte – positive – negative ions containing both the electrodes.

- **Working (2 M)**
  Electrolyte ions form electric double layers – Helmholtz electrical double layer – opposite polarity to the electrodes polarity – creating an electric field between them.
  Electric field polarizes the dielectric – molecules lineup - opposite direction – reduce its strength. Stores more electrical energy – electrode-electrolyte interface.

- **Diagram (1 M)**



- **Advantages & Disadvantages: (1 M)**
  Advantages:
  Highly safe.
  Very high life time.
  Recycled many times.
  Charged easily.
  Provides high power density – high load currents.
  Performance well at low temperature (-40^{o}C).

- **Disadvantages:**
  High cost.
  Cannot be used for continuous power supply.
  High self-discharge – higher than batteries.

- **Applications: (1 M)**

Energy harvesting - Kitchen appliances - Consumer electronics - Wind energy - Voltage stabilization in start/stop system.

11 **Describe the construction and working of Leclanche`s cell.**
Answer: Refer Page 9.14 - A. Ravikrishnan BTL 4 **(8 M)**

Description: (1 M)
Anode : Zinc Cylinder
Cathode: Carbon rod (graphite)
Electrolyte: Paste of NH_4Cl, $ZnCl_2$, MnO_2, Starch and water.
EMF = 1.5V

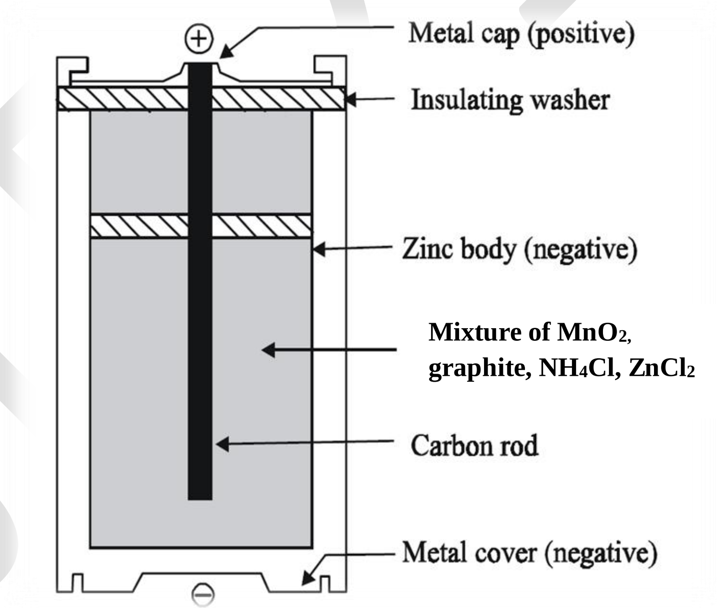
Working: (4 M)

Anode: $Zn \xrightarrow{\text{discharging}} Zn^{2+} + 2e^-$

Cathode: : $NH_4^+{}_{(aq)} + MnO_{2(s)} + 2e^- \xrightarrow{\text{discharging}} MnO(OH^-) + NH_3$

Overall reaction is: $Zn + NH_4^+{}_{(aq)} + MnO_{2(s)} \xrightarrow{\text{discharging}} Zn^{2+} + MnO(OH^-) + NH_3$

Diagram: (1 M)



Disadvantages: (1 M) NH_4Cl – acidic – corrodes zinc. Voltage drop occurs.

Uses: (1 M) Transistor radios, Calculators, Flash lights, torches etc.,

GE8151 PROBLEM SOLVING AND PYTHON PROGRAMMING **L T P C**
3 0 0 3

UNIT I ALGORITHMIC PROBLEM SOLVING 9
Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II DATA, EXPRESSIONS, STATEMENTS 9
Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROLFLOW,FUNCTIONS 9
Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV LISTS, TUPLES, DICTIONARIES 9
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.

UNIT V FILES, MODULES, PACKAGES 9
Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

COURSE OUTCOMES:
Upon completion of the course, students will be able to

- Develop algorithmic solutions to simple computational problems
- Read, write, execute by hand simple Python programs.
- Structure simple Python programs for solving problems.
- Decompose a Python program into functions.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python Programs.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2. Guido van Rossum and Fred L. Drake Jr, –An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

REFERENCES:

1. John V Guttag, –Introduction to Computation and Programming Using Python'', Revised and expanded Edition, MIT Press , 2013
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, –Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
3. Timothy A. Budd, –Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd.,, 2015.
4. Kenneth A. Lambert, –Fundamentals of Python: First Programs‖, CENGAGE Learning, 2012.
5. Charles Dierbach, –Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.

Paul Gries, Jennifer Campbell and Jason Montojo, –Practical Programming: An Introduction to Computer Science using Python 3‖, Second edition, Pragmatic Programmers, LLC, 2013.

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Subject Code: GE8151 **Year/Semester: I/01**
Subject Name: PROBLEM SOLVING AND PYTHON PROGRAMMING Subject Handler: Ms.S.Ancy

UNIT I ALGORITHMIC PROBLEM SOLVING	
Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion), Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, and guess an integer number in a range, Towers of Hanoi	
PART * A	
Q.No.	**Questions**
1.	**What is an algorithm? (Jan 2018)** BTL1 Algorithm is an ordered sequence of finite, well defined, unambiguous instructions for completing a task. It is an English-like representation of the logic which is used to solve the problem. It is a step-by-step procedure for solving a task or a problem. The steps must be ordered, unambiguous and finite in number
2	**What are the characteristics of Algorithm?** BTL1 In Algorithms each and every instruction should be precise and clear-cut. ✓ The instruction in an algorithm should not be repeated infinitely ✓ The algorithm make sure that it will ultimately be terminated ✓ Algorithm should be written in sequence ✓ It looks like normal English ✓ The desired result should be obtained only after the algorithm terminated
3	**List out the ways to represent an algorithm** BTL1 ✓ Normal English ✓ Flowchart ✓ Pseudo code ✓ Decision table ✓ Program
4	**List the building blocks of an algorithm.** BTL1 The building blocks of an algorithm are ✓ Statements ✓ Sequence ✓ Selection or Conditional ✓ Repetition or Control flow ✓ Functions
5	**Define statement. List its types.** BTL1 Statements are instructions in Python designed as components for algorithmic problem solving, rather than as one-to-one translations of the underlying machine language instruction set of the computer. There are three types of high-level programming language statements Input/output statements make up one type of statement. An input statement collects a specific value from the user for a variable within the program. An output statement writes a message or the value of a program variable to the user‘s screen

6	**How does flow of control work?** BTL1 Control flow (or flow of control) is the order in which individual statements, instructions or function calls of an imperative program are executed or evaluated. A control flow statement is a statement in which execution results in a choice being made as to which of two or more paths to follow.
7	**What is a function?** BTL1 Functions are "self-contained" modules. Once a function is written, it can be used over and over and over again. That accomplish a specific task. Functions usually "take in" data, process it, and "return‖ Functions can be "called" from the inside of other functions.
8	**Give the rules for writing Pseudo codes.** BTL1 ✓ Write one statement per line. ✓ Capitalize initial keywords. ✓ Indent to show hierarchy. ✓ End multiline structure. ✓ Keep statements to be language independent.
9	**Give the difference between flowchart and pseudo code**. BTL1 Flowchart and Pseudo code are used to document and represent the algorithm. An algorithm can be represented using a flowchart or a pseudo code. Flowchart is a graphical representation of the algorithm. Pseudo code is a readable, formally styled English like language representation of the algorithm.
10	**Define a flowchart.** BTL2 ✓ A flowchart is a diagrammatic representation of the logic for solving a task. ✓ A flowchart is drawn using boxes of different shapes with lines connecting them to show the flow of control. ✓ The purpose of drawing a flowchart is to make the logic of the program clearer in a visual form.

11	**Give an example of iteration.** BTL1
	a = 0 for i from 1 to 3 // loop three times
	{
	a = a + i // add the current value of i to a
	}
	print a // the number 6 is printed (0 + 1; 1 + 2; 3 + 3)

12	**Write down the rules for preparing a flowchart.** BTL2 While drawing a flowchart, some rules need to be followed— ✓ A flowchart should have a start and end. ✓ The direction of flow in a flowchart must be from top to bottom and left to right, and the relevant symbols must be used while drawing a flowchart.
13	**List the categories of Programming languages.** BTL1 Programming languages are divided into the following categories: ✓ Interpreted Programming language ✓ Functional Programming language ✓ Compiled Programming language ✓ Procedural Programming language ✓ Scripting Programming language

- ✓ Markup Programming language
- ✓ Logic-Based Programming language
- ✓ Concurrent Programming language
- ✓ Object Oriented Programming Languages

14 **Mention the characteristics of an algorithm.** BTL1

- ✓ Algorithm should be precise and unambiguous.
- ✓ Instruction in an algorithm should not be repeated infinitely.
- ✓ Ensure that the algorithm will ultimately terminate.
- ✓ Algorithm should be written in sequence.
- ✓ Algorithm should be written in normal English.
- ✓ Desired result should be obtained only after the algorithm terminates.

15 **Compare machine language, assembly language and high-level language.** BTL1

Machine language is a collection of binary digits or bits that the computer reads and interprets. This language is not easily understandable by the human.

An assembly language directly controls the physical hardware. A program written in assembly language consists of a series of instructions mnemonics that correspond to a stream of executable instructions, when translated by an assembler can be loaded into memory and executed. The programs written in this language are not portable and the debugging process is also not very easy.

A high level language is much more abstract, that must be translated or compiled in to machine language. It is easily understandable and the programs are portable. Debugging the code is easy and the program written is not machine dependent.

16 **What is the difference between algorithm and pseudo code?** BTL2

An algorithm is a systematic logical approach used to solve problems in a computer while pseudo code is the statement in plain English that may be translated later to a programming language. Pseudo code is the intermediary between algorithm and program

17 **Give the differences between recursion and iteration.** BTL1

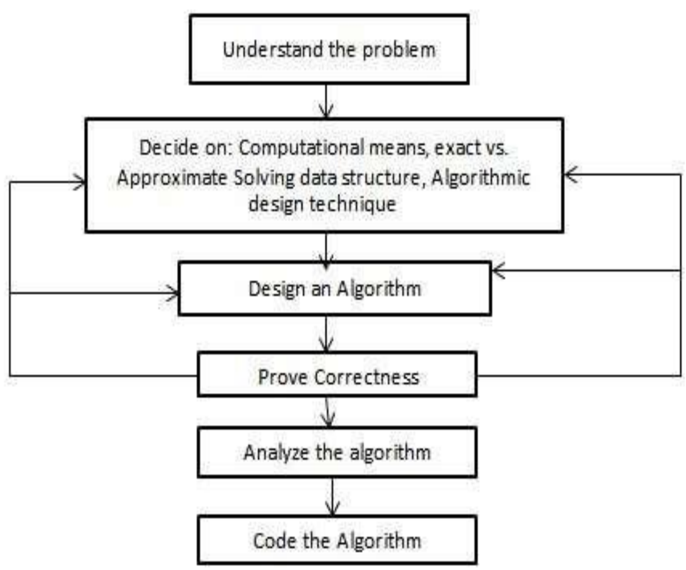
Recursion	Iteration
Function calls itself until the base condition is reached.	Repetition of process until the condition fails.
Only base condition (terminating condition) is specified.	It involves four steps: initialization, condition, execution and updation.
It keeps our code short and simple.	Iterative approach makes our code longer.
It is slower than iteration due to overhead of maintaining stack.	Iteration is faster.
It takes more memory than iteration due to overhead of maintaining stack.	Iteration takes less memory.

18 **What are advantages and disadvantages of recursion?** BTL1

Advantages

- ✓ Recursive functions make the code look clean and elegant.
- ✓ A complex task can be broken down into simpler sub-problems using recursion.

	✓ Sequence generation is easier with recursion than using some nested iteration. **Disadvantages** ✓ Sometimes the logic behind recursion is hard to follow through. ✓ Recursive calls are expensive (inefficient) as they take up a lot of memory and time. Recursive functions are hard to debug.
19	**What is algorithmic problem solving?** BTL1 Solving the problem that requires the formulation of an algorithm for their solution is called algorithmic problem solving.
20	**What is Pseudocode?** BTL2 Pseudocode is a compact and informal high-level description of a program using the conventions of a programming language, but intended more for humans. Pseudocode does not contain programming level details like declaration of variables, looping syntax.
21	**List out the limitations of Flowchart.** BTL2 ✓ It is not easy to draw flow chart for some complex logic ✓ Alteration and modifications are not easily done. ✓ Reproduction or reuse of flowchart are very difficult. ✓ Cost is very high.
22	**Write an algorithm to accept two numbers, compute the sum and print the result (Jan 2018)** BTL2 ✓ Start ✓ Read the two numbers a and b ✓ Calculate sum=a + b ✓ Display the sum ✓ Stop
23	**Write python program to find simple interest.** BTL3 **p=10000** **n=10** **r=5** **Si=(p*r*n)/100**
24	**What is Data?** BTL2 Data is the value given to the program upon which the operation can be done
25	**Write python program to get input from the user and print.** **A=input("Enter a number")** **Print (A)**
PART * B	
1	**What are the building blocks of an algorithm? Explain in detail. (16M)** BTL3 **Answer: Page :1.19 - 1.24 – Dr. Ramesh Babu** The building blocks of algorithm are (2M) ✓ Statements – the instructions in the code ✓ State - the state of the variable ✓ Control flow – flow of the program ✓ Functions - a block of code that performs a specific task Statements: There are 3 types of statement (5M) There are 3 types of statement ✓ Input/Output Statement

	✓ Assignment Statement ✓ Control Statement State: There are 3 types of state (3M) ✓ Initial state ✓ Current state ✓ Final state Control flow: (2M) ✓ if ✓ if – else ✓ switch Repetition (2M) ✓ while ✓ for Functions: (2M) A function is a block of organized reusable code that is used to perform a single action.
2	**Explain Algorithmic problem solving in detail.(16M)** BTL3 **Answer:Page:1.11 - 1.16 – Dr. Ramesh Babu** Steps – Explain each steps of the problem solving (16M) 
3	**Describe pseudo code with its guidelines.(16M)** BTL3 **Answer: Page:1.25 - 1.27 – Dr. Ramesh Babu** Pseudocode is an informal language used by programmer for human understanding rather than machine understanding. (3M) ✓ Guidelines - Pseudo Code (3M) ✓ Write one statement per line (2M) ✓ Capitalize Initial Keywords (2M)

	✓ Indent to show hierarchy (2M) ✓ End Multiline Structure (2M) ✓ Keep statements language independent (2M)
4	**What is flowchart? Explain in detail (16M)**BTL3 **Answer: Page:1.27 - 1.38 – Dr. Ramesh Babu** A flowchart is a pictorial representation of the algorithm defined in a sequence of steps and decisions needed to perform a process. (3M) Aim - flowchart (4M) ✓ Program preparation can be simplified using the flowchart ✓ Flowchart are easier to understand at a glance. ✓ Flowchart are easy to analyze and compare various methods ✓ Flowchart assist in reviewing and debugging of a program ✓ Flowchart provide effective programming documentation Symbols - flowchart (5M**)** Structure in Flowchart (4M) ✓ Sequence Structure ✓ Selection structure ✓ Loop structure
5	**Write an algorithm and give the flowchart to find the net salary of an employee. (16M)** BTL1 **Answer: Page:1.59 –1.60 Dr. Ramesh Babu** Algorithm (5M) Step 1: Start Step 2 : Read the basic salary Step 3 : IF the basic is greater than or equal to 4000 ELSE Goto Step 4 Step 3.1 : DA= 0.32 * basic (Dearness Allowance) Step 3,2 : HRA = 0.15 * basic (House Rent Allowance) Step 3.3 : CCA = 325 (City Compensatory Allowance) Step 3.4 : Net Salary basic + DA HRA + CCA Step 4 : Print the Net Salary Step 5 : Stop Flowchart (8M) Explanation (3M)

6	**Write the program to Guess an integer between 0 to 100. (16M)** BTL1
	Answer: Page:1.59- 1.60 – Dr. Ramesh Babu
	import random (13M)
	randomNumber = random.randrange(0,100)
	print("Random number has been generated")
	guessed = False
	while guessed==False:
	userInput = int(input("Your guess pleas: "))
	if userInput==randomNumber:
	guessed = True

	print("Well done!")
	elif userInput>100:
	print("Our guess range is between 0 and 100, please try a bit lower")
	elif userInput<0:
	print("Our guess range is between 0 and 100, please try a bit higher")
	elif userInput>randomNumber:
	print("Try one more time, a bit lower")
	elif userInput < randomNumber:
	print("Try one more time, a bit higher")
	print("End of program")
	Explanation (3M)

7	**Write an algorithm to insert a card in a list of sorted cards. (16M)** BTL1 **Answer: Page:1.76-1.77 – Dr. Ramesh Babu** Algorithm: (13M) Step 1: Start Step 2: Declare the variables N, List[],I and X Step 3: READ Number of element in sorted list as N Step 4: SET i=0 Step 5: IF i<N THEN go to step 6 ELSE go to step 9 Step 6: READ Sorted list element as List[i] Step 7: i=i+1 Step 8: go to step 5 Step 9: READ Element to be insert as X Step 10: SET i=N-1 Step 11: IF i>0 AND X<List[i] THEN go to step 12 ELSE go to step 15 Step 13: i=i-1 Step 14: go to step 11 Step 15: List[i+1]=X Step 16: Stop Explanation (3M)
8	**Write an algorithm to find the minimum number in a list. (16M)**BTL4 **Answer: Page:1.75-1.76 – Dr. Ramesh Babu** ✓ Algorithm (5M) ✓ Pseudocode (3M) ✓ Flowchart (5M) ✓ Explanation (3M)

9	**Illustrate the Tower of Hanoi (16M) (Jan -2018)** BTL4
	Answer:Page:1.83-1.85 – Dr. Ramesh Babu
	✓ Algorithm (3M)
	def TowerOfHanoi(n , from_rod, to_rod, aux_rod):
	if n == 1:
	print "Move disk 1 from rod",from_rod,"to rod",to_rod
	return

	TowerOfHanoi(n-1, from_rod, aux_rod, to_rod) print "Move disk",n,"from rod",from_rod,"to rod",to_rod TowerOfHanoi(n-1, aux_rod, to_rod, from_rod) n = 4 TowerOfHanoi(n, \'A\', \'C\', \'B\') ✓ Diagram (5M) ✓ Flowchart (5M) ✓ Explanation (3M)

UNIT II - DATA, EXPRESSIONS, STATEMENTS	
Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.	
PART * A	
Q.No.	**Questions**
1.	**What is meant by interpreter?** BTL1 An interpreter is a computer program that executes instructions written in a programming language. It can either execute the source code directly or translate the source code in a first step into a more efficient representation and executes this code.
2	**How will you invoke the python interpreter?** BTL1 The Python interpreter can be invoked by typing the command "python" without any parameter followed by the "return" key at the shell prompt.
3	**What is meant by interactive mode of the interpreter?** BTL1 Interactive mode is a command line shell which gives immediate feedback for each statement, while running previously fed statements in active memory. As new lines are fed into the interpreter, the fed program is evaluated both in part and in whole.
4	**Write a snippet to display “Hello World” in python interpreter.** BTL2 In script mode: >>>print -"Hello World" Hello World In Interactive Mode : >>> "Hello World" 'Hello World'
5	**What is a value? What are the different types of values?** BTL1 A value is one of the fundamental things – like a letter or a number – that a program manipulates. Its types are: integer, float, Boolean, strings and lists.
6	**Define a variable and write down the rules for naming a variable** BTL1 A name that refers to a value is a variable. Variable names can be arbitrarily long. They can contain both letters and numbers, but they have to begin with a letter. It is legal to use uppercase letters, but it is good to begin variable names with a lowercase letter.
7	**Define keyword and enumerate some of the keywords in Python** BTL1 A Keyword is a reserved word that is used by the compiler to parse a program. Keywords cannot be used as variable names. Some of the keywords used in python are: and, del, from, not, while, is, continue.
8	**Define statement and what are its types** BTL1 A Statement is an instruction that the Python interpreter can execute. There are two types of statements: print and assignment statement.

9	**What do you meant by an assignment statement?** BTL1 An assignment statement creates new variables and gives them values: Eg 1: Message = 'And now for something completely different' Eg 2: n = 17
10	**What is tuple? How literals of type are written? Give an example (Jan 2018)** BTL1 ✓ Tuple is a sequence of immutable Python objects. ✓ Tuples are sequences, like lists. ✓ The differences between tuples and lists are, the tuples cannot be changed unlike lists and tuples use parentheses, whereas lists use square brackets. ✓ Creating a tuple is as simple as putting different comma-separated values. Comma-separated values between parentheses can also be used. ✓ Example: tup1 = ('physics', 'chemistry', 1997, 2000);
11	**What is an expression?** BTL1 An expression is a combination of values, variables, and operators. An expression is evaluated using assignment operator. Examples: Y=x + 17
12	**What do you mean by an operand and an operator? Illustrate your answer with relevant example** BTL1 An operator is a symbol that specifies an operation to be performed on the operands. The data items that an operator acts upon are called operands. The operators +, -, *, / and ** perform addition, subtraction, multiplication, division and exponentiation. Example: 20+32 In this example, 20 and 32 are operands and + is an operator.
13	**What is the order in which operations are evaluated? Give the order of precedence** BTL1 The set of rules that govern the order in which expressions involving multiple operators and operands are evaluated is known as rule of precedence. ✓ Parentheses have the highest precedence followed by exponentiation ✓ Multiplication and division have the next highest precedence followed by addition and subtraction.
14	**Illustrate the use of * and + operators in string with example.** BTL2 The * operator performs repetition on strings and the + operator performs concatenation on strings. Output: Example: >>>Hello*3 HelloHelloHello >>>‘Hello+World‘ HelloWorld
15	**What is the symbol for comment?** BTL1 # is the symbol for comments in Python. Example: # compute the percentage of the hour that has elapsed.

16	**What is function call?** BTL1 A function is a named sequence of statements that performs a computation. When we define a function, we specify the name and the sequence of statements. Later, we can –call‖ the function by its name called as function call.

17	**Identify the parts of a function in the given example.** BTL1
	>>> betty = type("32")
	>>> print betty
	The name of the function is *type*, and it displays the type of a value or variable. The value or variable, which is called the argument of the function, is enclosed in parentheses. The argument is *32*. The function returns the result called return value. The return value is stored in *betty*.

18	**Does python supports Object oriented concept?** BTL1 Yes python support object oriented concepts like class, object, constructor, polymorphism
19	**What is mean by identifiers?** BTL1 Identifiers are function name, variable name, class name
20	**What is scope of variable?** BTL1 Variable has scope i.e up to which line it can be used. Its depends where your declared. Variables declared inside the functions are local variable, its scope is only inside the function, not outside the function
21	**What is type conversion in python?** BTL1 Process of converting one data type into the other data type is called type convertions Eg: a=10 Float(a)
22	**What is expression in python?** BTL1 An line which has any operator in a program is called expression Eg: 10+20

23	**Write a python program to find a number is even or odd** BTL2
	num = int(input("Enter a number: "))
	if (num % 2) == 0:
	  print("{0} is Even".format(num))
	else:
	  print("{0} is Odd".format(num))

24	**Write a python program to find a factorial of a number** BTL2
	num = float(input("Enter a number: "))
	if num > 0:
	  print("Positive number")
	elif num == 0:
	  print("Zero")
	else:
	  print("Negative number")

25	**Write a python program to find a GREATEST 3 of a number** BTL2 num1 = 10 num2 = 14

<table>
<tr><td></td><td>num3 = 12num1 = float(input("Enter first number: "))
#num2 = float(input("Enter second number: "))
#num3 = float(input("Enter third number: "))

if (num1 >= num2) and (num1 >= num3):
  largest = num1
elif (num2 >= num1) and (num2 >= num3):
  largest = num2
else:
  largest = num3

print("The largest number between",num1,",",num2,"and",num3,"is",largest)</td></tr>
<tr><td></td><td>PART * B</td></tr>
<tr><td>1.</td><td>What is the role of an interpreter? Give a detailed note on python interpreter and interactive mode of operation.(16M) BTL3
Answer:Page:2.24- 2.26 Dr.V.Ramesh
Interpreter- processes the program
(6M)
Two Types of modes
(10M)
Interactive Mode – displays the result immediately
>>>2+2
4
Script mode-store and execute the program</td></tr>
<tr><td>2</td><td>List down the rules for naming the variable with example. (16M) BTL3
Answer:Page:2.36-Dr.V.Ramesh
Rules for writing the variable
(10M)
✓ Variables names must start with a letter or an underscore, such as:
_underscore
underscore_
✓ The remainder of your variable name may consist of letters, numbers and underscores.
password1
n00b
un_der_scores
✓ Names are case sensitive.
case_sensitive, CASE_SENSITIVE, and Case_Sensitive are each a different variable.
Example Program
(6M)
>>> a_var=10
>>>print a_var
10</td></tr>
</table>

<table>
<tr><td>3</td><td>
What is operator? Explain operators in Python. (Jan 2018) (16M) BTL2
Answer:Page:2.65 Dr.V.Ramesh
Operator
✓ Performs an operation on operands
✓ >>>3+3
(3M)
Types
(10M)
✓ Arithmetic Operators.
✓ Comparison (Relational) Operators.
✓ Assignment Operators.
✓ Logical Operators.
✓ Bitwise Operators.
✓ Membership Operators.
✓ Identity Operators.
Example Program for each operator
(3M)
>>>2+3
5
>>>2>3
False
>>>a=10
>>>print a
10
>>> 10 in [10,20,30]
True
</td></tr>
<tr><td>4</td><td>
Outline the operator precedence in python (Jan 2018) (16M) BTL3
Answer: Page: 2.79 Dr.V.Ramesh
Operator Precedence
(3M)
-order of execution
Tabulation with rules
(10M)
<table>
<tr><th>Precedence</th><th>Operators</th></tr>
<tr><td>High</td><td>*/ %</td></tr>
<tr><td>Low</td><td>+-</td></tr>
</table>
1. Parentheses (simplify inside 'em)
2. Exponents
3. Multiplication and Division (from left to right)
4. Addition and Subtraction (from left to right)
Explanation
(3M)
</td></tr>
<tr><td>5</td><td>
(i) Write a python program to exchange the value of two variable (ii) Write a python program using function to find the sum of first „n" even numbers and print the result (Jan 2018) (16 M) BTL2
</td></tr>
</table>

	Answer:(i) Page: SP.5-Dr.V.Ramesh (ii) Page: SP.10-DR.V.Ramesh
	(i) Program:
	(8M)
	`x = 5`
	`y = 10`
	`# create a temporary variable and swap the values`
	`temp = x`
	`x = y`
	`y = temp`
	`print('The value of x after swapping: {}'.format(x))`
	`print('The value of y after swapping: {}'.format(y))`
	(ii) Program:
	`def evensum(n):`
	(8M)
	`  curr = 2`
	`  sum = 0`
	`  i = 1`
	
	`  # sum of first n even numbers`
	`  while i <= n:`
	`    sum += curr`
	`        # next even number`
	`    curr += 2`
	`    i = i + 1`
	`  return sum`
	`# Driver Code`
	`n = 20`
	`print("sum of first ", n, "even number is: ", evensum(n))`

7	**(i)Write a Python program to check whether a given year is a leap year or not (ii) Write a Python program to convert celsius to Fahrenheit? (iii) Write a Python program to find the distance between two points? (16M)** BTL3
	Answer: (i)Page:1.64-Dr.V.Ramesh (ii)Page:1.67-Dr.V.Ramesh (iii)Answer:Page:2.50-DR.V.Ramesh
	
	(i)Program:
	(8M)
	`year = int(input("Enter a year"))`
	`if (year % 4) == 0:`
	`  if (year % 100) == 0:`
	`    if (year % 400) == 0:`
	`      print("%d is a leap year‖% year)`
	`    else:`
	`      print("%d is not a leap year"%d)`
	`  else:`
	`    print("%d is a leap year‖% year)`
	`else:`

	print("%d is not a leap year‖% year)
	
	(i)Program:
	(4M)
	# Python Program to convert temperature in celsius to fahrenheit
	# change this value for a different result celsius = 37.5
	# calculate fahrenheit
	fahrenheit = (celsius * 1.8) + 32
	print('%0.1f degree Celsius is equal to %0.1f degree Fahrenheit' %(celsius, fahrenheit))
	
	(iii)Program
	(4M)
	import math
	p1 = [4, 0]
	p2 = [6, 6]
	distance = math.sqrt(((p1[0]-p2[0])**2)+((p1[1]- p2[1])**2))
	print(distance)

9	**Write a program to circulate the value of n variable?(16M)**BTL3
	Answer:Page:2.98-DR.V.Ramesh
	Program
	(12M)
	# Circulate the values of n variables
	
	no_of_terms = int(input("Enter number of values : "))
	list1 = []
	for val in range(0,no_of_terms,1):
	    ele = int(input("Enter integer : "))
	    list1.append(ele)
	
	print("Circulating the elements of list ", list1)
	
	for val in range(0,no_of_terms,1):
	    ele = list1.pop(0)
	    list1.append(ele)
	    print(list1)
	Output
	(2M)
	Explanation
	(2M)

10	**What is function? How it is defined? Explain the flow of execution(16M)** BTL3 **Answer: Page:3.28-DR.V.Ramesh** ✓ -Group of statement (6M)

	✓ -should be called ✓ -executes when called ✓ Syntax of Function (6M) ✓ def functionname(parameters): ✓ ///statements ✓ Example (4M)

11	**Explain Modules in python(16M)** BTL3
	Answer:Page:5.44-DR.V.Ramesh
	✓ Group of functions, variable and classes
	(2M)
	✓ Syntax of Function
	(2M)
	def functionname(parameters):
	///statements
	Example
	(3M)
	def add(a,b):
	Print (a+b)
	Import module
	(4M)
	import modulename
	Example
	(5M)

UNIT III – ALGORITHMIC PROBLEM SOLVING
Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local andGlobal scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.
PART * A

Q.No	Questions
1	**What are the benefits of modulus operator?** BTL1 The modulus operator is more useful than it seems. For example, you can check whether one number is divisible by another. If x % y is zero, then x is divisible by y. Also, you can extract the right-most digit or digits from a number. For example, x % 10yields the right-most digit of x (in base 10). Similarly x % 100 yields the last two digits.
2	**List operators supported in python.**BTL2 Arithmetic Operators. Relational Operators. Assignment Operators. Logical Operators. Membership Operators. Identity Operators. Bitwise Operators.
3	**Does Array available in python?** BTL3 Array is not exist in python. But in a list if it has same type of element then it is called Array. Eg: array=[1,2,3,5] char_array=[_g‘,‘o‘,‘o‘,‘d‘]

4	**Write the syntax of if and if-else statements.** BTL1
	if:
	Statement
	if:
	Statement
	elif:
	Statement

5	**Define Iteration.** BTL1 Computers are often used to automate repetitive tasks. Repeating identical or similar tasks without making errors is something that computers do well and people do poorly. In a computer program, repetition is also called **iteration**.

6	**Write the syntax for while statement.** BTL2 While loop is used to execute number of statements or body till the condition passed in while is true. Once the condition is false, the control will come out of the loop. Here, body will execute multiple times till the expression passed is true. The Body may be a single statement or multiple statement. **Syntax:** while <expression>: statements
7	**Define for loop with syntax** BTL1 The for loop processes each item in a sequence, so it is used with Python‘s sequence data types – strings, lists, and tuples .Each item in turn is (re-)assigned to the loop variable, and the body of the loop is executed. The general form of a for loop is: It has a header terminated by a colon (☺ and a body consisting of a sequence of one or more statements indented the same amount from the header. **For** LOOP_VARIABLE **in** SEQUENCE:
8	**Define break statement.** BTL1 Break statement is a jump statement that is used to pass the control to the end of the loop. When break statement is applied the control points to the line following the body of the loop hence applying break statement makes the loop to terminate and controls goes to next line pointing after loop body.
9	**Define continue statement with syntax.** BTL1 Continue Statement is a jump statement that is used to skip the present iteration and forces next iteration of loop to take place. It can be used in while as well as for loop statements. While<condition>: Stetement1 Statement2 If<condition>: Continue Statement3 Statement4
10	**Define Pass Statement.** BTL1 When you do not want any code to execute, pass Statement is used. It is same as the name refers to. It just makes the control to pass by without executing any code. If we want to bypass any code pass statement can be used
11	**Define Fruitful function.** BTL1 Fruitful functions are those that return a value. Such as the math functions, yield results; for lack of a better name, I call them **fruitful functions**.
12	**What are the types of variables based on scope?** BTL2 There are two types of variables based on Scope: ✓ Local Variable.

	✓ Global Variable
13	**Explain local variable and global variable** BTL3 Variables declared **inside a function body** is known as Local Variable. These have a local access thus these variables cannot be accessed outside the function body in which they are declared. Variable defined **outside the function** is called Global Variable. Global variable is accessed all over program thus global variable have widest accessibility.
14	**What is Function composition with an example?** BTL2 Function composition is a way of combining functions such that the result of each function is passed as the argument of the next function. For example, the composition of two functions f and g is denoted f(g(x)).x is the argument of g, The result of g is passed as the argument of f .The result of the composition is the result of f..
15	**What is known as Infinite Recursion?** BTL3 If a recursion never reaches a base case, it goes on making recursive calls forever, and the program never terminates. This is known as **infinite recursion**, it is generally not a good idea. Here is a minimal program with an infinite recursion:
16	**Define Strings?** BTL1 A string is a sequence of characters. You can access the characters one at a time with the bracket operator []. String pythons are immutable (cannot be modified). In Python, Strings are stored as individual characters in a contiguous memory location. The benefit of using String is that it can be accessed from both the directions in forward and backward. Both forward as well as backward indexing are provided using Strings in Python. ✓ Forward indexing starts with 0,1,2,3,.... ✓ Backward indexing starts with -1,-2,-3,-4,....
17	**What are the types of operators supported by string?** BTL1 ✓ Basic Operators. ✓ Membership Operators. ✓ Relational Operators.

18	**Write a python program to accept two number and find greatest between them and print result (Jan 2018)** BTL 3
	a=input(―Enter a number‖)
	b=input(―Enter a number‖)
	if a>b:
	    print ―a is greater‖
	else:
	    print ―b is greater‖

19	**What is known as string slices?** BTL 1 A segment of a string is called a **slice**. String slice can be defined as substring which is the part of string. Therefore further substring can be obtained from a string. There can be many forms to slice a string. As string can be accessed or indexed from both the direction and hence string can also be sliced from both the direction that is left and right.
20	**Differentiate for loop and while loop.** For loops works only with sequence whereas While loop works with numbers
21	**Point out the uses of default arguments in python.** Default arguments is used when the number of arguments to be passed is not passed properly
22	**Justify the effects of slicing operations on an array** Slicing operator is used to access the substring or sub sequence in any sequence and string
23	**How to access the elements of an array using index?** Str=‖Welcome‖ >>>Str[0] w
24	**Explain about break statement with an example.** For I in python: if I==‘h‘: break print I
25	**Name the type of Boolean operators.** 1. True 2. False
	Part * B
1	**(i)What are Conditional execution? Explain in detail. (ii) Define Iteration. Briefly discuss looping statements in detail (Jan 2018) (16M)** BTL1 **Answer: (i)Page:2.95-DR.V.Ramesh (ii) Page:2.102-Dr.V.Ramesh** (i)Condition true - execute (2M) Types of conditional execution with example program for each (6M) ✓ If ✓ If …else ✓ If …elif.. else **(ii)** Repeated execution up to some condition true (2M)

<table>
<tr><td></td><td>Types of iteration with example program for each
(6M)
✓ For
✓ While
✓ While … else
✓ Break
Continue</td></tr>
<tr><td>2</td><td>(i)What is meant by Fruitful functions? Explain with suitable examples (ii) Define recursion. Discuss its usage in programming (16M) BTL3
Answer: (i) Page:3.19-Dr.V.Ramesh (ii) Page:3.47-DR.V.Ramesh
(i)
✓ function returns value
✓ called to execute
Syntax:
(3M)
def functionname(a,b):
    return (a+b)
Example:
(3M)
def add(a,b):
    return(a+b)

(ii)
✓ functions calls itself
(2M)
✓ performs like loops
✓ Syntax
(2M)
def fname(n):
  if n == 1:
    return 1
  else:
    return n * fname(n-1)

Example:
(6M)
def name(n):
  if n == 1:
    return 1
  else:
    return n * name(n-1)</td></tr>
<tr><td></td><td>Discuss in detail about the string functions and methods. (16M) BTL 4
Answer:Page:3.65-DR.V.Ramesh
List of string functions with example</td></tr>
</table>

3	(16M) ✓ strrev() ✓ toupper() ✓ tolower() ✓ isdigit() ✓ isalpha() ✓ capitalize() ✓ find() ✓ split()

4	**(i) Write a program to find square root of a number. (ii) Write a Python Program to find the factorial of a number with and without recursion. (16M)** BTL4
	
	Answer:Page:SP 28 -DR.V.Ramesh, Page:3.49-DR.V.Ramesh
	
	(i) Program
	(6M)
	number = int(input(―Enter a number to find the square root : ‖))
	if number < 0 :
	Print (―Please enter a valid number.‖)
	else :
	sq_root = number ** 0.5
	print(‖Square root of {} is {} ‖.format(number,sq_root))
	
	(ii) Program
	
	Without recursion
	(6M)
	n=int(input(―Enter number:‖))
	fact=1
	while(n>0):
	fact=fact*n
	n=n-1
	print(‖Factorial of the number is: ‖)
	print(fact)
	
	With recursion
	(4M)
	def recur factorial(n):
	‖‖‖Function to return the factorial
	of a number using recursion‖‖‖
	if n == 1:
	return n

	else: return n*recur factorial(n-1)

5	**Write a python program to print N Fibonacci series (Jan 2018) (8M)** BTL6
	Answer:Page: 3.50-DR.V.Ramesh
	Fibonacci Series using Recursion
	def fib(int n):
	if (n <= 1):
	return n;
	return fib(n-1) + fib(n-2);
	n = 9;
	print(fib(n));

6	**Write a program to find sum of array and exponentiation[16M]** BTL6
	Answer:Page:3.51-DR.V.Ramesh
	Sum of array
	(6M)
	a = [6,7,29,4,6,7,8,9]
	acc = 0
	for i in a:
	acc += i
	print acc
	
	Exponentiation
	(10M)
	def power(base,exp):
	if(exp==1):
	return(base)
	if(exp!=1):
	return(base*power(base,exp-1))
	base=int(input(―Enter base: ―))
	exp=int(input(―Enter exponential value: ―))
	print(―Result:‖,power(base,exp))

7	**Explain linear search with example (Jan 2018) (16M)** BTL6 **Answer:Page:4.48 DR.V.Ramesh** Diagram representation (8M) Program (8M)
8	**Explain binary search with example(16M)** BTL6 **Answer:Page:4.50-DR.V.Ramesh** Diagram representation (8M) Program (8M)

	UNIT – IV - LISTS, TUPLES, DICTIONARIES
	Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters ;Tuples: tuple assignment, tuple as return value ;Dictionaries: operations and methods ;Advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram
	PART * A
1	**Define list.** BTL1 A list is a ordered set of values. It is a sequence or collection of values, these values can be any data type. The values in a list are called elements or sometimes items.
2	**What are the list operations?** BTL1 ✓ Adding list ✓ Replicating list ✓ Slicing list ✓ Updating elements in the list ✓ Deleting element from the list ✓ Traversing the list or list looping
3	**What are the different ways to create a list?** BTL1 ✓ The simplest is to enclose the elements in square brackets ([ ]): ✓ We can assign list values to variables

4	**Illustrate negative indexing in list with an example.** BTL1
	Python allows negative indexing for its sequences. The index of -1 refers to the last item, -2 to the second last item and so on.
	A negative index accesses elements from the end of the list counting backwards.
	Eg:
	my_list = ['p','r','o','b','e']
	
	# Output: e
	print(my_list[-1])
	e

5	**List out the methods that are available with list object in python programming.** BTL1 ✓ index(object) ✓ count(object) ✓ pop()/pop(index) ✓ insert(index,object) ✓ extend(sequence) ✓ remove(object) ✓ reverse() ✓ sort() ✓ copy()
6	**Show the membership operators used in list.** BTL1 Python's membership operators test for membership in a sequence, such as strings, lists or tuples. There are two membership operators.

- ✓ In
- ✓ not in

7 **Define Python tuple.** BTL1

A tuple is a sequence of immutable Python objects. Tuples are sequences, just like lists. The differences between tuples and lists are, the tuples cannot be changed unlike lists and tuples use parentheses, whereas lists use square brackets

8 **What are the advantages of tuple over list**? BTL1

- ✓ We generally use tuple for heterogeneous (different) datatypes and list for homogeneous (similar) datatypes.
- ✓ Since tuple are immutable, iterating through tuple is faster than with list. So there is a slight performance boost.
- ✓ Tuples that contain immutable elements can be used as key for a dictionary. With list, this is not possible.
- ✓ If you have data that doesn't change, implementing it as tuple will guarantee that it remains write-protected.

9 **Classify the Python accessing Elements in a tuples**? BTL1

- ✓ Indexing
- ✓ Negative Indexing
- ✓ Slicing

10 **Point out the methods used in tuples**? BTL1

count(*x*)	Return the number of items that is equal to *x*
index(*x*)	Return index of first item that is equal to *x*

11 **How a tuple is iterated? Explain with an example**? BTL1

Using a for loop we can iterate though each item in a tuple.

Eg:

```
for name in ('John','Kate'):
    print("Hello",name)
```

output:

```
Hello John
Hello Kate
```

12 **Explain how tuples are used as return values?** BTL1

Functions can return tuples as return values a function (which can only return a single value), can create a single tuple holding multiple elements.

Eg:

```
def circleInfo(r):
    """ Return (circumference, area) of a circle of radius r """
    c = 2 * 3.14159 * r
    a = 3.14159 * r * r
    return (c, a)
print(circleInfo(10))
```

output:

```
(62.8318, 314.159)
```

13 **Define dictionary with an example?** BTL1

	A dictionary is an unordered set of key and value pair. It is one of the compound data types of python. A dictionary contains a collection of indices, which are called **keys**, and a collection of values. Each key is associated with a single value Eg: data={100:'Ravi' ,101:'Vijay' ,102:'Rahul'} print (data) Output: {100: 'Ravi', 101: 'Vijay', 102: 'Rahul'}
14	**What are the properties of dictionary keys?** BTL1 ✓ More than one entry per key not allowed ✓ Keys must be immutable
15	**Can you use the addition assignment operator, +=, with two lists. What is the result**? BTL1 'pythonic' way to do list concatenation

16	**Perform the bubble sort on the elements 23,78,45,8,32,56** BTL1
	def bubbleSort(alist):
	    for passnum in range(len(alist)-1,0,-1):
	        for i in range(passnum):
	            if alist[i]>alist[i+1]:
	                temp = alist[i]
	                alist[i] = alist[i+1]
	                alist[i+1] = temp
	
	alist = [54,26,93,17,77,31,44,55,20]
	bubbleSort(alist)
	print(alist)
	output:
	[14, 21, 27, 41, 43, 45, 46, 57, 70]

17	**What is empty? list how its created?** BTL1 **The which has no element is called empty list.** **L1=[]**
18	**What is list mutability?** BTL1 List items can be changed using its index values it is called list mutability
19	**What is list cloning?** BTL1 List cloning is a process of copying data of one list to another list. There are two types of cloning Deep copy and shallow copy
20	**What is list aliasing?** In list aliasing, items of one list will be copied to other list. Change in one list will affect the other
21	**Describe list comprehension.** h_letters = [letter for letter in 'human'] print(h_letters)
22	**Print list items in reverse** h_letters =‖Welcome‖ print(h_letters.reverse())
23	**What is the use of copy method in dictionary?** Creates a copy of dictionary in another name

	original = {1:'one', 2:'two'} new = original.copy() print('Orignal: ', original) print('New: ', new)

24	**How to delete or remove elements from a dictionary?**
	squares = {1:1, 2:4, 3:9, 4:16, 5:25}
	# Output: 16
	print(squares.pop(4))

25	**Difference in Using copy() method, and = Operator to Copy Dictionaries** Using =,Here, when the new dictionary is cleared, the original dictionary is also cleared Using copy(), Here, when the new dictionary is cleared, the original dictionary remains unchanged
	PART * B
1	**What is python List ?Describe the List usage with suitable examples(16M)** BTL2 **Answer:Page:4.3-4.5 -DR.V.Ramesh** ✓ Definition (3M) A list is a ordered set of values. It is a sequence or collection of values, these values can be any data type. The values in a list are called elements or sometimes items. ✓ Creating a new List (3M) ✓ Assessing List elements (5M) ✓ List operations (5M)

2	**Write a program to illustrate the heterogeneous list.(16M)** BTL2
	Answer:Page:4.8-DR.V.Ramesh
	Defintion: Lists in Python can contain elements of different types (2M)
	Eg: sample_ages = [10, 12.5, 'Unknown'] (2M)
	Program: (10M)
	numList = [2000, 2003, 2005, 2006]
	stringList = ["Essential", "Python", "Code"]
	mixedList = [1, 2, "three", 4]
	subList = ["A", "B", ["C", 2006]]
	listList = [numList, stringList, mixedList, subList]
	
	for x in listList:
	    for y in x:
	   for y in x:
	        if isinstance(y, int):
	            print(y + 1)
	        if isinstance(y, str):
	            print("String:" + y)
	Output (2M)

3	**Describe the following**

Creating the List ,Accessing values in the Lists ,Updating the Lists, Deleting the list Elements (16 M) (BTL2)

Answer:Page:4.10-4.13-DR.V.Ramesh

- ✓ Creating theList (3M)

<list_variable>= [<value 1>, <value 2>,…….<value n>]

- ✓ Accessing values in theLists (5M)
- ✓ Updating theLists (4M)
- ✓ Deleting the listElements **(**4M)

del <list_name>[starting index: ending index]

4

Write a Program for Illustrating all the list operations(16M)(BTL3)

Answer:Page:4.3-DR.V.Ramesh

Program (10M)

```
print ('list operations')
list1=[10,20]
list2=[30,40]
list3=list1+list2
print ('concatenating list',list3)
print ('Replicating list',list1*4 )
list4=[1,2,4,5,7]
print ('list slicing',list1[0:2])
print ('list slicing',list4[4])
list4[2]=3
print ('updated list is',list4)

del list4[3]

print ('list after deletion is',list4)

for friend in ['Margot', 'Kathryn', 'Prisila']:

invitation = "Hi " + friend + ". Please come to my party on Saturday!"

 print('traversing the list‘, invitation)
```

output (6 M)

```
list operations
concatenating list [10, 20, 30, 40]
Replicating list [10, 20, 10, 20, 10, 20, 10, 20]
list slicing [10, 20]
list slicing 7
updated list is [1, 2, 3, 5, 7]
list after deletion is [1, 2, 3, 7]
traversing the list Hi Margot. Please come to my party on Saturday!
traversing the list Hi Kathryn. Please come to my party on Saturday!
```

	traversing the list Hi Prisila. Please come to my party on Saturday!
5	**Illustrate List Comprehension with suitable examples(16M)** (BTL2) **Answer:Page:4.22-DR.V.Ramesh** Definition (5M) Python includes a more advanced and powerful operation known as a list comprehension expression. List comprehensions are coded in square brackets and are composed of an expression and a looping construct that share a variable name The output of list comprehension is List Example (8M) Explanation (3M)
6	**Discuss the Python List Methods with examples(16M)** (BTL2) **Answer:Page:4.19-DR.V.Ramesh** ✓ Introduction (4M) ✓ index(object) (2M) ✓ count(object) (2M) ✓ pop()/pop(index) (2M) ✓ insert(index,object) (2M) ✓ remove(object) (2M) ✓ reverse() (2M)
7	**What is a Python Tuple? What are the Advantages of Tuple over List?(16M)** (BTL2) **Answer:Page:4.59-DR.V.Ramesh** ✓ Definition: A tuple is another sequence data type that is similar to the list. A tuple is a sequence of immutable Python objects. A tuple consists of a number of values separated by commas. Unlike lists, however, tuples are enclosed within parentheses. (3M) ✓ Advantages of Tuple over List (4M) ✓ Tuples are immutable‖. Explain with Examples. (9M)
8	**Explain the basic Tuple Operations with examples (16M)** (BTL2) **Answer:Page:4.66-4.68-DR.V.Ramesh** ✓ Adding Tuple - using + (4M) ✓ Replicating Tuple – using * (4M) ✓ Tuple slicing – using : (4M) ✓ Deleting the complete tuple as a whole - using del (1M) ✓ Explanation (3M)

9	**Create a python program to perform selection sort on the elements (16M)** (BTL2)
	Answer:Page:4.38-DR.V.Ramesh
	def selectionSort(x): (10M)
	for i in range(len(x)-1,0,-1):
	pMax=0
	for j in range(1,i+1):
	if x[j]>x[pMax]:
	pMax = j
	tmp = x[i]
	x[i] = x[pMax]

	x[pMax] = tmp x = [98,26,52,21,67,39,48,99,11] selectionSort(x) print(x) Output (3M) Explanation (3M)

10	**Create a python program to perform insertion sort (16M)**(BTL2)
	Answer:Page:4.36-DR.V.Ramesh
	Def insertionSort(x): (10M)
	for index in range(1,len(x)):
	currentvalue = x[index]
	position = index
	while position>0 and x[position-1]>currentvalue:
	x[position]=x[position-1]
	position = position-1
	x[position]=currentvalue
	x = [98,26,52,21,67,39,48,99,11]
	insertionSort(x)
	print(x)
	Output (3M)
	Program explanation (3M)

11	**Create a python program to perform Merge Sort (16M)** (BTL2)
	Answer:Page:4.44-DR.V.Ramesh
	def mergeSort(x): (10M)
	print("Splitting ",x)
	if len(x)>1
	mid = len(x)//2
	lefthalf = x[:mid]
	righthalf = x[mid:]
	mergeSort(lefthalf)
	mergeSort(righthalf)
	i=0
	j=0
	k=0
	while i <len(lefthalf) and j <len(righthalf):
	if lefthalf[i] <righthalf[j]:
	x[k]=lefthalf[i]
	i=i+1
	else:
	x[k]=righthalf[j]
	j=j+1

	``
	        k=k+1
	    while i <len(lefthalf):
	        x[k]=lefthalf[i]
	        i=i+1
	        k=k+1
	    while j <len(righthalf):
	        x[k]=righthalf[j]
	        j=j+1
	        k=k+1
	print("Merging ",alist)
	``
	Output (3M)
	Program explanation (3M)

<table>
<tr><td colspan="2">

UNIT-V

FILES, MODULES, PACKAGES: Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

</td></tr>
<tr><td>Q.No</td><td>PART * A</td></tr>
<tr><td>1</td><td>What are the types of files that can be handles in python? BTL1
There are two types of files that can be handled in python.
✓ Text files
✓ Binary files</td></tr>
<tr><td>2</td><td>Define text file. BTL1
A test file is a sequence of characters stored on a permanent medium like a hard drive, flash memory or CD-ROM.</td></tr>
<tr><td>3</td><td>What is mode of the file and its types? BTL1
The mode tells the interpreter and developer which way the file will be used.
The modes are:
_r‘ – Read mode
_w‘ – Write mode
_a‘ – Append mode
_r+‘ – Special read and write mode</td></tr>
<tr><td>4</td><td>Define module. BTL1
✓ A module is a file containing Python definitions and statements.
✓ The file name is the module name with the suffix .py appended.
✓ Within a module, the module‘s name (as a string) is available as the value of the global variable_name_.
✓ Modules are used to categorize code in python into smaller part.
✓ A module is a Python object with arbitrarily named attributes that you can bind and reference. Simply, a module is a file consisting of Python code. A module can define functions, classes and variables. A module can also include runnable code.</td></tr>
<tr><td>5</td><td>What are the advantages for using module? BTL2
✓ Reusability
✓ Categorization</td></tr>
<tr><td>6</td><td>Mention the built-in modules in python. BTL1
There are many built-in modules in python.
Some of them are as follows: math, random, threading, collections, os, mailbox, string, time, tkinter, etc.
Each module has a number of built-in functions which can be used to perform various functions.</td></tr>
<tr><td>7</td><td>Define package. BTL1
A package is simply a collection of similar modules, sub packages etc..</td></tr>
<tr><td>8</td><td>What are the steps involved to create and import package? BTL2
✓ Create a directory, say Info
✓ Place different modules inside the directory.</td></tr>
</table>

	✓ Create a file_init_.py ✓ Import the package and use the attributes using package.
9	**How to locate the modules in python?**BTL3 When you import a module, the Python interpreter searches for the module in the following sequences − ✓ The current directory. ✓ If the module isn't found, Python then searches each directory in the shell variable PYTHONPATH. ✓ If all else fails, Python checks the default path. On UNIX, this default path is normally /usr/local/lib/python/. The module search path is stored in the system module sys as the **sys.path** variable. The sys.path variable contains the current directory, PYTHONPATH, and the installation-dependent default.
10	**What are the advantages of files?** BTL2 ✓ When the data is stored in a file, it is stored permanently. ✓ The files in the data can be utilized as and when required. ✓ It is possible to update the data. ✓ Files are highly useful to store huge amount of data.
11	**Write the syntax for write () method and read () method?** BTL1 fileObject.write(string) fileObject.read([count])
12	**Define syntax errors.** BTL1 Syntax errors, also known as parsing errors, are perhaps the most common kind of complaint you get while you are still learning Python. >>> while True print ('Hello Python') Syntax Error: invalid syntax >>>
13	**Mention the order for the search in python module.** BTL2 ✓ The current directory. ✓ PYTHONPATH(an environment variable with a list of directory). ✓ The installation dependent default directory.
14	**Define package.** BTL1 A package is a directory that contains modules. Having a directory of modules allows us to have modules contained within other modules. This allows us to use qualified module names, clarifying the organization of our software
15	**What is Errors?** BTL3 In Python, there are two kinds of errors: syntax errors and exceptions. This post will describe what those errors are. Upcoming posts will show how we can handle those errors
16	**What is syntax error?** BTL3 Let's start with syntax errors, (also known as parsing errors). The parser repeats the offending line and displays an 'arrow' pointing at the earliest point in the line where the error was detected >>> while True print 'Hello world' File "", line 1, in ?

	while True print 'Hello world'
17	**What is exception?** BTL3 Even if a statement or expression is syntactically correct, it may cause an error when an attempt is made to execute it. Errors detected during execution are called exceptions Example of an exception error. >>> 10 * (1/0)
18	**Define Namespaces.** BTL3 Variables are names or identifiers that map to objects. A namespace is a dictionary of variable names/keys and their corresponding objects values. Each function has its own local namespace.
19	**Mention the attributes related to file object.** BTL3 ✓ File.closed ✓ file.mode ✓ file.name ✓ file.softspace
20	**Write a python program to read a file one line at a time** BTL3 **To read one line at a time, use:** fh = open("hello".txt", "r") print fh.readline() **Output:** Python programming is good Thank you
21	**What is Try and Except?** BTL3 If an error is encountered, a try block code execution is stopped and transferred down to the except block. In addition to using an except block after the try block, you can also use the finally block. The code in the finally block will be executed regardless of whether an exception occurs.
22	**How to raise an exception?** BTL3 You can raise an exception in your own program by using the raise exception [, value] statement. Raising an exception breaks current code execution and returns the exception back until it is handled.

23	**List some exception error.** BTL3 ✓ IOError ✓ ImportError ✓ ValueError ✓ KeyboardInterrupt
24	**What is command line argument?** BTL3 Command line arguments are values passed in during execution of a program. These values are passed after the file name.

25	**Write a program to find number of words in a file.** BTL3
	WordCount.py
	
	import sys
	wordcount=0
	for lines in sys.argv:
	    f1=lines.split()
	    wordcount=wordcount+len(f1)
	print 'word count:', str(wordcount-1)

	PART * B
1	**Write a Python program to demonstrate the file I/O operations(16M)** BTL4 **Answer:Page:5.12-DR.V.Ramesh** ✓ Introduction – storage of bits (4M) ✓ Program (6M) ✓ Explanation - open() function – close () funation- working of file need to be explained (6M)
2	**Discuss with suitable examples (i) Close a File. (ii) writing file (Jan 2018) (16M)** BTL4 **Answer:Page:5.5-DR.V.Ramesh** (i) Close a File. ✓ Syntax - close() (4M) ✓ Program (4M) (ii)Writing to a File. Syntax - write () (4M) ✓ Program (4M)

3	**i)Write a program to catch a Divide by zero exception. Add a finally block too.**
	ii)Write a function to print the hash of any given file in python. (16M) BTL5
	Answer:Page:5.41-DR.V.Ramesh
	
	<u>Program</u> (8M)
	import random
	try:
	  ri = random.randint(0, 2)
	  if ri == 0:
	    infinity = 1/0

	elif ri == 1:
	  raise ValueError("Message")
	  #raise ValueError, "Message" # Deprecated
	elif ri == 2:
	  raise ValueError # Without message
	except ZeroDivisionError:
	  pass
	except ValueError as valerr:
	# except ValueError, valerr: # Deprecated?
	  print valerr
	  raise # Raises the exception just caught
	except: # Any other exception
	  pass
	finally: # Optional
	  pass # Clean up
	class CustomValueError(ValueError): pass # Custom exception
	try:
	  raise CustomValueError
	  raise TypeError
	except (ValueError, TypeError): # Value error catches custom, a derived class, as well
	  pass
	
	ii)Program to print the hash of any given file in python (8M)

4	**(i)Describe in detail about Exception with Arguments (ii)Describe in detail about user – defined Exceptions (Jan 2018) (16M)** BTL1 **Answer:Page:5.43-6-DR.V.Ramesh, Page:5.34-DR.V.Ramesh** **(i) Exception with Arguments** Syntax (4M) Example (4M) **(ii) Describe in detail about user – defined Exceptions.** About Exception (4M); Example (4M)
5	**(i)Explain with example of closing a file (Jan 2018) (ii) Discover syntax for reading from a file. (6M)** BTL3 **Answer:Page:5.12-DR.V.Ramesh** ✓ Syntax (4M) ✓ Example (4M) **(ii)Discover syntax for reading from a file.** ✓ file.read(). (1M) ✓ file.read(5) (2M) ✓ file.readline() (1M)

	✓ file.readline(3) (2M) ✓ file.readlines() (2M)
6	**What is command line arguments? Explain with example.** BTL2

Command Line Arguments

Command line arguments are values passed in during execution of a program. These values are passed after the file name.

Sys.argv is the package used for accessing command line arguments.

Sys.argv[0] will be file name.

Cmdline.py

```
import sys
print sys.argv[0]
print sys.argv[1]
print sys.argv[2]
print sys.argv[3]
print len(sys.argv)
```

Output

```
>>>python Cmdline.py good morning hello hi
                0          1     2     3   4

cmdline.py
good
morning
hello
```

GE8152 ENGINEERING GRAPHICS L T P C
2 0 4 4

OBJECTIVES:

To develop in students, graphic skills for communication of concepts, ideas and design of engineering products.

To expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (Not for Examination) 1

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES AND FREEHAND SKETCHING 7+12

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 6+12

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS 5+12

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 5+12

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6 +12

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method

TOTAL: 90 PERIODS

OUTCOMES:

- On successful completion of this course, the student will be able to familiarize with the fundamentals and standards of Engineering graphics perform freehand sketching of basic geometrical constructions and multiple views of objects.

- Project orthographic projections of lines and plane surfaces.
- Draw projections and solids and development of surfaces.
- Visualize and to project isometric and perspective sections of simple solids.

TEXT BOOK:

1. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2009.
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.

REFERENCES:

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
2. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. Luzzader, Warren.J and Duff, John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
5. N S Parthasarathy and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
6. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson, 2nd Edition, 2009.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

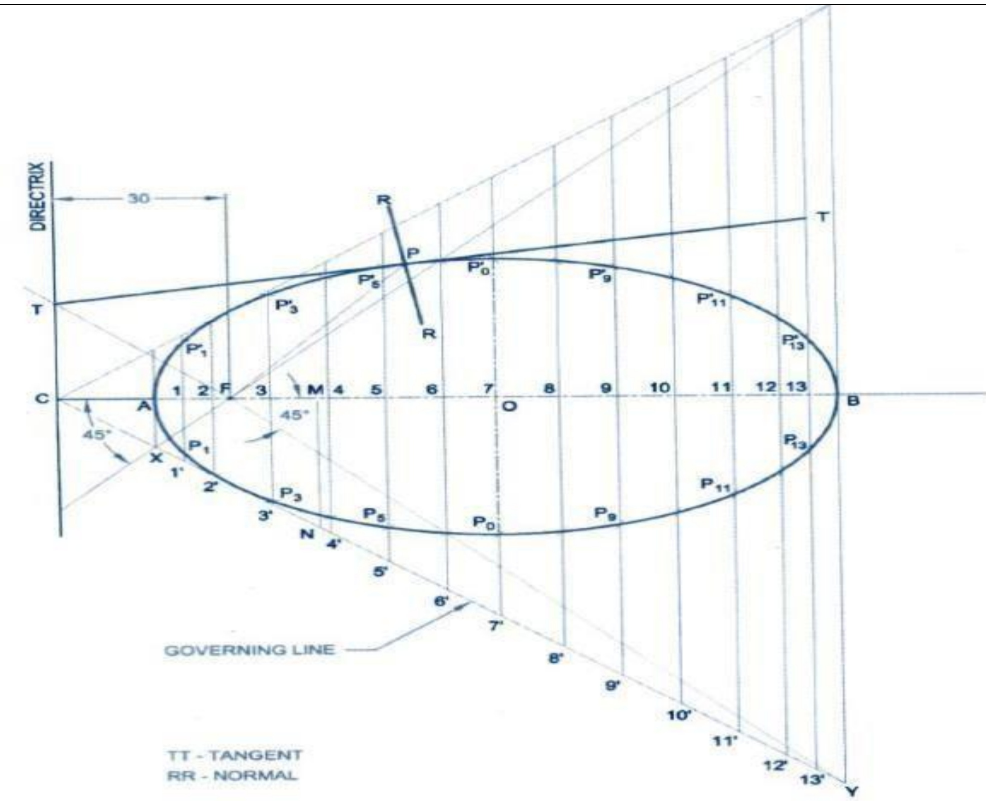
REGULATION: 2017 ACADEMIC YEAR: 2019-2020

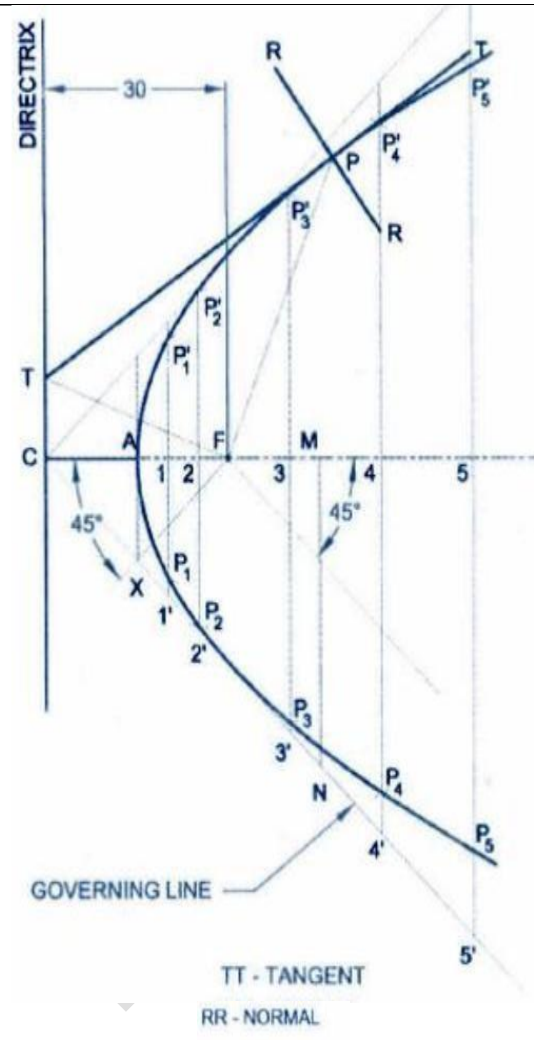
Subject code: GE 8152 **Year/ Semester : I/I**

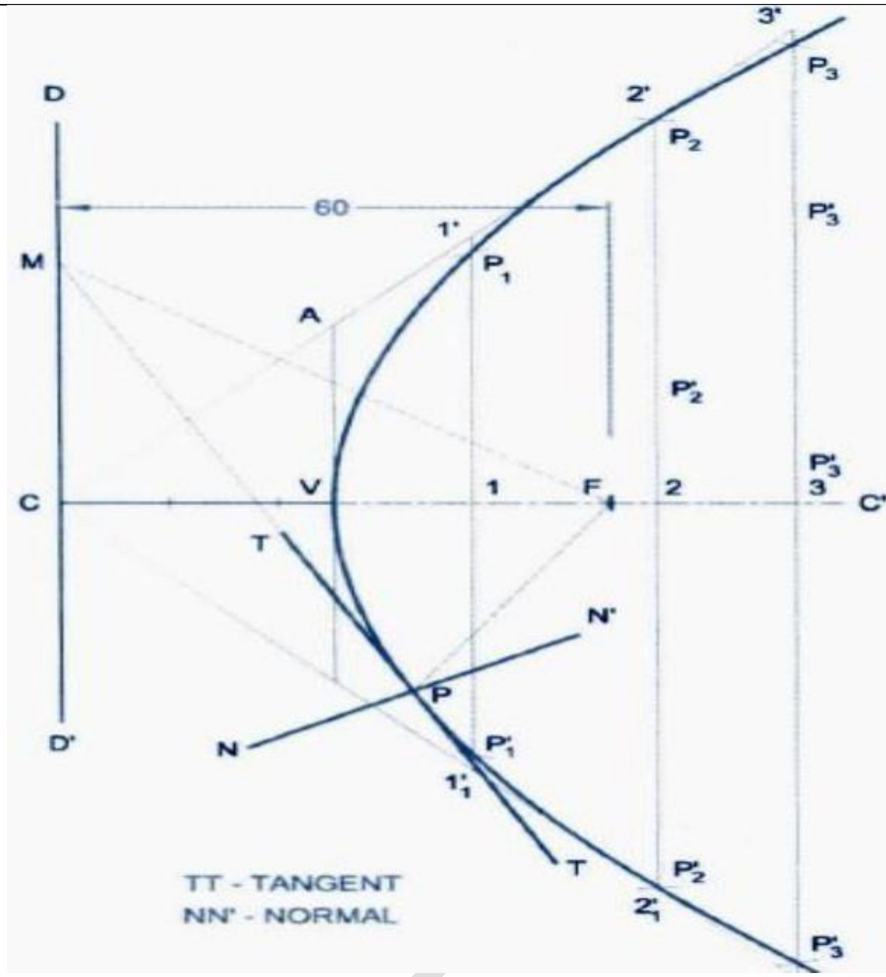
Subject: Engineering Graphics

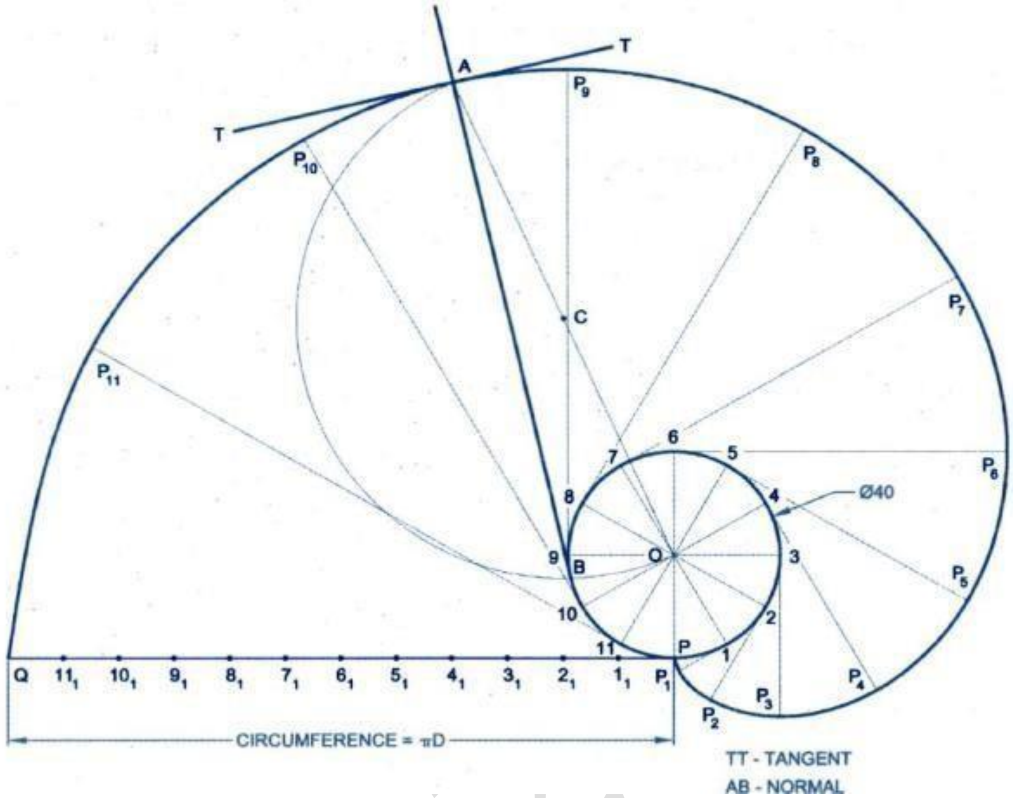
Subject Handler: Mr.D.Christopher Selvam Mr.M.Kalaimani, Mr.S.Vignesh, Ms.Arokya Anicia

	UNIT I PLANE CURVES AND FREEHAND SKETCHING
	Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects
Q.No.	**Questions**
1	**Construct an ellipse given the distance of the focus from the directrix as 30 mm and eccentricity as 2/3. Also draw tangent and normal to the curve at any point. (May 2016)(20 M)** BTL3 **Answer: Page: 45 – M. Saravanan**

	 Construction of eccentricity triangle **(5M)** Construction of curve (Ellipse) **(10 M)** Normal, tangent **(3 M)** Lettering & dimensioning **(2 M)**
2	**Construct a parabola given the distance of the focus from the directrix as 30 mm. Also draw tangent and normal to the curve from any point on it. (Nov. 2016) (20 M)** BTL3 **Answer: Page: 52 – M. Saravanan**

	 Construction of a eccentricity triangle **(5M)** Construction of a curve (Parabola) **(10M)** Normal, tangent **(3 M)** Lettering & dimensioning **(2 M)**
3	**Draw a hyperbola when the distance between the focus and directrix is 40 mm and the eccentricity is 4/3. Draw a tangent and normal at any point on the hyperbola. (May 2015) (May)(20 M)** BTL3 **Answer: Page: 57 – M. Saravanan**

	 Construction of a eccentricity triangle **(5M)** Construction of a curve (Hyperbola) **(10 M)** Normal, tangent **(3 M)** Lettering & dimensioning **(2 M)**
4	**Draw the involute of a square of side 30 mm. Also draw tangent and normal to the curve from any point on it. (Nov. 2015) (20 M)** BTL3 **Answer: Page: 71 – M. Saravanan**

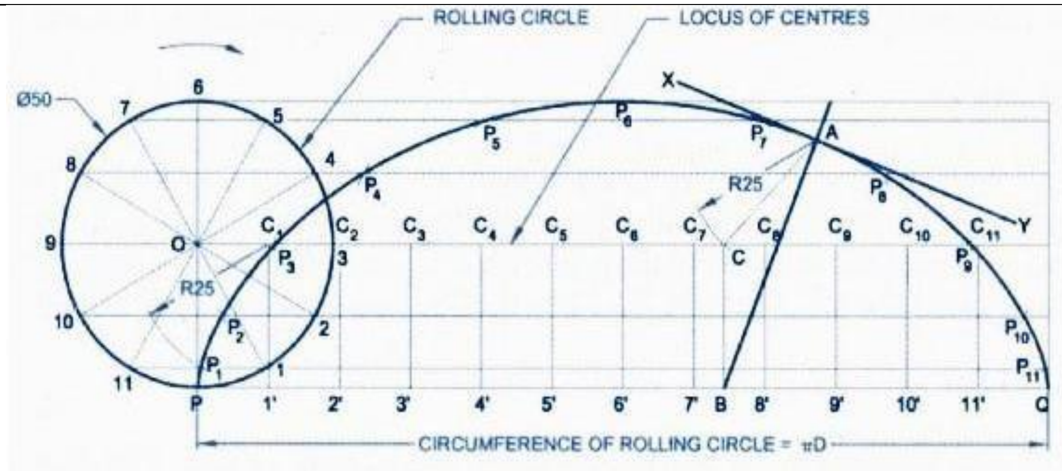
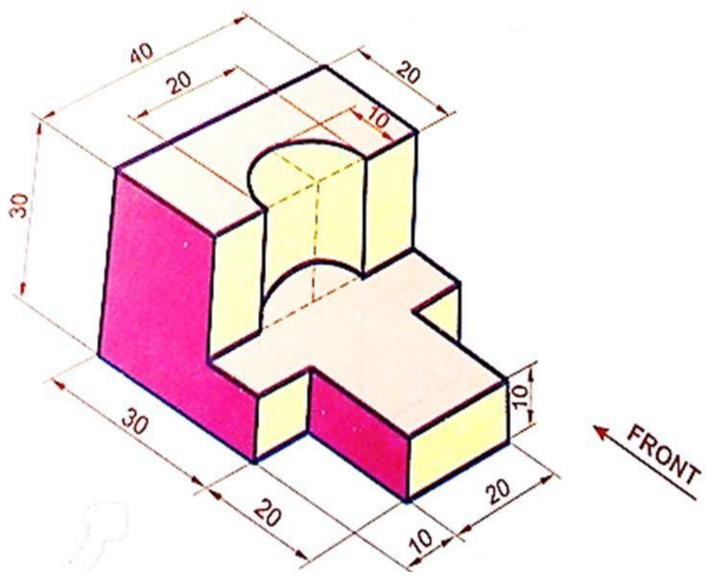
<table>
<tr><td></td><td>

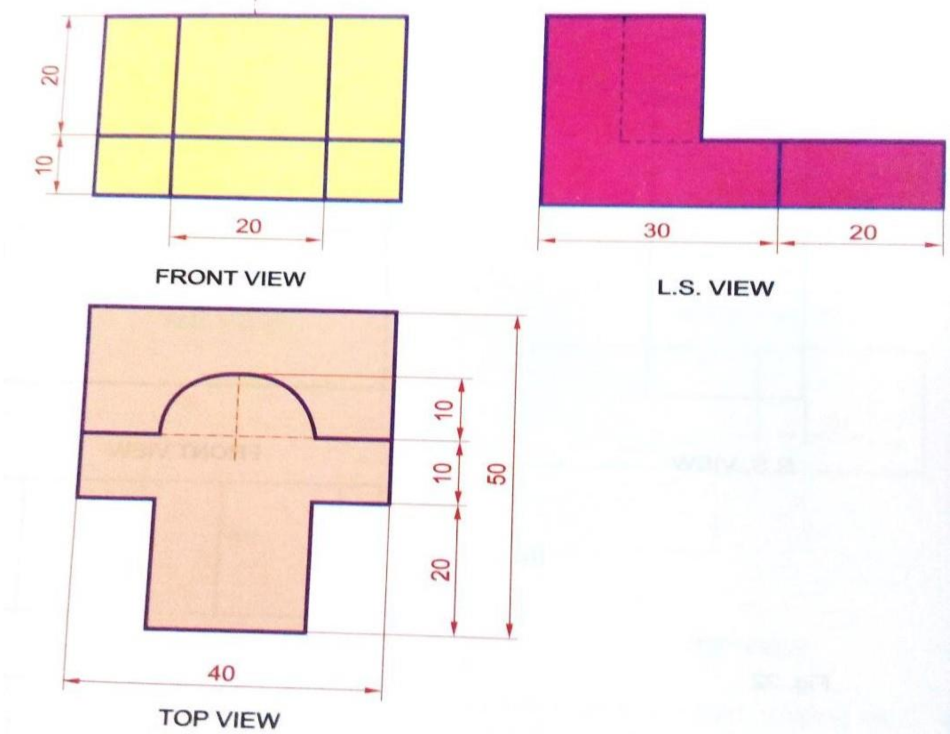
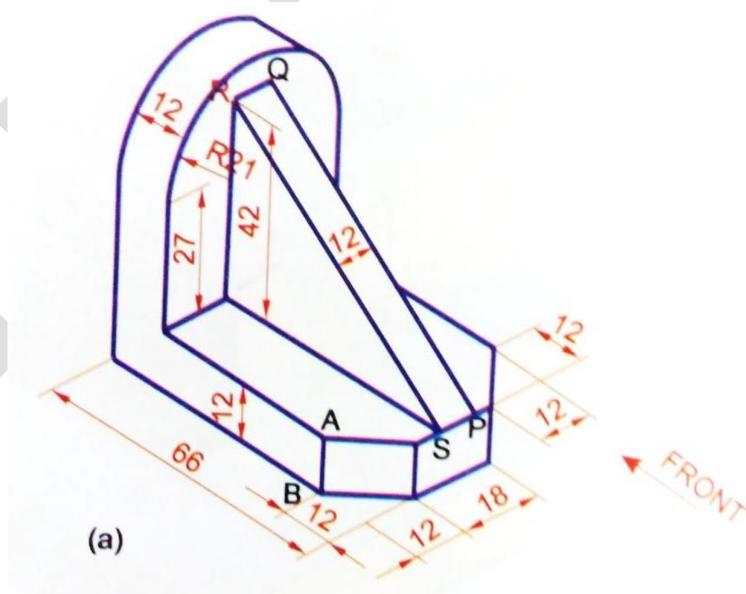
Construction of perpendicular tangent lines from each equal divided points from circle (5M)

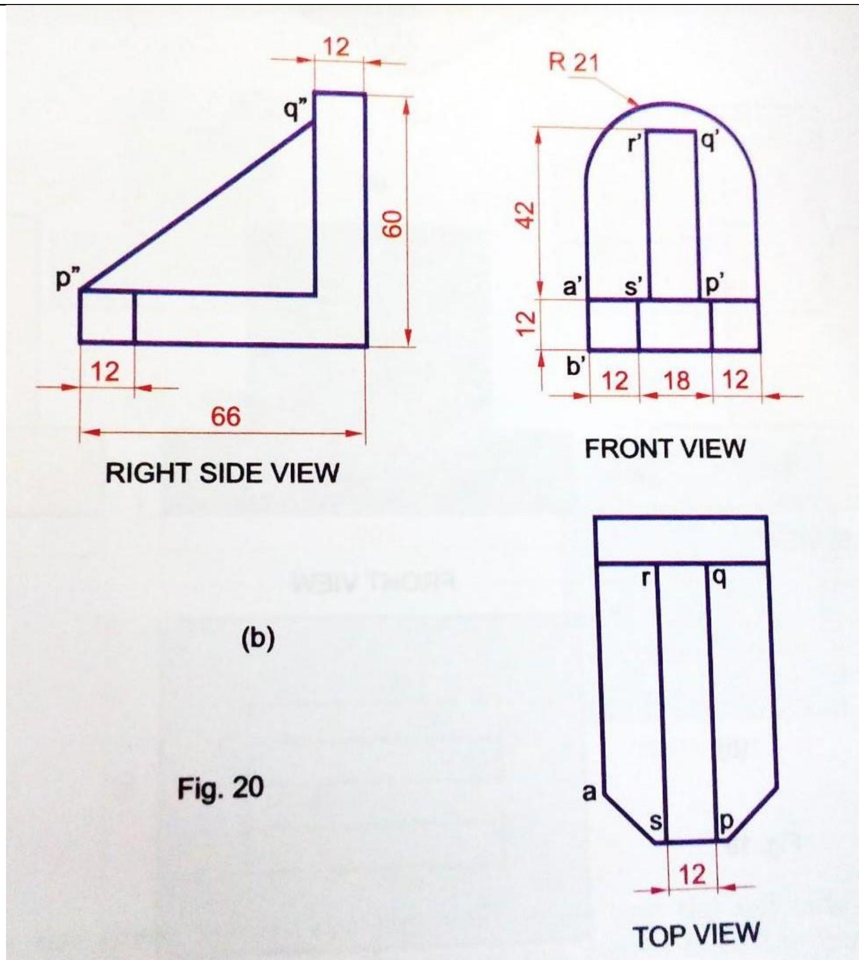
Construction of involutes (10 M)

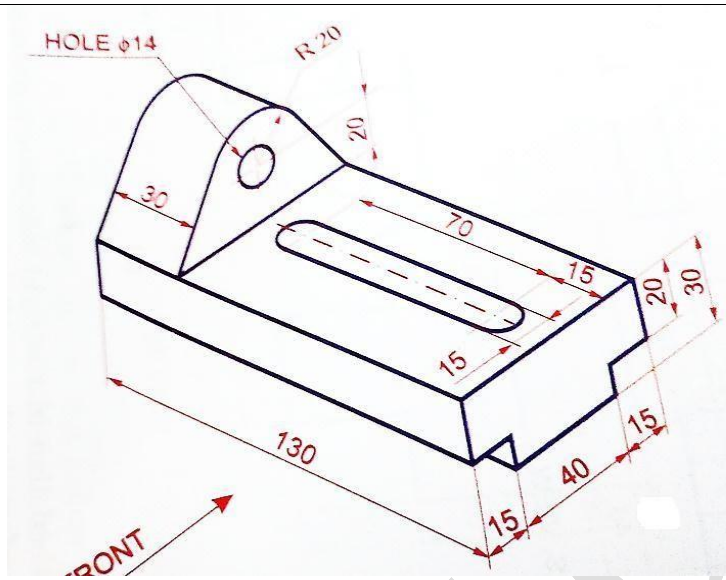
Normal, tangent (3 M)

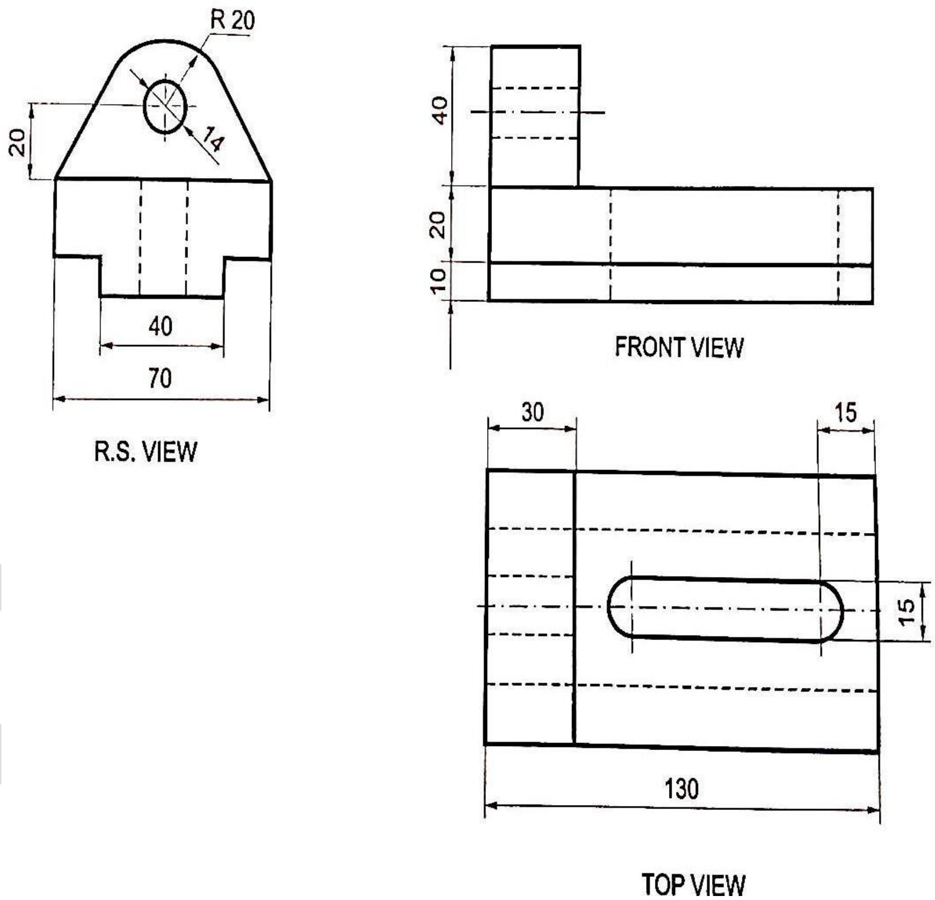
Lettering & dimensioning (2 M)</td></tr>
<tr><td>5</td><td>A circle of 50 mm diameter rolls along a straight line without slipping. Draw the curve traced by a point P on the circumference for one complete revolution. Draw a tangent and normal on it 40 mm from the base line. (May 2014) (Jan2019) (20 M) BTL3
Answer: Page: 63 – M. Saravanan</td></tr>
</table>

	 Construction of rolling circle, straight line equal to circumference and equal divisions of both **(5M)** Construction of cycloid **(10 M)** Normal, tangent **(3 M)** Lettering & dimensioning **(2 M)**
6	**Draw the front, top and side view of the given object (May 2016) (20 M)**.BTL3 **Answer: Page: 120 – M. Saravanan** 

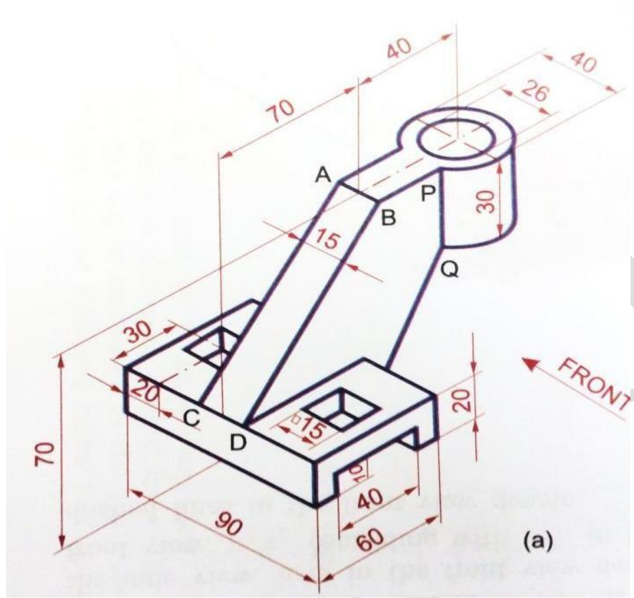
	 Front view **(10M) ;** Top view **(6M) ;** Side view **(4 M)**
7	**Draw the front, top and side view of the given object. (Nov. 2016) (20 M)** BTL3 **Answer: Page: A1.73– M. S. Kumar** 

	 Front view **(10M)** Top view **(6M)** Side view **(4 M)**
8	**Draw the front, top and side view of the given object. (May 2015) (20 M)** BTL3 **Answer: Page: 541– M. Saravanan**





Front view **(10M) ;** Top view **(6M) ;** Side view **(4 M)**

8	**Draw the front, top and side view of the given object** (**JAN 14) (20 M)** BTL3 **Answer: Page: 531– M. Saravanan** 

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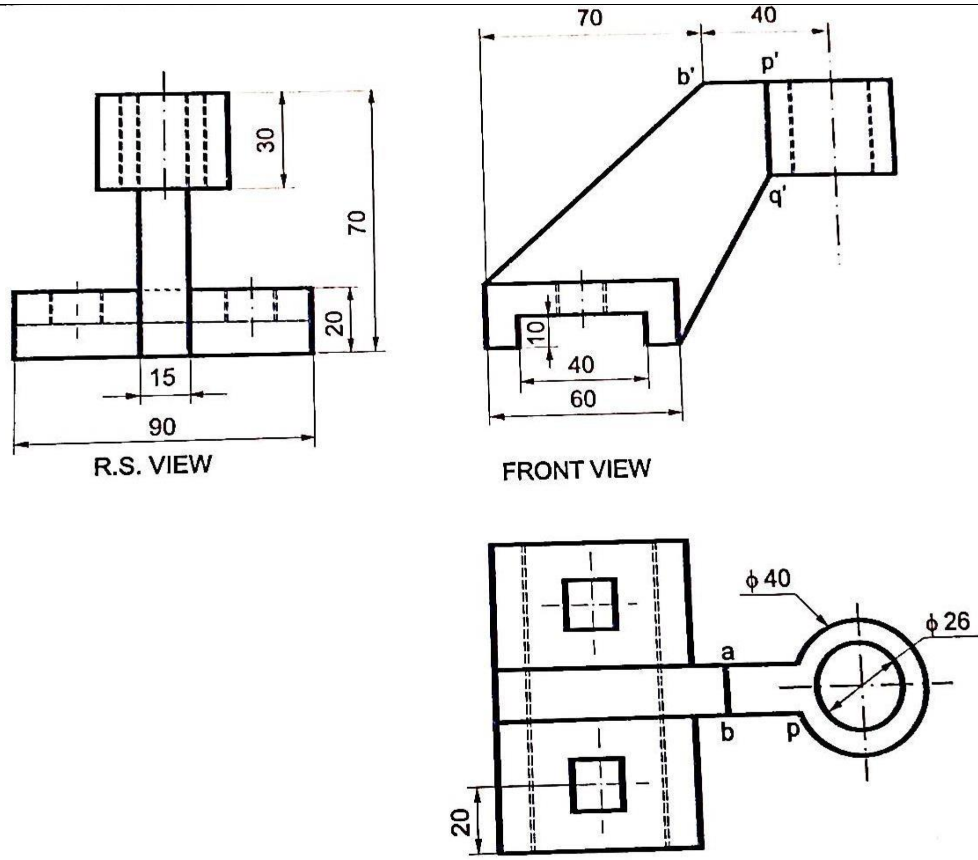

Front view **(10M) ;** Top view **(6M) ;** Side view **(4 M)**
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<td>
Draw the front, top and side view of the given object. (May 2013) (20 M) BTL3
Answer: Page: 546 – K.V. Natarajan
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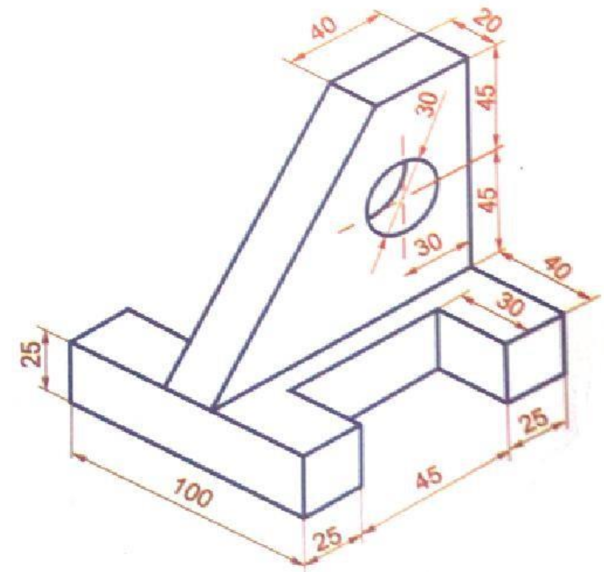
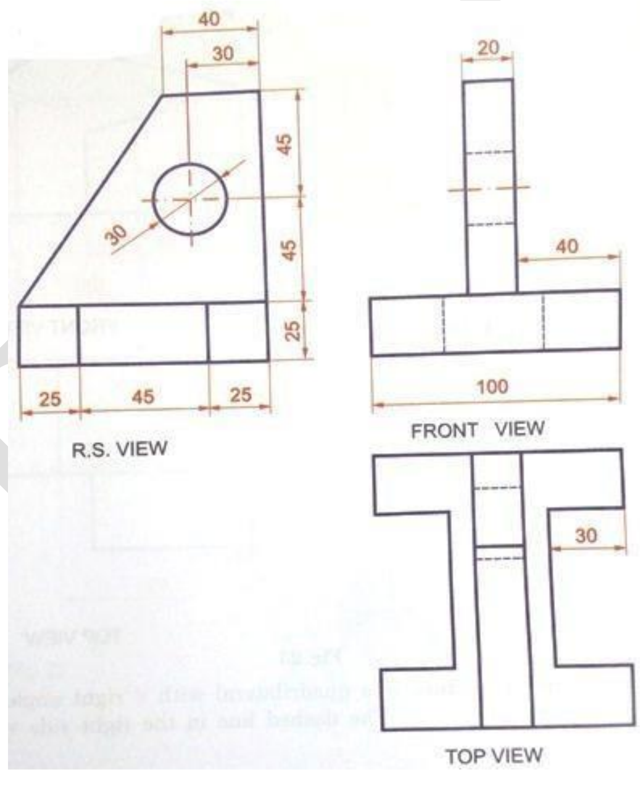
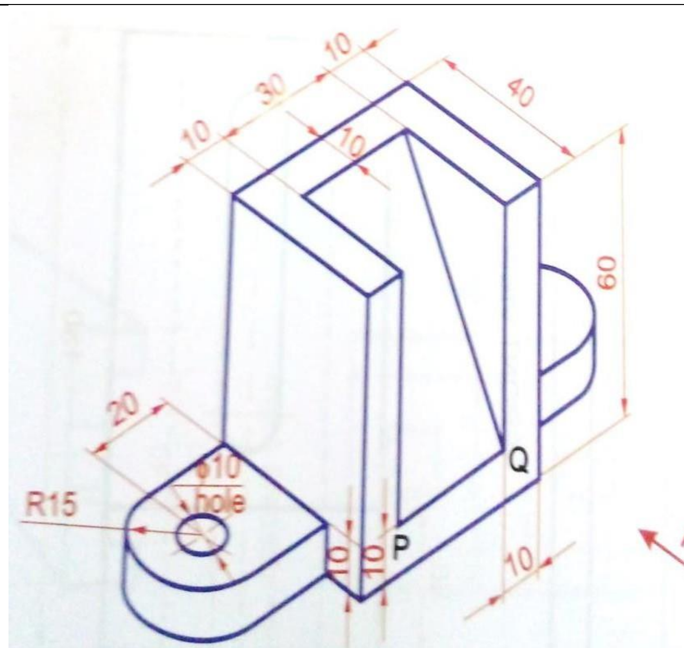




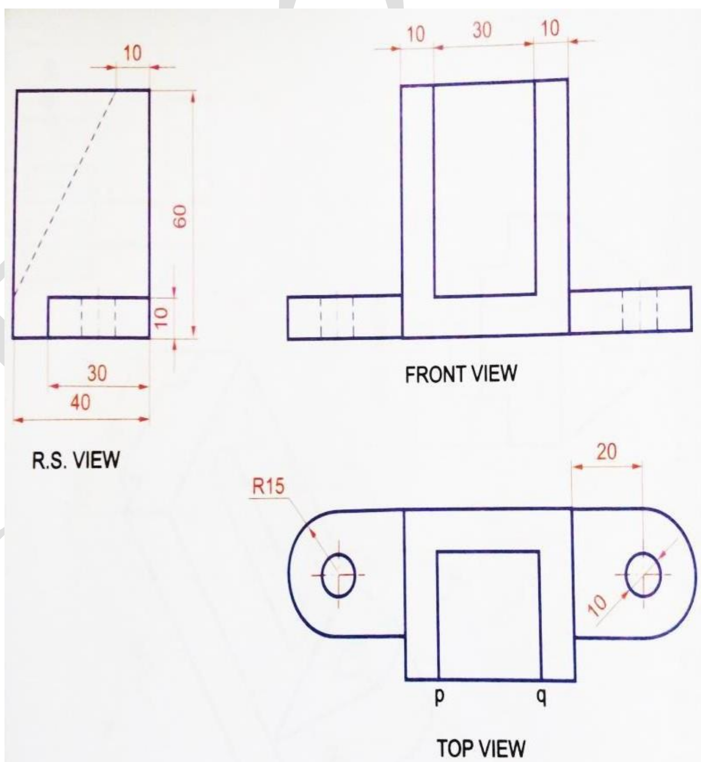
Front view **(10M) ;** Top view **(6M) ;** Side view **(4 M)**

10 **Draw the front, top and side view of the given object. (Nov 2013) (20 M)** BTL3

Answer: Page: 538– K.V. Natarajan



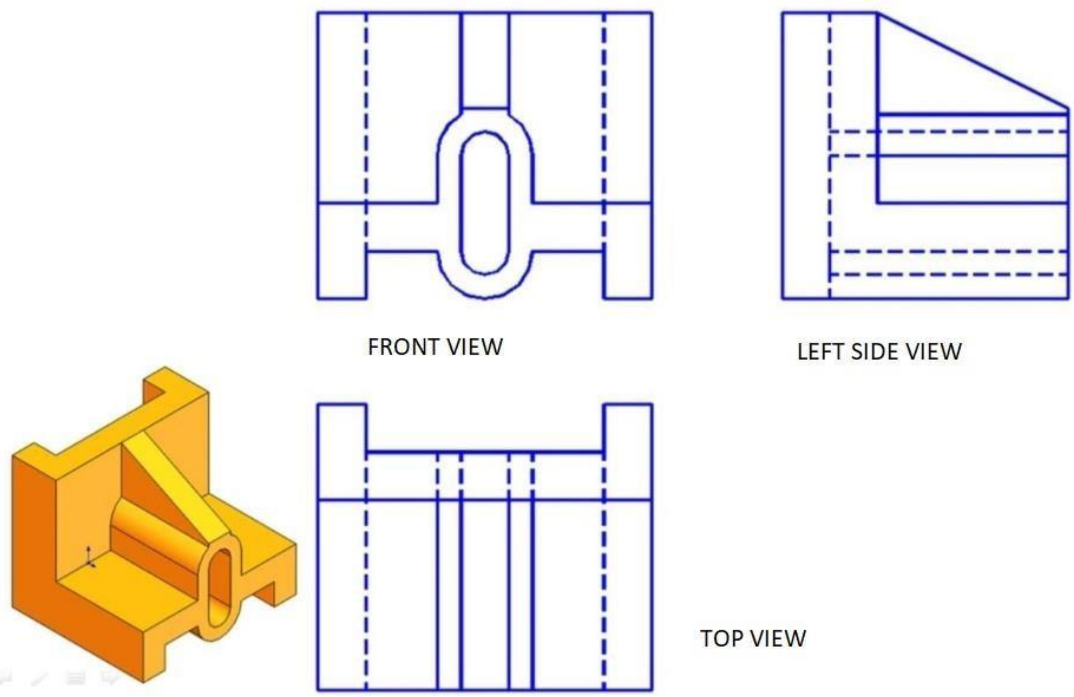
Front view **(10M) ;** Top view **(6M) ;** Side view **(4 M)**



Front view **(10M) ;** Top view **(6M) ;** Side view **(4 M)**

11. **Sketch by free hand the front view, top view and right side view of the object. Assume the proportional dimensions in mm. (Jan2019) (20 M)** BTL3

Answer: Page: 94– T.Jeyapoovan



Front view **(10M) ;** Top view **(6M) ;** Side view **(4 M)**

	UNIT II - PROJECTION OF POINTS, LINES AND PLANE SURFACE
	Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.
Q.No.	**Questions**
1	**A straight line AB has its end A, 15mm above HP and 20mm in front of VP. The end B is 50mm above HP and 65mm in front of VP. Draw its projections when the distance between the end projections is 50mm.Also find the true length of the line and its true inclinations with the HP and VP. (May 2016) (20 M)** BTL3 **Answer: Page: 149 - K.V. Natarajan**

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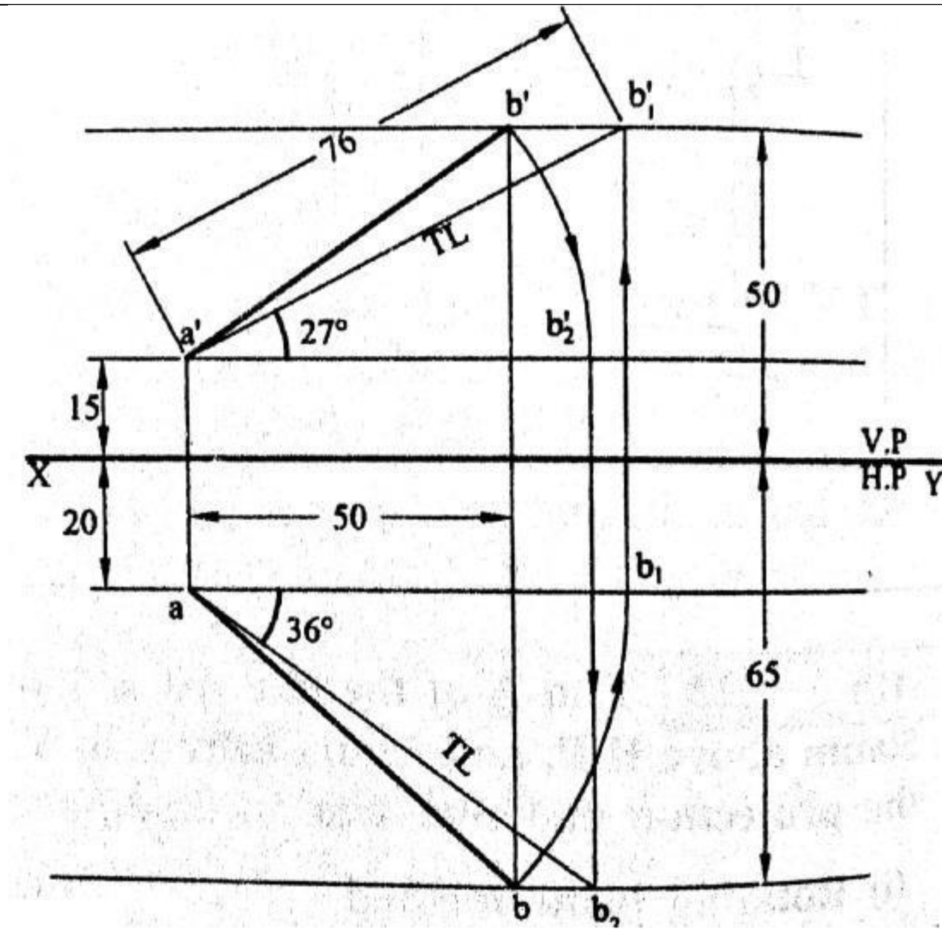

Marking one end point (a’, a) **(5 M)**
Marking distance between projectors **(2 M)**
Marking second end point **(3 M)**
Rotating line : FV $a'b'$ to $a'b'_2$ and TV **ab to ab₁(5 M) Finishing TL (3 M)**
Lettering & dimensioning **(2 M)**
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<td>
One end P of a line PQ, 55mm long is 35mm in front of the VP and 25mm above the HP. The line is inclined at 40º to the HP and 30 º to the VP. Draw the projection of PQ. (Nov. 2016) (20 M) BTL3
Answer: Page: 151 - K.V. Natarajan
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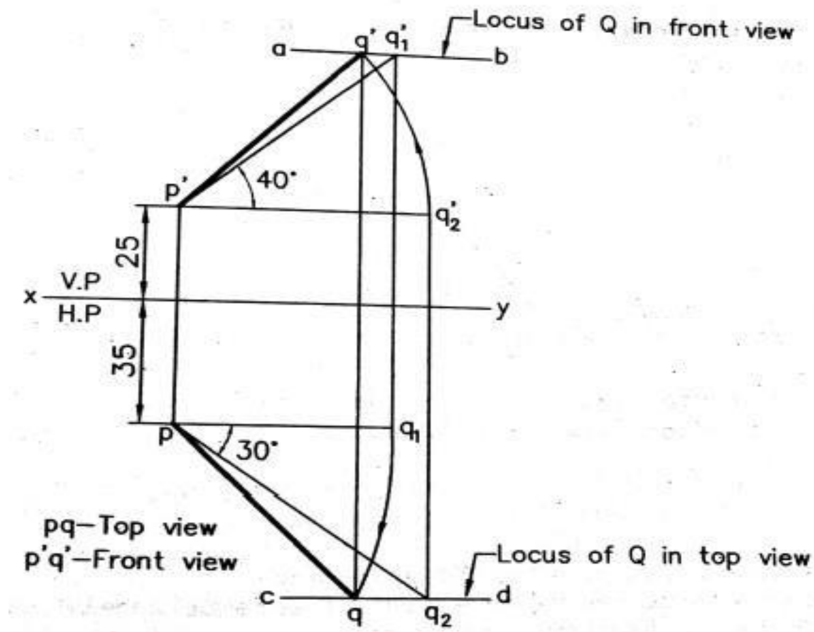
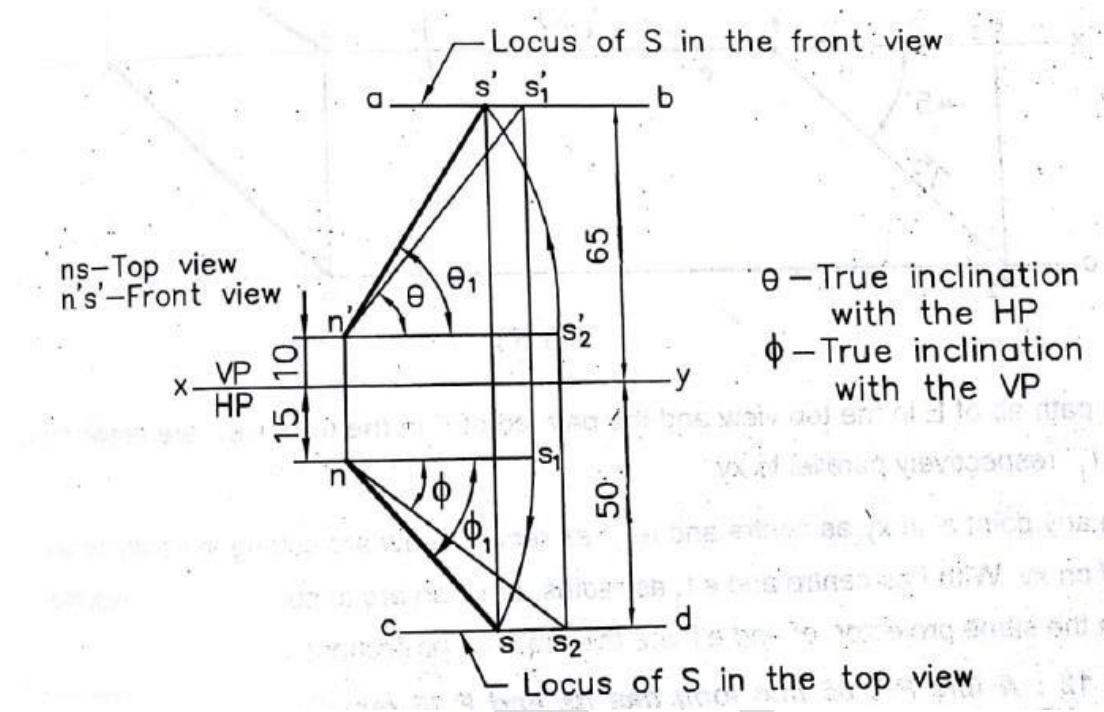
	 Marking one end point (p', p) **(5 M)** Marking inclined to HP (TL) **(2 M)** Marking inclined to VP (TL) **(2 M)** Projecting and getting q_1 as well as q'_2 **(2 M)** Rotating line : FV and TV **(5 M)** Finishing FV and TV **(2 M)** Lettering & dimensioning **(2M)**
3	**A line NS 80mm long has its end N 10mm above the HP and 15mm in front of the VP . The other end S is 65mm above the HP and 50mm in front of the VP. Draw the projection of the line and find its true inclination with the HP and VP. (May 2015) (20 M)** BTL3 **Answer: Page: 153 - K.V. Natarajan**

	 Marking one end point (n' , n) **(5 M)** Marking locus of s' and locus of s **(3 M)** Intersecting s'_1 and s_2 on locus for the TL **(3 M)** Projecting and getting s_1 as well as s'_2 **(2 M)** Rotating line : FV and TV **(5 M)** Lettering & dimensioning **(2 M)**
4	**A line EF, 85mm long has its end E, 25mm above the HP and 20mm in front of the VP. The top and front views of the line have lengths of 55mm and 70mm respectively. Draw the projections of the line and find its true inclination with the VP and HP. (Nov 2015) (20 M)** BTL3 **Answer: Page: 163 – K.V. Natarajan**

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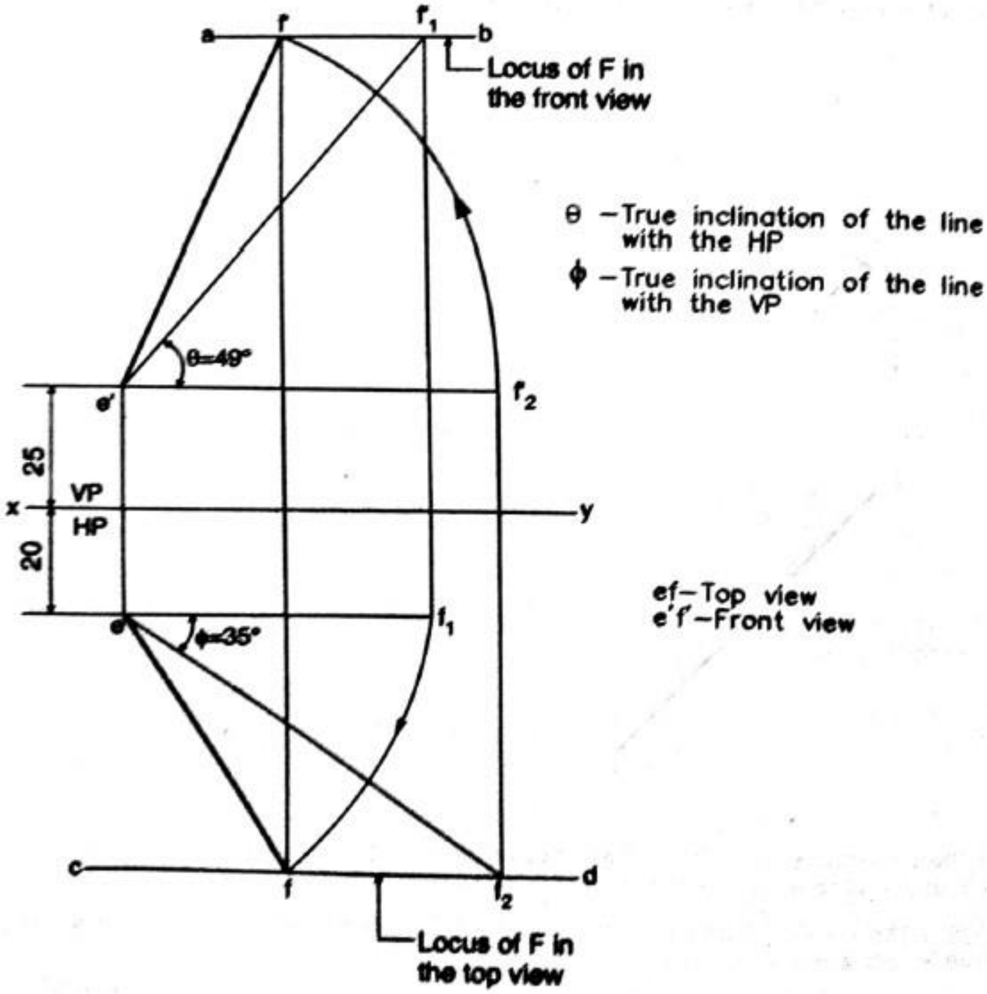

Marking one end point (e' , e) **(5 M)**
Drawing e' f '$_2$ and e f_1 parallel to xy **(4 M)**
Projection of f '$_2$ and f_1 perpendicular to xy **(2 M)**
Intersecting above projection for TL to get f_2 and f '$_1$ **(2 M)**
Rotating line : FV and TV **(5 M)**
Lettering & dimensioning **(2 M)**

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The end P of a line PQ 70mm long is 15mm above the HP and 20mm in front of the VP.Q is 40mm above the HP. The top view of the line is inclined at 45 to the VP. Draw the projection of the line and find its true inclination with the VP and HP. (May 2014) (20 M) BTL3

Answer: Page: 157 – K.V. Natarajan

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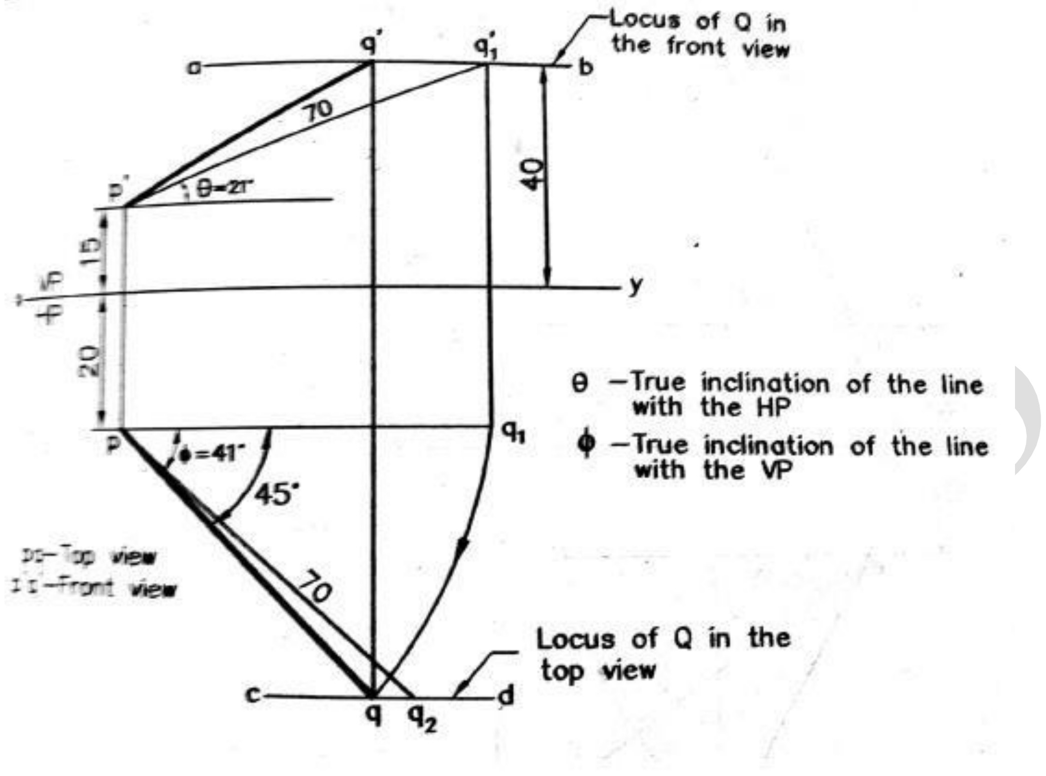

Marking one end point (p’ , p) **(5 M)**
Marking locus of q ’ for 40 mm above HP **(2 M)**
Intersecting q'_1 on locus of q ’ for the TL **(2 M)**
projecting q'_1 on locus of p for marking q_1 **(2 M)**
Drawing TV of pq for 45^0 **(2 M)**
Rotating line : FV and TV **(5 M)**
Lettering & dimensioning **(2 M)**
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<td>
A line EF, 75 mm long is in the first quadrant with end E in the HP and end F in the VP. The line is inclined at 30⁰ to the HP and 45⁰ to the VP. Draw the projections of the line EF. (Nov. 2014) (20 M) BTL3

Answer: Page: 161 – K.V. Natarajan
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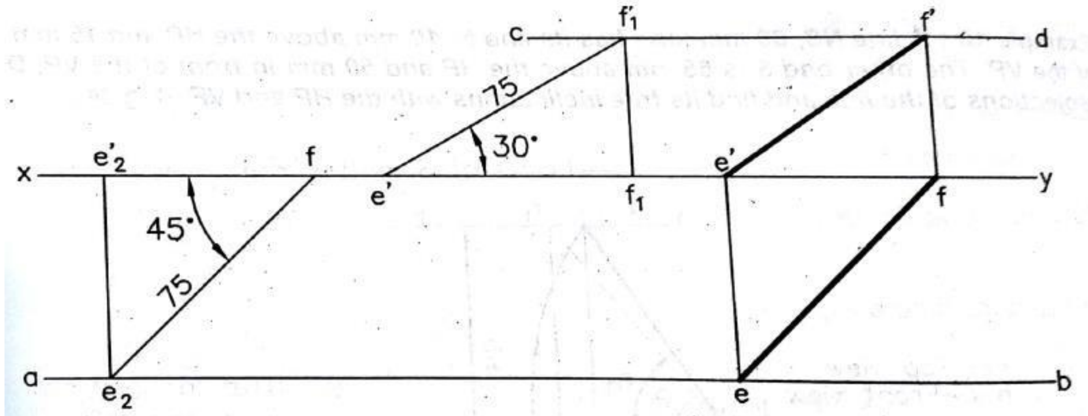
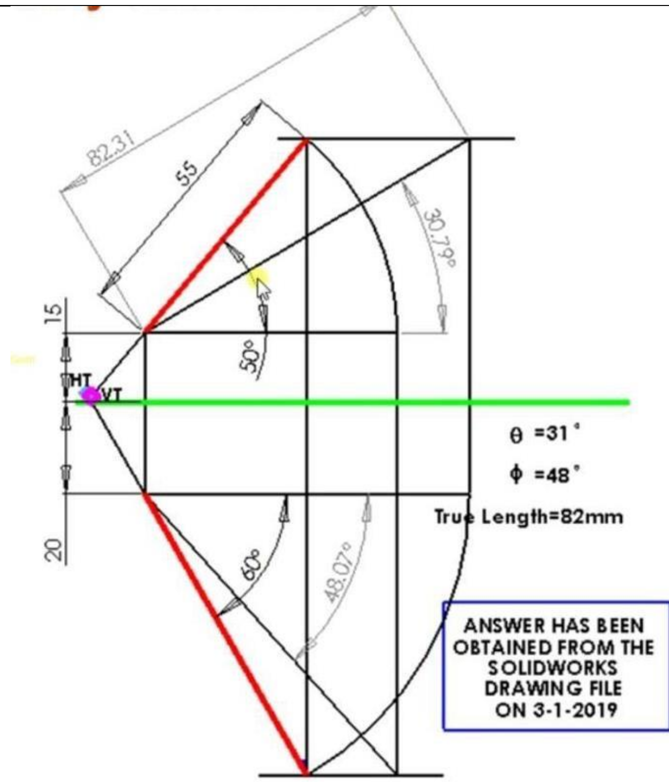
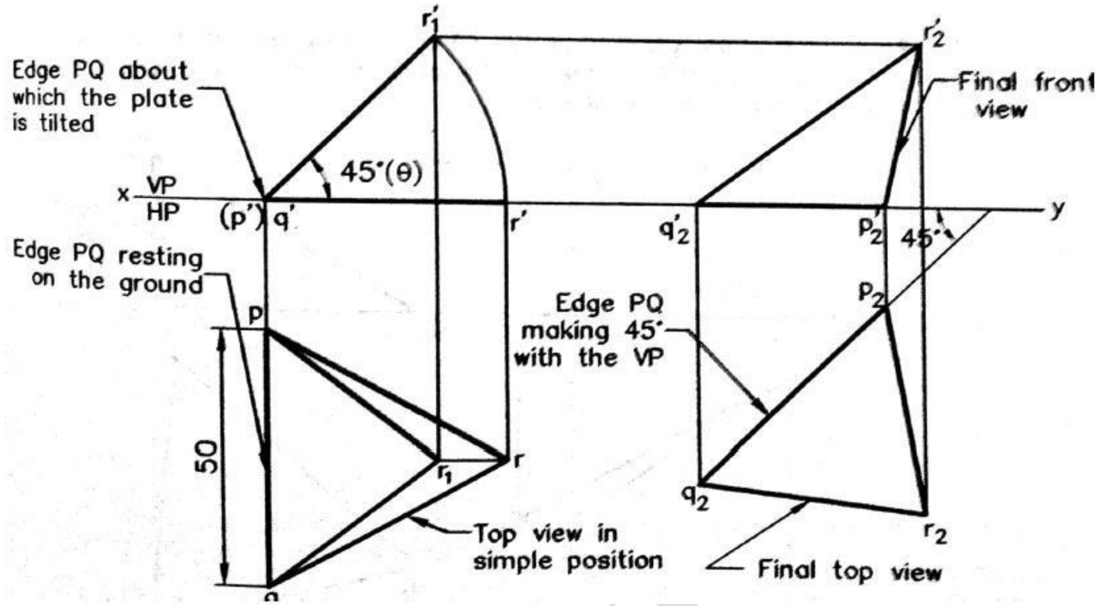
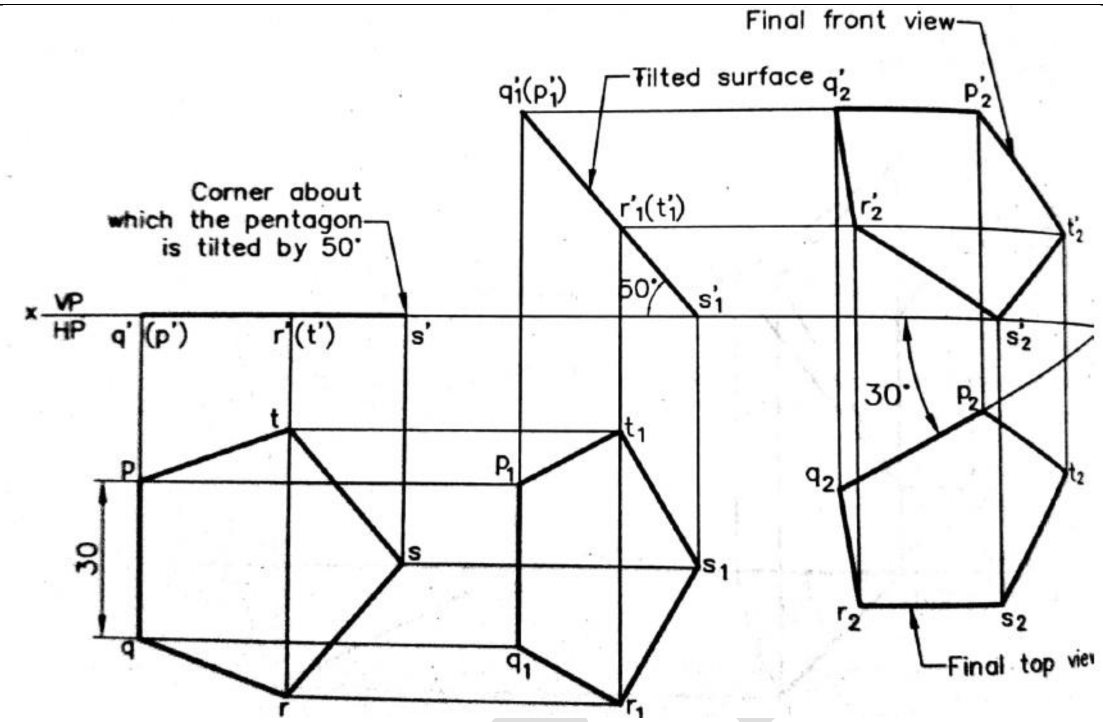
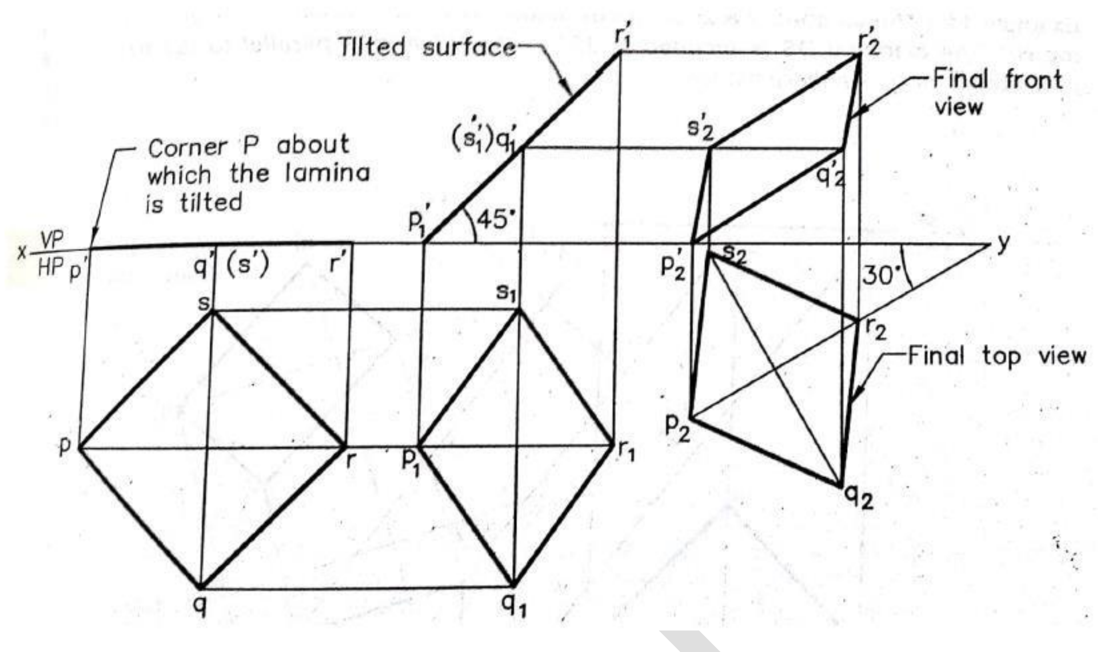
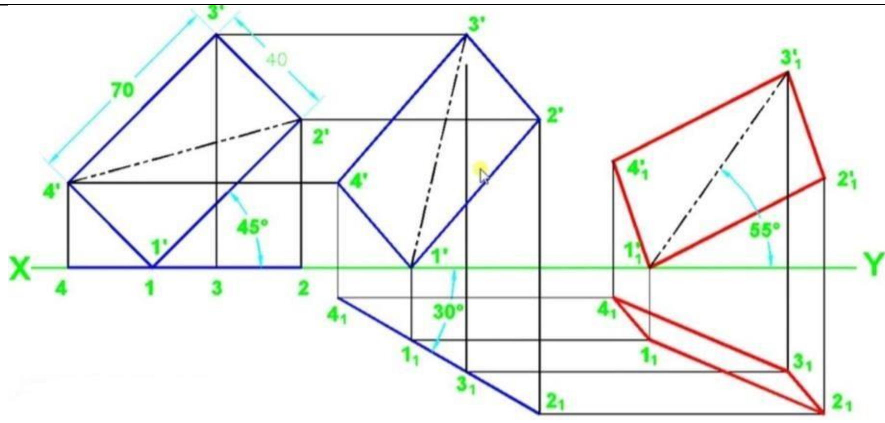
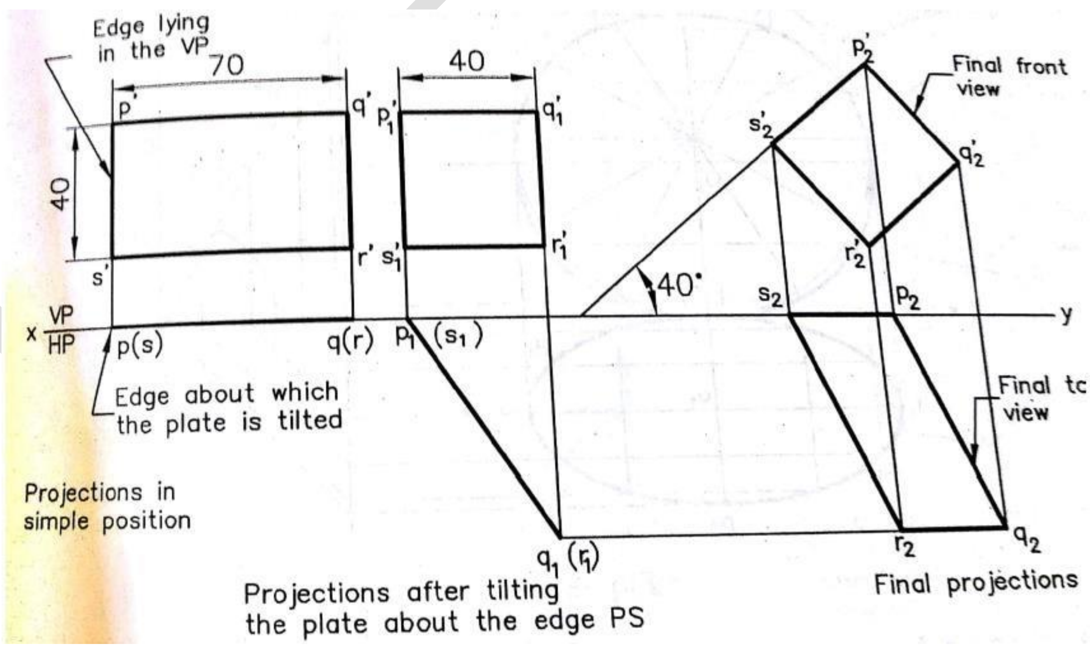
	 Marking e 'f_1 at 30^0 to HP for TL (75 mm) **(5 M)** Marking of fe_2 at 45^0 to VP for TL (75 mm) **(5 M)** Making of line ab and cd parallel to xy with help of e_2 and f_1**(2 M)** Projection of e_2 and f_1 **(2 M)** Completion of actual FV (e'f') and TV (ef) **(6 M)**
7.	**A line AB is 50^0 inclined to xy and measures 55mm long, while its top view is is inclined at 60^0 to xy line. The end A of the line is 15mm above HP and 20mm in front of VP. Draw the projection of the line and find its true length and true inclination with HP and VP. Also show the traces. (Jan2019) (20 M)** BTL3 **Answer: Page: 161 – K.V. Natarajan**

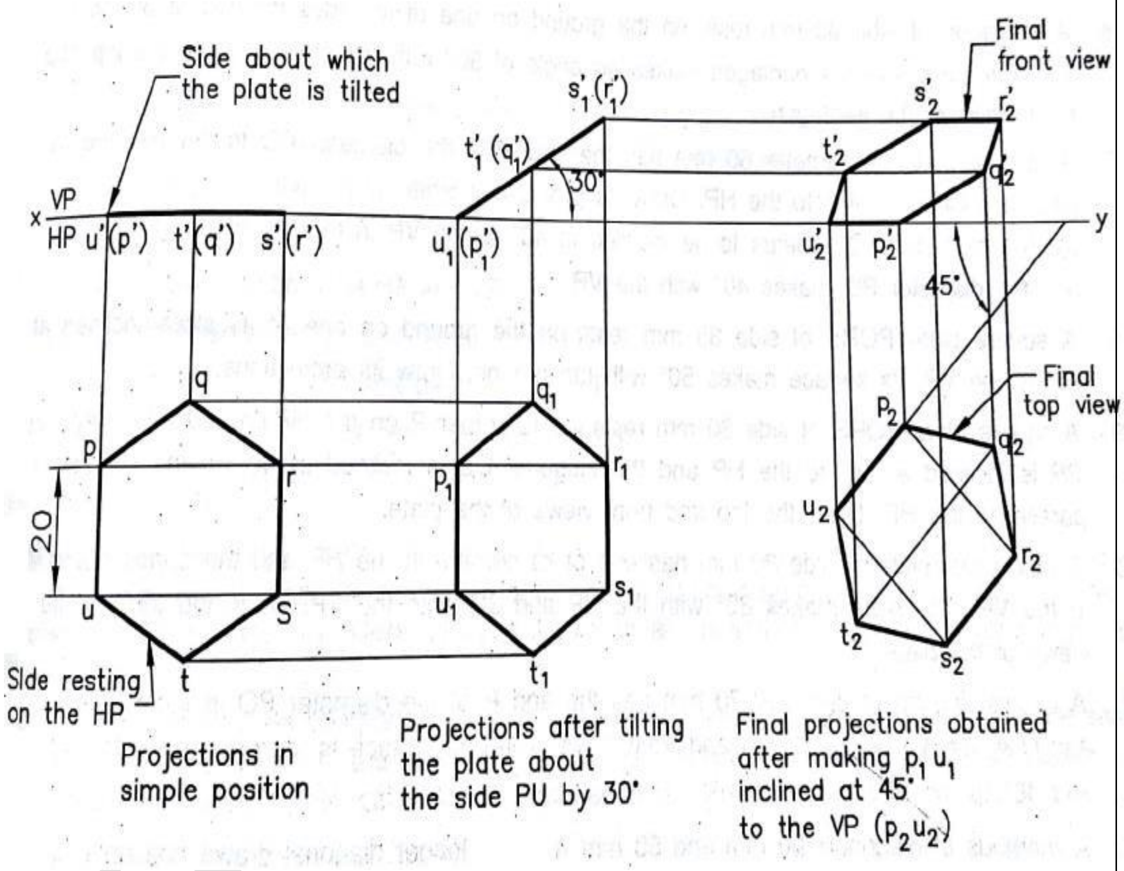
	 Marking one end point (p', p) **(5 M)** Marking inclined to HP (TL) **(2 M)** Marking inclined to VP (TL) **(2 M)** Projecting and getting q_1 as well as q'_2 **(2 M)** Rotating line : FV and TV **(5 M)** Finishing FV and TV **(2 M)** Lettering & dimensioning **(2M)**
8	**An equilateral triangular plane PQR has 50mm sides. It rests on the ground on the edge PQ making an angle of 45 with the VP .The other edges PR and QR have length of 40mm each in the top view. Draw the projection of the plane and find its inclination with the HP. (May 2013) (20 M)** BTL3 **Answer: Page: 199 – K.V. Natarajan**

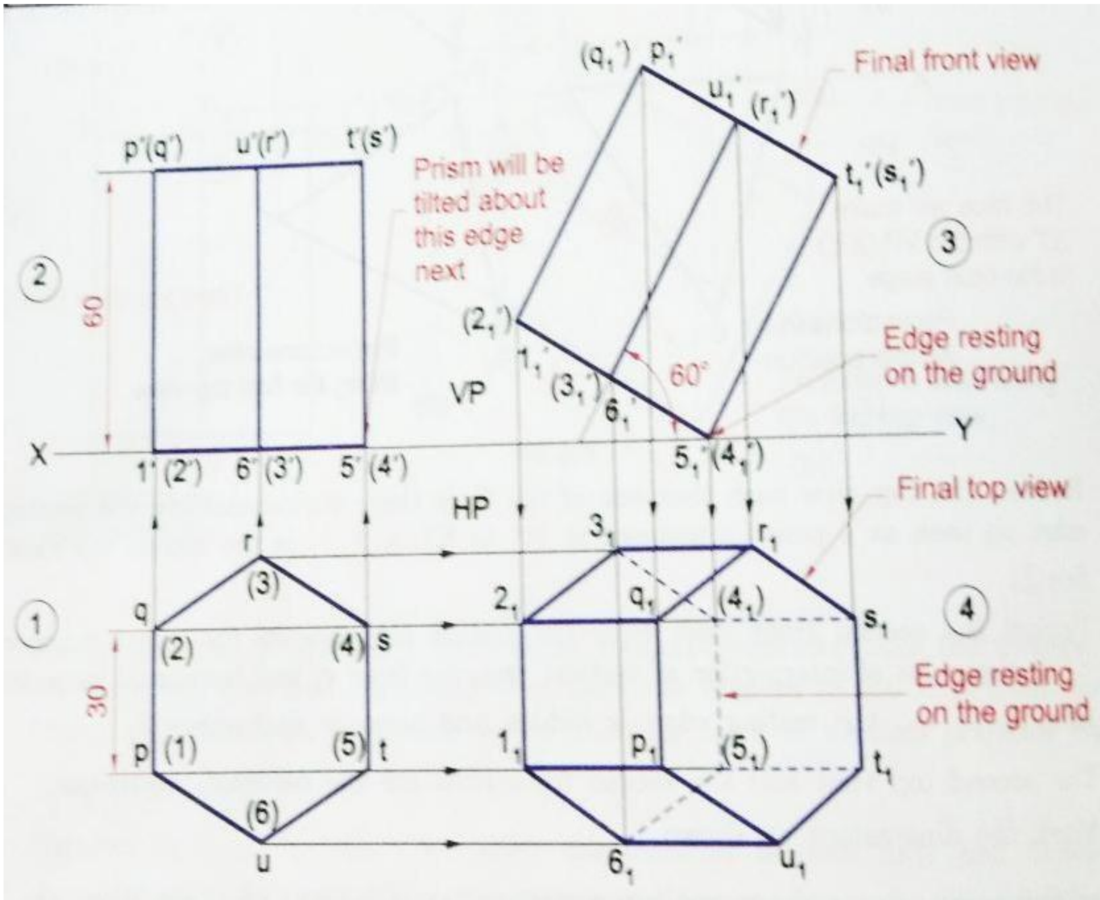
	 Initial top view **(3 M)** Initial front view **(3 M)** Actual front view **(7 M)** Actual top view**(7 M)**
9	**A pentagon of side 30mm rests on the ground on one of its corner with its side containing the corner being equally inclined to the ground. The side opposite to the corner on which it rests is inclined at 30 to the VP and is parallel to the HP. The surface of the pentagon makes 50 with the ground. Draw the top and front views of the pentagon. (Nov. 2013) (20 M)** BTL3 **Answer: Page: 202 – K.V. Natarajan**

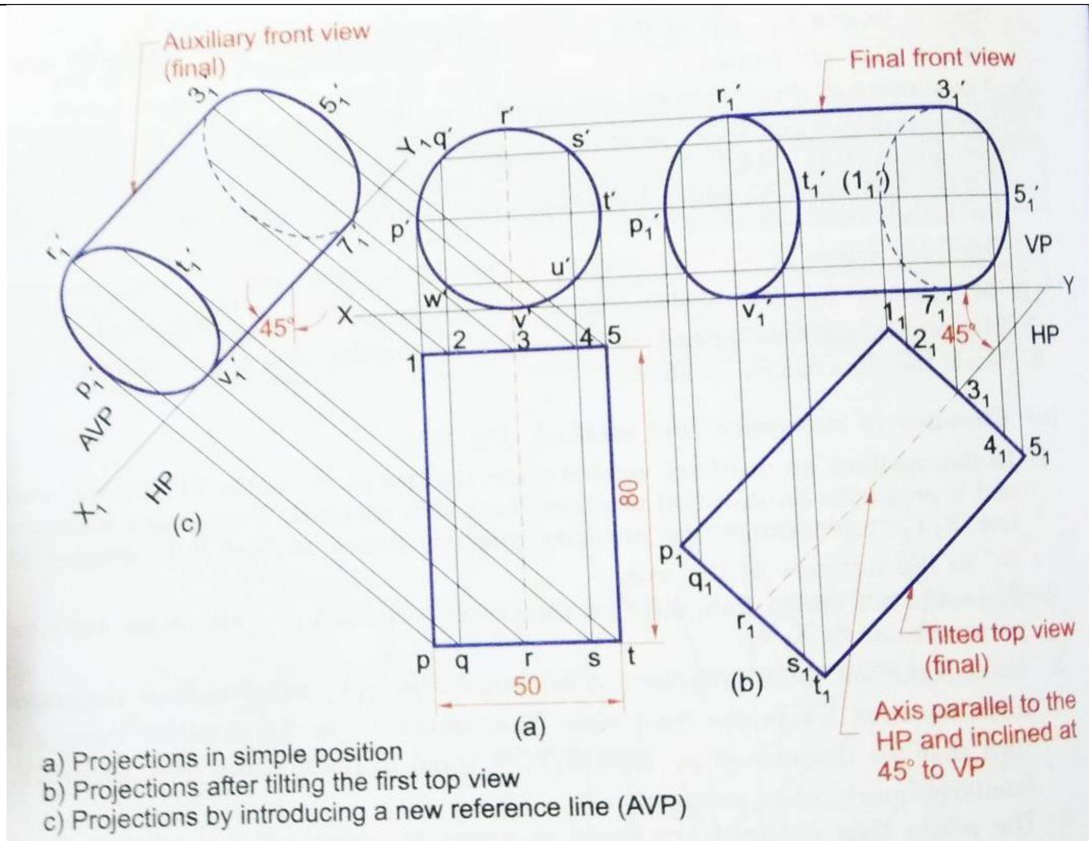
	 Initial top view **(3 M)** Initial front view **(3 M)** Actual front view **(7 M)** Actual top view **(7 M)**
10	**A square lamina PQRS of side 40mm rests on the ground on its corner P in such a way that the diagonal PR is inclined at 45 to the HP and apparently inclined at 30^0 to the VP .Draw its projection. (May 2012) (20 M)** BTL3 **Answer: Page: 203 – K.V. Natarajan**

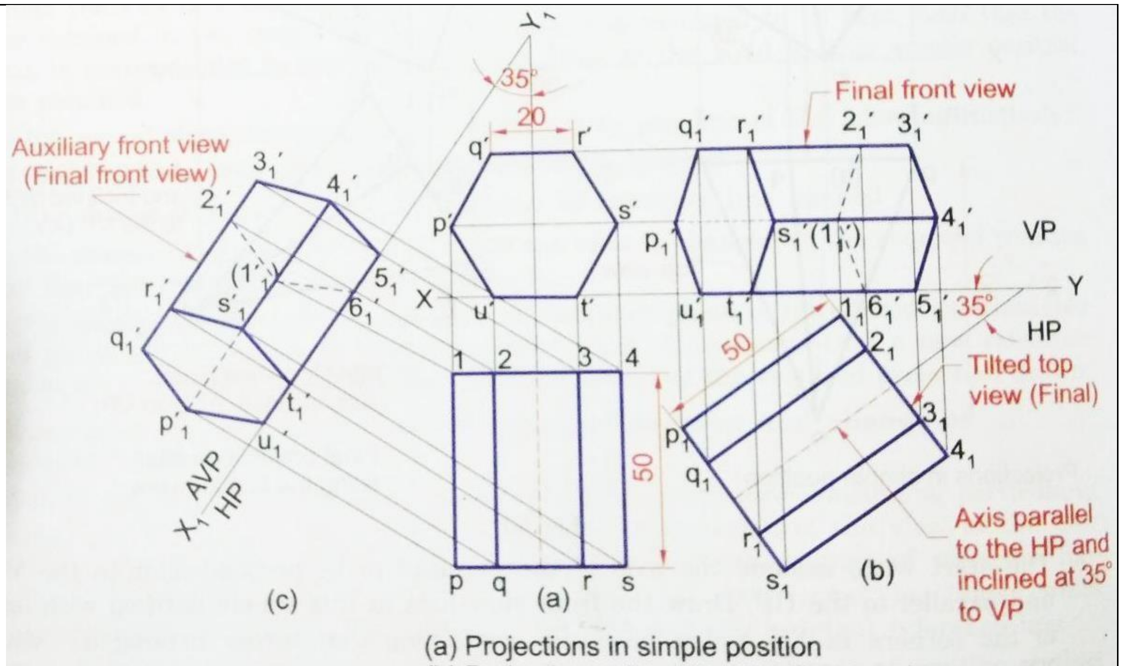
	 Initial top view **(3 M)** Initial front view **(3 M)** Actual front view **(7 M)** Actual top view **(7 M)**
11	**A rectangular lamina 40x70mm size is standing on one of its corner with the sides equally inclined to HP. The surface of the lamina is inclined to VP at an angle 30^0 to VP. The diagonal passing through the resting corner makes an angle of 55^0 with HP. Draw the projection of the rectangular lamina. (Jan2019) (20 M)** BTL3 **Answer: Page: 207 – K.V. Natarajan**

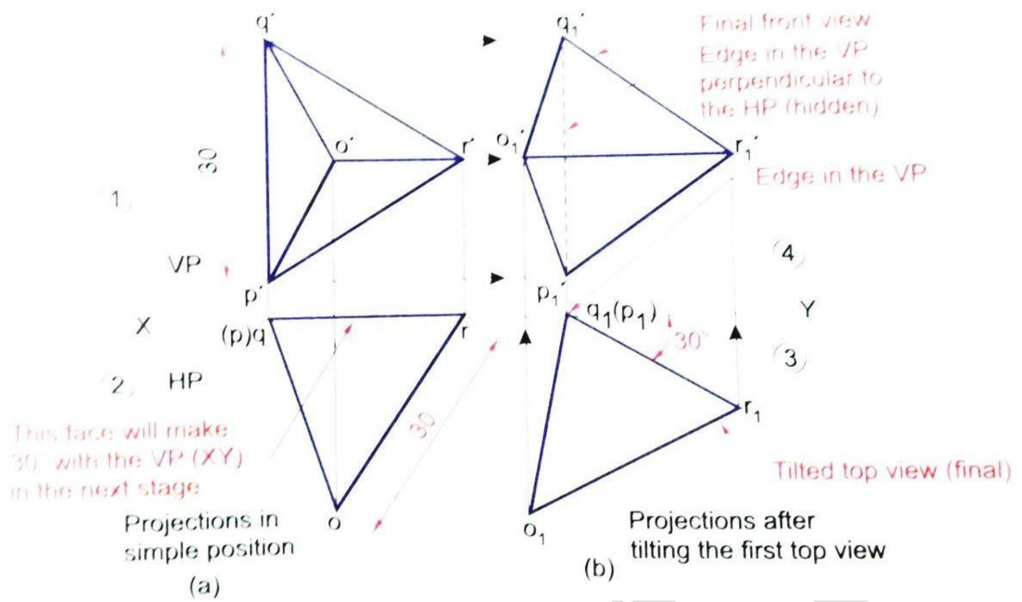
	 Initial top view **(3 M)** Initial front view **(3 M)** Actual front view **(7 M)** Actual top view **(7 M)**
12	**A rectangular plate 70 x 40 mm has one of its shorter edges in the VP inclined at 40^0 to the HP .Draw its top view if the front view is a square of side 40mm. Find the true inclination of the plate with the VP. (May 2016) (Jan2019) (20 M)** BTL3 **Answer: Page: 207 – K.V. Natarajan**  Initial front view **(3 M)** Initial top view **(3 M)**

	Actual (final)top view **(7 M)** Actual (final) front view **(7 M)**
13	**A hexagonal plate of side 20mm rests on the HP on one of its sides inclined at 45^0 to the VP. Surface of the plate makes an angle of 30^0 with the HP. Draw the front and top view of the plate. (Nov 2016) (Jan2018) (20 M)** BTL3 **Answer: Page: 209 – K.V. Natarajan**  Initial top view **(3 M)** Initial front view **(3 M)** Actual front view **(7 M)** Actual top view **(7 M)**
	UNIT-III – PROJECTIONS OF SOLIDS
	Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method
Q.No.	**Questions**
1	**A hexagonal prism of base side 30 mm and axis length 60 mm rests on the HP on one of its base edges with its axis inclined at 60° to the HP and parallel to the VP. Draw its front and top views. (May 2016) (20 M)**BTL3 **Answer: Page: 247 – K.V. Natarajan**

	 Initial top view **(3 M)** Initial front view **(3 M)** Actual front view **(7 M)** Actual top view **(7 M)**
2	**Draw the projections of a cylinder of diameter 50 mm and axis length 80 mm when it is lying on the ground with its axis inclined at 45° to the VP and parallel to the ground. (Nov. 2016) (20 M)** BTL3 **Answer: Page: 243– K.V. Natarajan**

	 Initial front view **(3 M)** Initial top view **(3 M)** Actual top view **(7 M)** Actual front view **(7 M)**
3	**Draw the projections of a hexagonal prism of base side 20 mm and axis length 50 mm when it is lying on the ground on one of its rectangular faces and the axis inclined at 35° to the VP. (May 2015) (20 M)** BTL3 **Answer: Page: 214 – K.V. Natarajan**

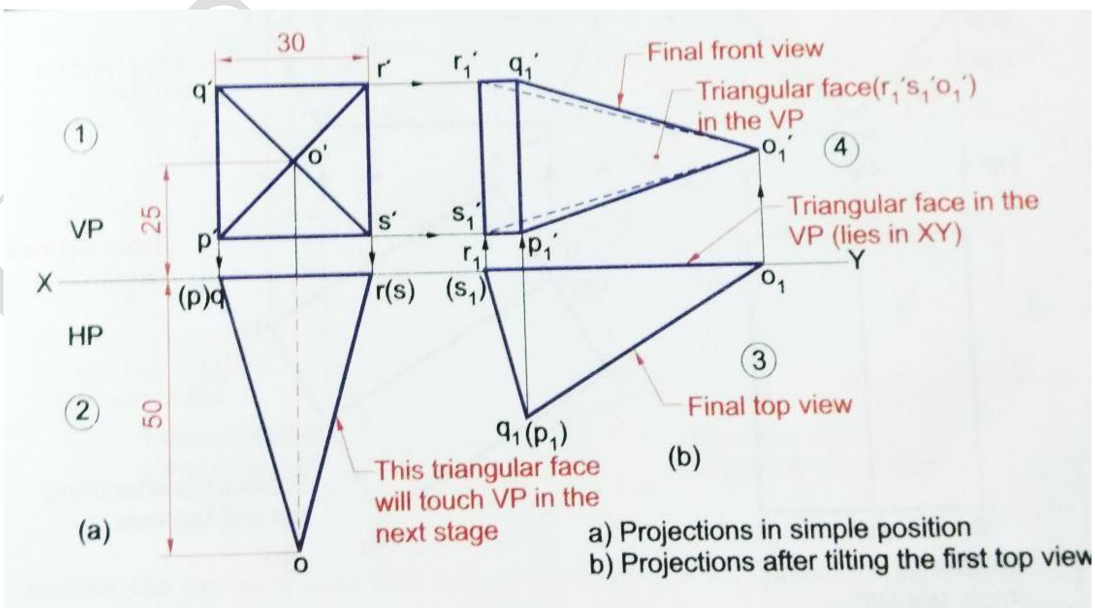
	 Fig. 31 (a) Projections in simple position (b) Projections after tilting the first top view (c) Projections by introducing a new reference line Initial front view **(3 M)** Initial top view **(3 M)** Actual top view **(7 M)** Actual front view **(7 M)**
4	**A tetrahedron of edge 30 mm rests on one of its edges on the VP. That edge is normal to the HP. One of the faces containing the resting edge is inclined at 30° to the VP. Draw the projections of the tetrahedron. (Nov. 2015) (Jan2019) (20 M)** BTL3 **Answer: Page: 245– K.V. Natarajan**



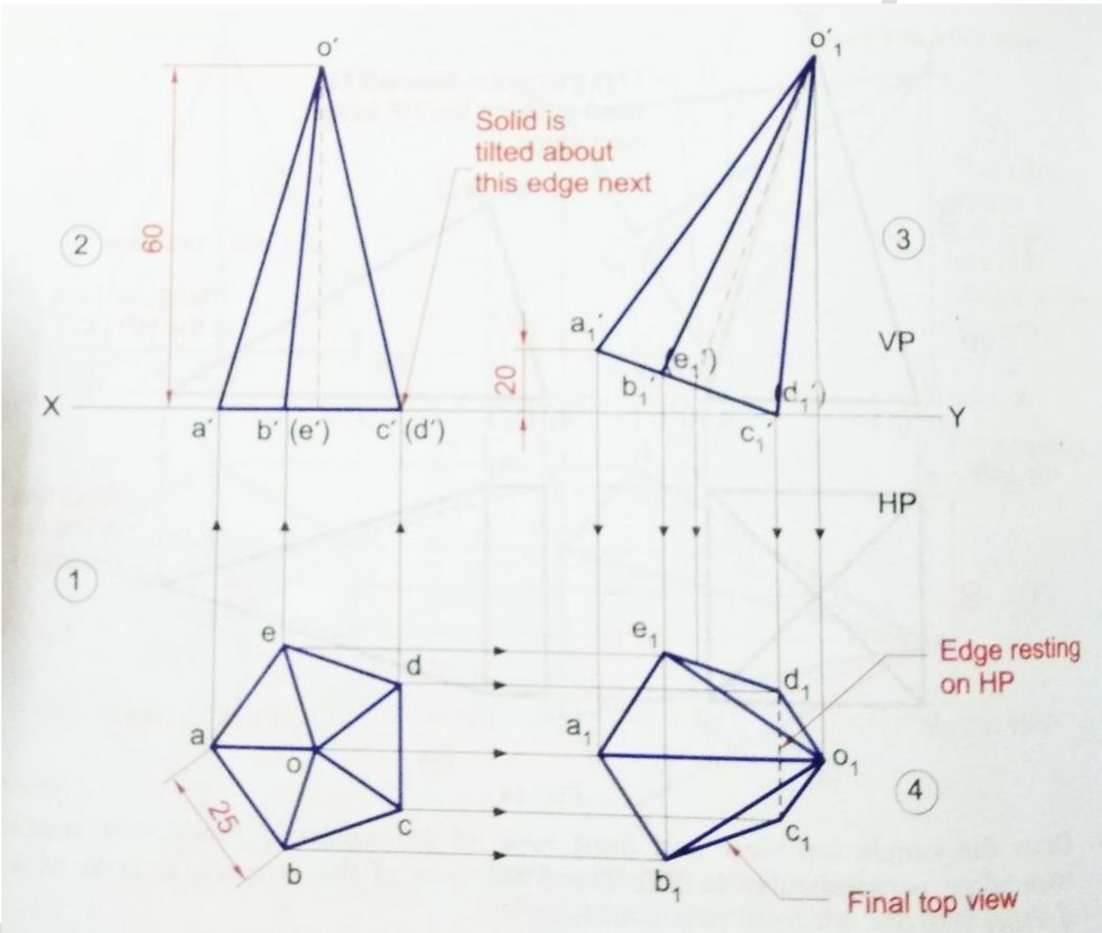
Initial front view **(3 M)**
Initial top view **(3 M)**
Actual top view **(7 M)**
Actual front view **(7 M)**

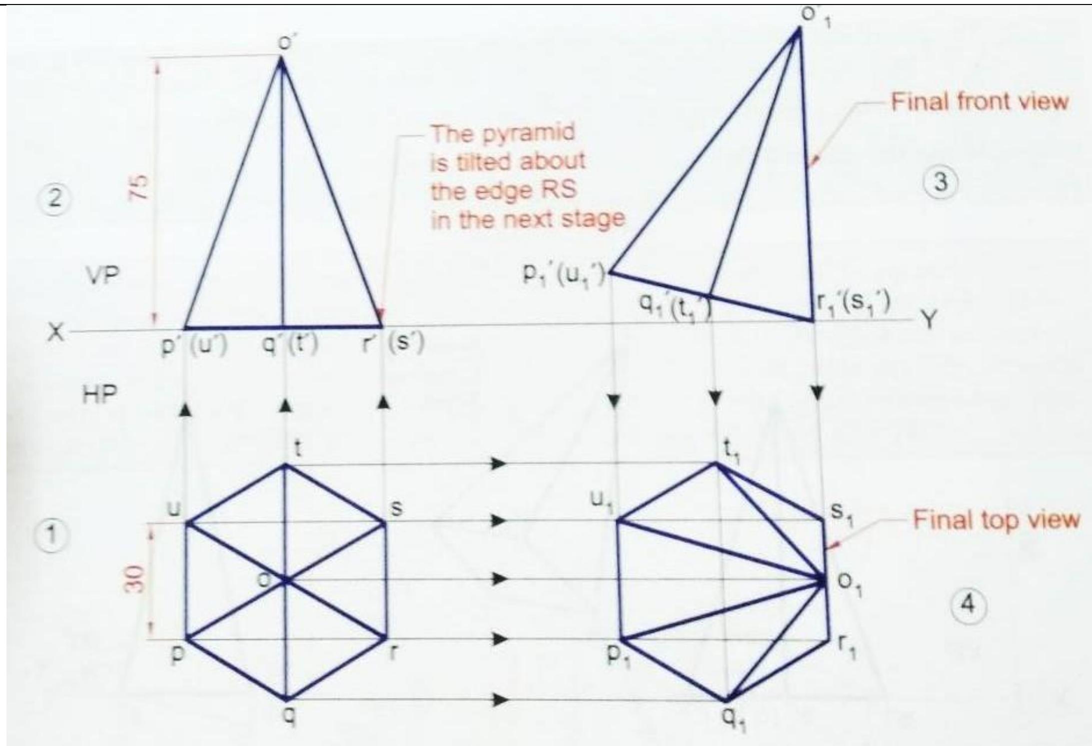
5 **A square pyramid of base side 30 mm, axis length 50 mm has one of its triangular faces in the VP and the axis parallel to and 25 mm above the HP. Draw its projection. (May 2013) (20 M)** BTL3

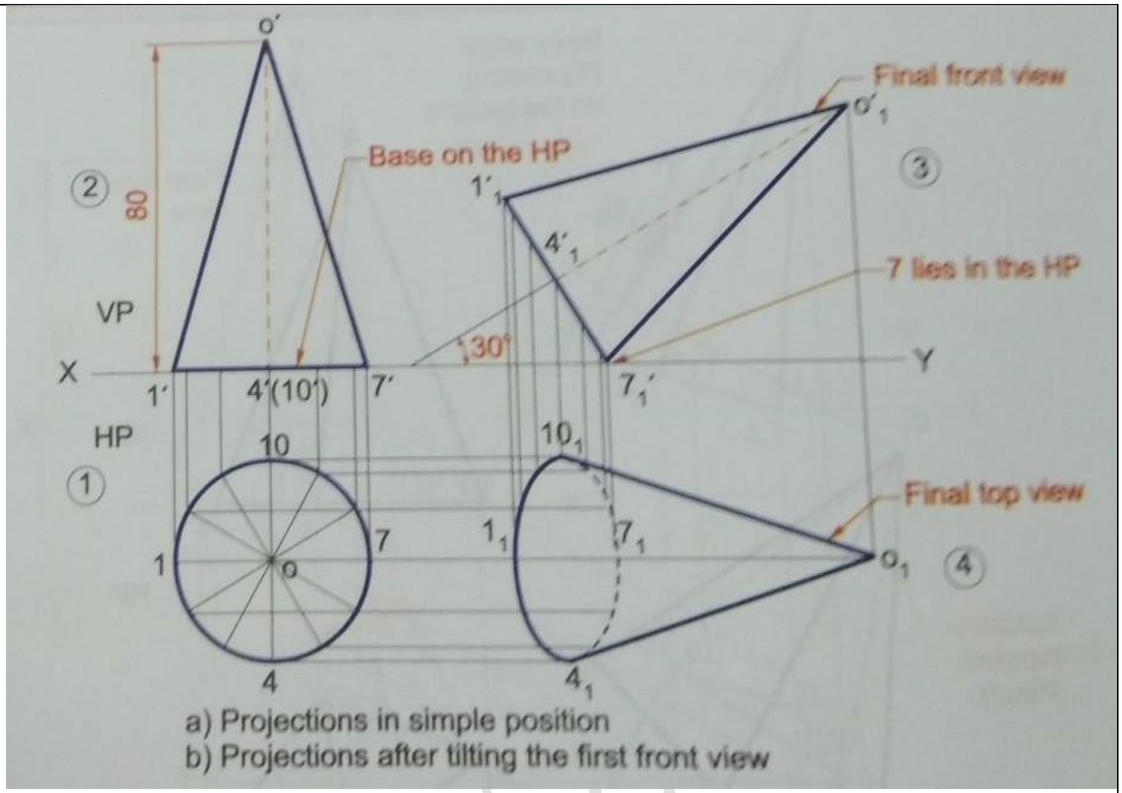
Answer: Page: 244 – K.V. Natarajan

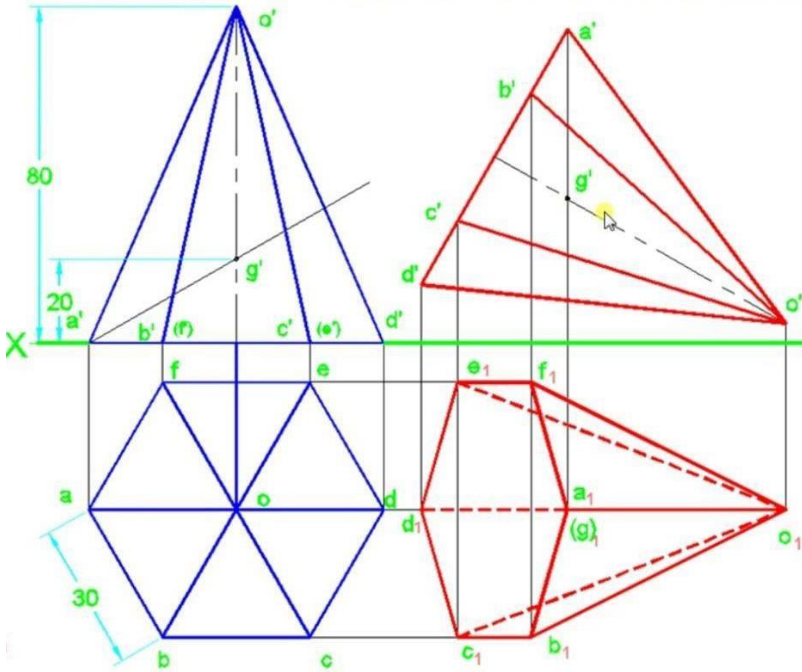


Initial front view **(3 M)**

	Initial top view **(3 M)** Actual top view **(7 M)** Actual front view **(7 M)**
6	**A pentagonal pyramid of base edge 25 mm and axis length 60 mm rest on the base side on HP such that the highest base corner is 20 mm above HP. Its axis is parallel to the VP. Draw its top and front views. (Nov. 2013) (20 M)** BTL3 **Answer: Page: 257 – K.V. Natarajan**  Initial top view **(3 M)** Initial front view **(3 M)** Actual front view **(7 M)** Actual top view **(7 M)**
7	**A hexagonal pyramid of base side 30 mm and altitude 75 mm rest on the HP on one of its base edges such that the triangular face containing the resting edge is perpendicular to both the HP and the VP. Draw it projections. (May 2012) (20 M)** BTL3 **Answer: Page: 267 – K.V. Natarajan**

	 Initial top view **(3 M)** Initial front view **(3 M)** Actual front view **(7 M)** Actual top view **(7 M)**
8	**Draw the projections of a cone of base diameter 50 mm and axis length 70 mm when it is lies on the ground on one of its generators with the axis parallel to the VP. (Nov. 2012) (Jan2018) (20 M)** BTL3 **Answer: Page: 259 – K.V. Natarajan**

	 Initial top view **(3 M)** Initial front view **(3 M)** Actual front view **(7 M)** Actual top view **(7 M)**
9	**A hexagonal pyramid having a base with a 30mm side and an 80mm long axis is freely suspended from one of the corner of the base. Draw its projections when its axis is parallel to the VP. (Jan2019) (20 M)** BTL3 **Answer: Page: 314 – T.Jeyapoovan**

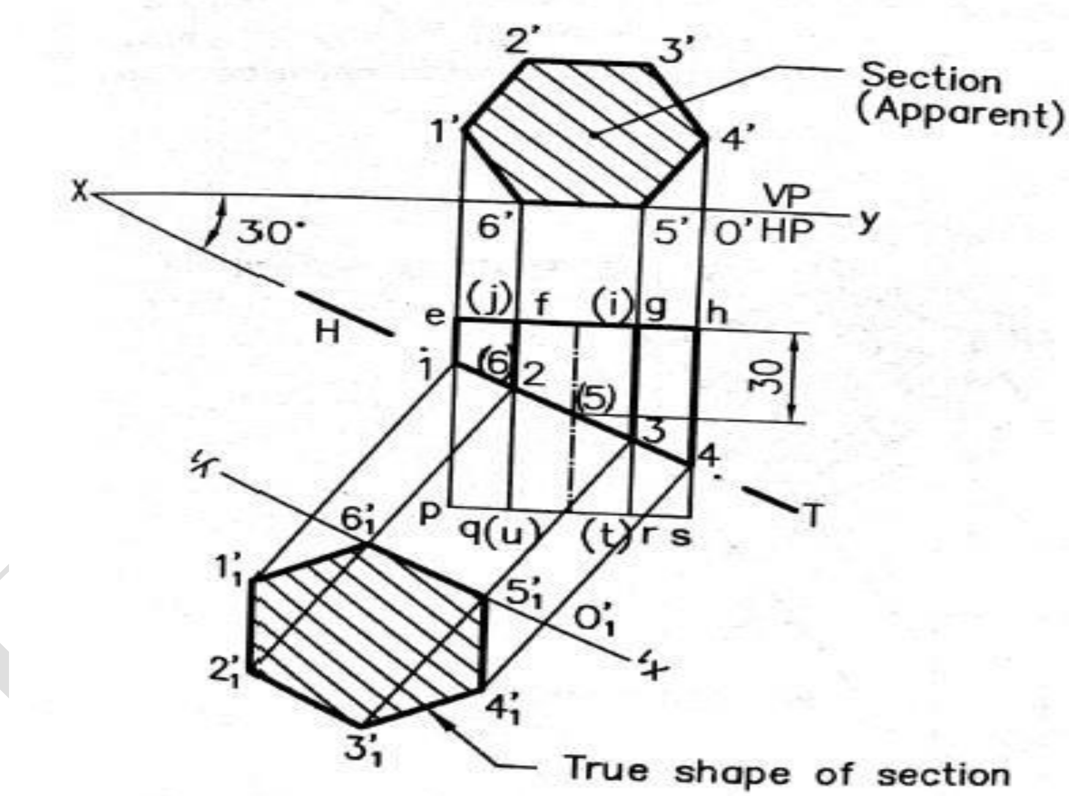


Initial top view **(3 M)**
Initial front view **(3 M)**
Actual front view **(7 M)**
Actual top view **(7 M)**

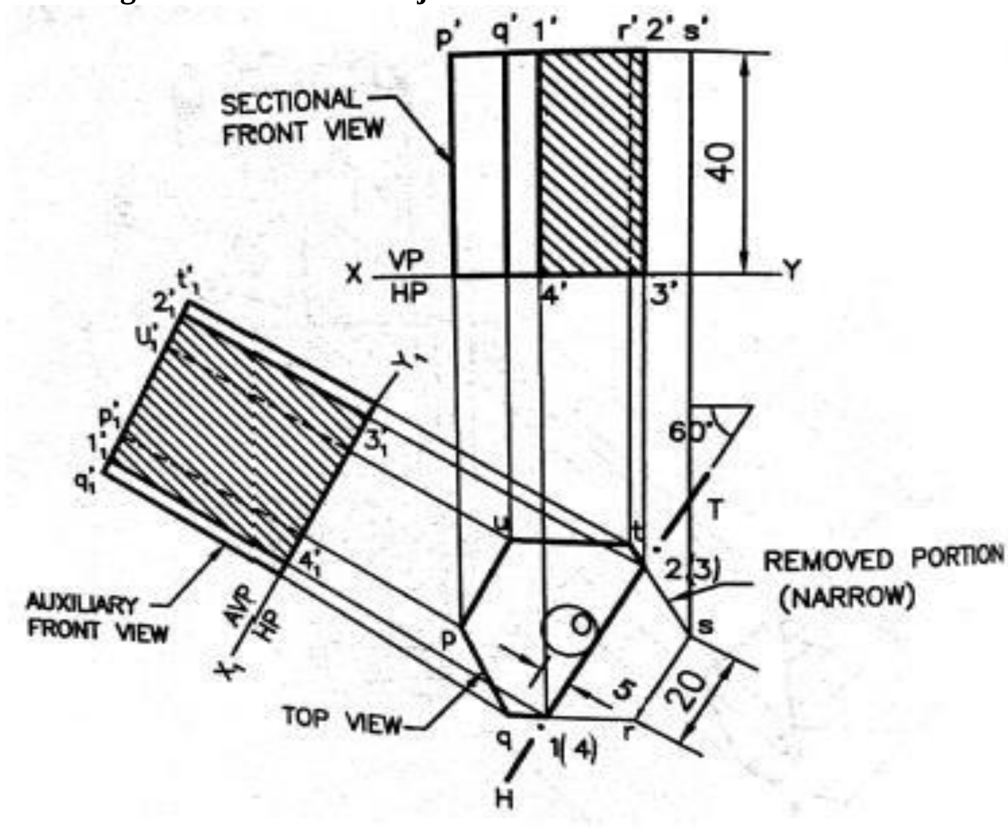
	UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES
	Sectioning of solids mentioned in unit-III with simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.
Q.No.	**Questions**

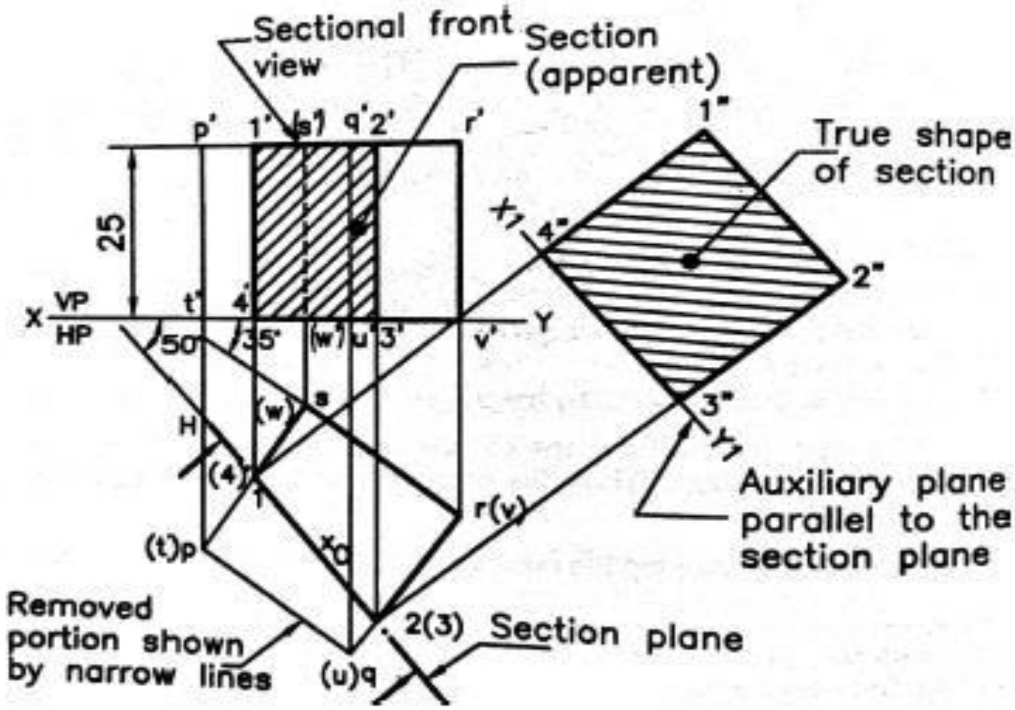
1

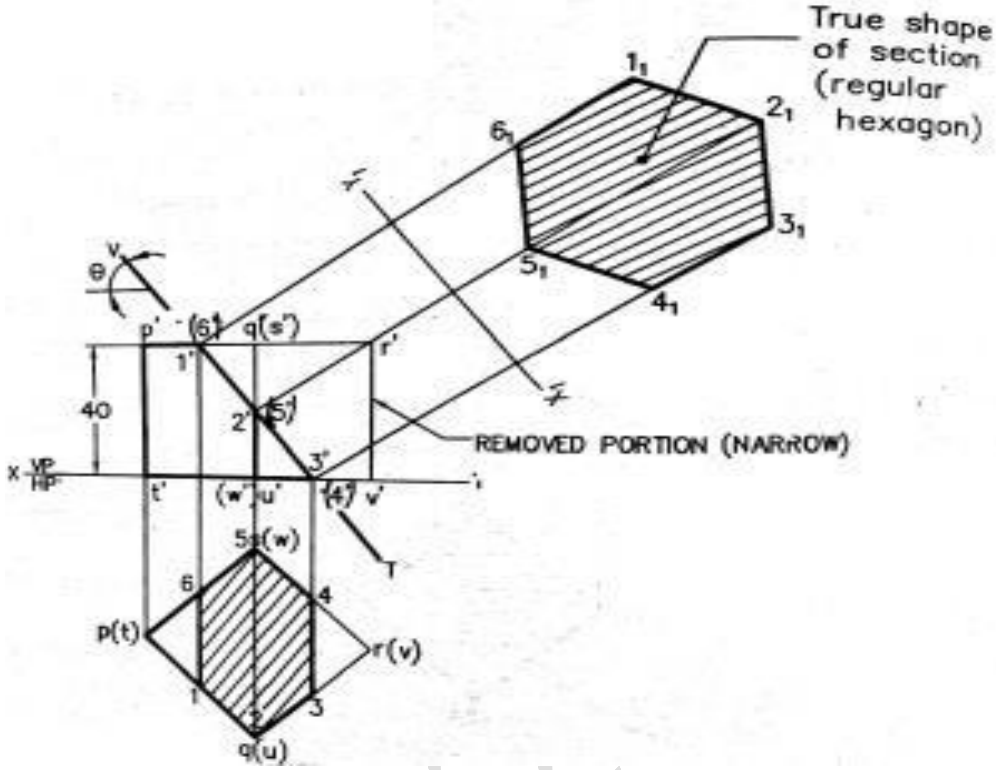
A hexagonal prism of base 30mm and axis length 70mm rest on the HP on one of its rectangular face with its axis perpendicular to the VP. It is cut by a vertical plane inclined at 30^{o} to the VP. The cutting plane meets the axis at a distance of 30mm from one end. Draw the top view, sectional front view and the true shape of the sectional. (20 M) BTL3 **(Jan-2019)**
Answer: Page: 300 – K.V. Natarajan



front view **(3 M)**
top view **(2 M)**
cutting plane position **(3 M)**
sectional front view **(2 M)**
True shape of section **(7 M)**
Lettering and dimensioning **(3 M)**

2	**A hexagonal prism of base side 20mm and height 40mm rests on the HP on one of its ends with two rectangular faces parallel to the VP. It is cut by a plane perpendicular to the HP and inclined at 60º to the VP at a distance of 5mm from the axis. Draw the top view, sectional front view and an auxiliary front view on the AVP parallel to the cutting plane. (20 M)** BTL3 **(Jan-2019)** **Answer: Page: 304 – K.V. Natarajan**  Top view **(3M)** front view **(2 M)** cutting plane position **(3 M)** sectional front view **(2 M)** True shape of section **(7 M)** Lettering and dimensioning **(3 M)**
3	**A cube of side 25mm rests on the HP on one of it faces with a vertical face inclined at 35ºto the VP. A plane perpendicular to the HP and inclined at 50ºto the VP cuts the cube, 3mm away from the axis. Draw the top view and the sectional front view. Also draw the true shape of the section. (20 M)** BTL3 **Answer: Page: 294 – K.V. Natarajan (Nov-2018)**

	 top view **(3 M)** front view **(2 M)** cutting plane position **(3 M)** sectional front view **(2 M)** True shape of section **(7 M)** Lettering and dimensioning (**3 M)**
4	**A cube of side 40mm is placed and cut by a plane in such a way that the true shape of the section is a regular hexagon. Draw the front and top views of the cube and determine the inclination of the plane with the HP. (20 M)** BTL3 **Answer: Page: 298 – K.V. Natarajan (Nov-2018)**



top view **(3M)**
front view **(2 M)**
cutting plane position **(3 M)**
sectional top view **(2 M)**
True shape of section **(7 M)**
Lettering and dimensioning **(3 M)**

5 **A cylinder of diameter 40mm and height 50mm rests on its base on the HP. It is cut by a plane perpendicular to the VP and inclined at 50º to the HP. The cutting plane meets the axis at a distance of 15mm from the top. Draw the front view sectional top view and the true shape of the section. (20 M)** BTL3
Answer: Page: 324 – K.V. Natarajan (Nov-2018)

<table>
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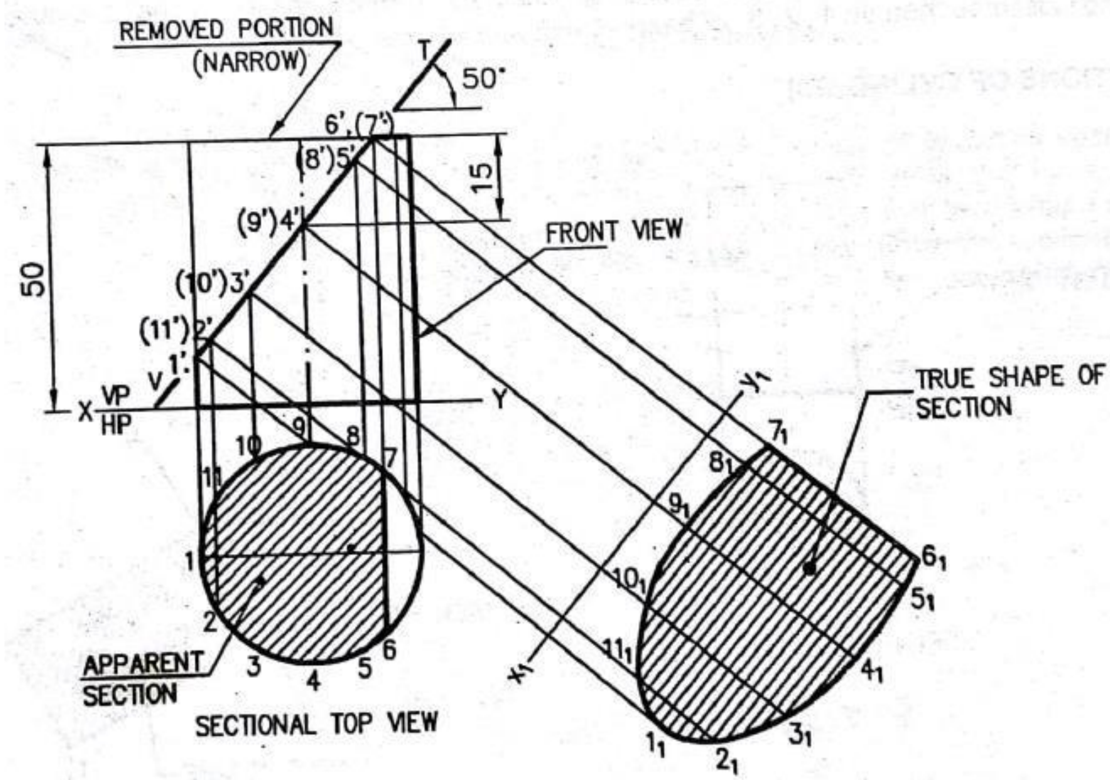
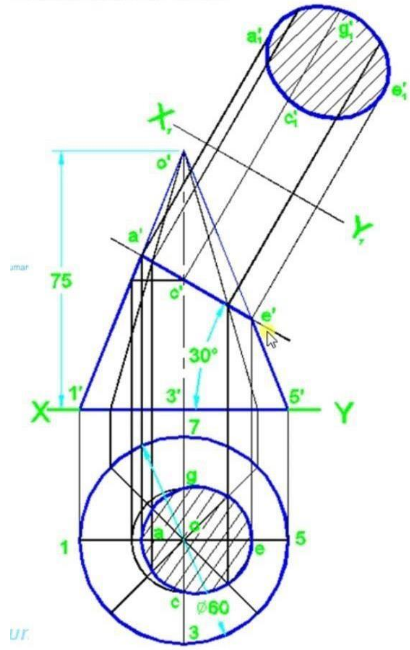
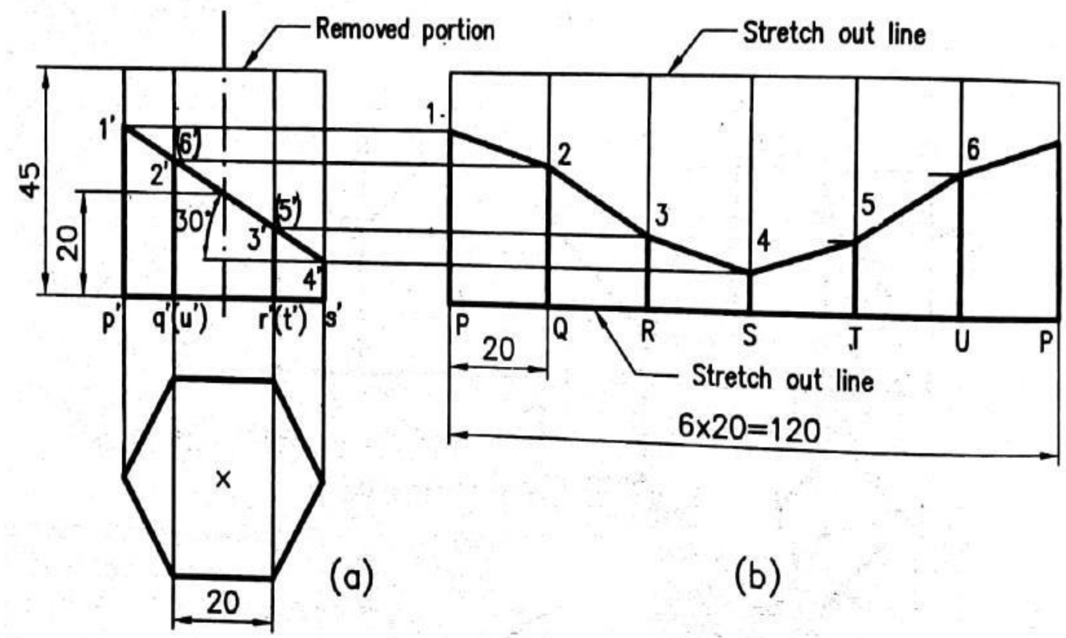
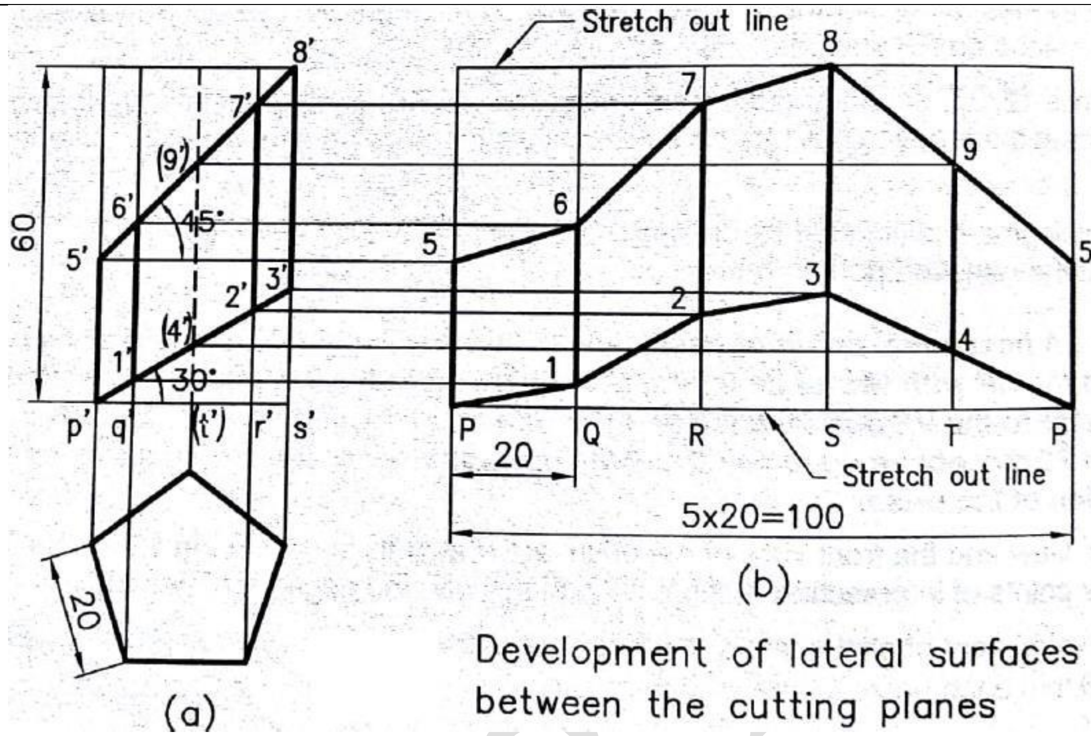
<td>


top view (3 M)
front view (2 M)
cutting plane position (3 M)
sectional top view (2 M)
True shape of section (7 M)
Lettering and dimensioning (3 M)
</td>
</tr>
<tr>
<td>6</td>
<td>A circular cone of base diameter 60mm and height 75mm is resting on its base on the HP. It's cut by a plane perpendicular to the VP and inclined at 30^0 to HP bisecting the axis of the cone. Draw the sectioned top view and true shape of the section when top half of the sectioned solid is removed. (Jan2019)(20 M) BTL3
Answer: Page: 328 – K.V. Natarajan</td>
</tr>
</table>

	 top view **(3 M)** front view **(2 M)** cutting plane position **(3 M)** sectional top view **(2 M)** True shape of section **(7 M)** Lettering and dimensioning **(3 M)**
7	**A hexagonal prism of base side 20mm and height 45mm is resting on one of its ends on the HP with two of its lateral face parallel to the VP. It is cut by a plane perpendicular to the VP and inclined at 30^{o} to the HP. The plane meets the axis at a distance of 20mm about the base. Draw the development of the lateral surface of the lower portion of the prism. (20 M)** BTL3 **Answer: Page: 353 – K.V. Natarajan (Nov-2018)**

	 Top view **(3 M)** front view **(2 M)** Stretch out line equal to circumference of polygon **(3 M)** Equal divisions of development area as per polygon **(2 M)** Marking and drawing of lateral development **(7 M)** Lettering and dimensioning **(3 M)**
8	**A pentagonal prism of base side 20mm and height 60mm is cut by two planes as shown in Fig. (a). Draw the development of the lateral surfaces of the portion between the planes. (20 M)** BTL3 **Answer: Page: 354 – K.V. Natarajan (Nov-2018)**

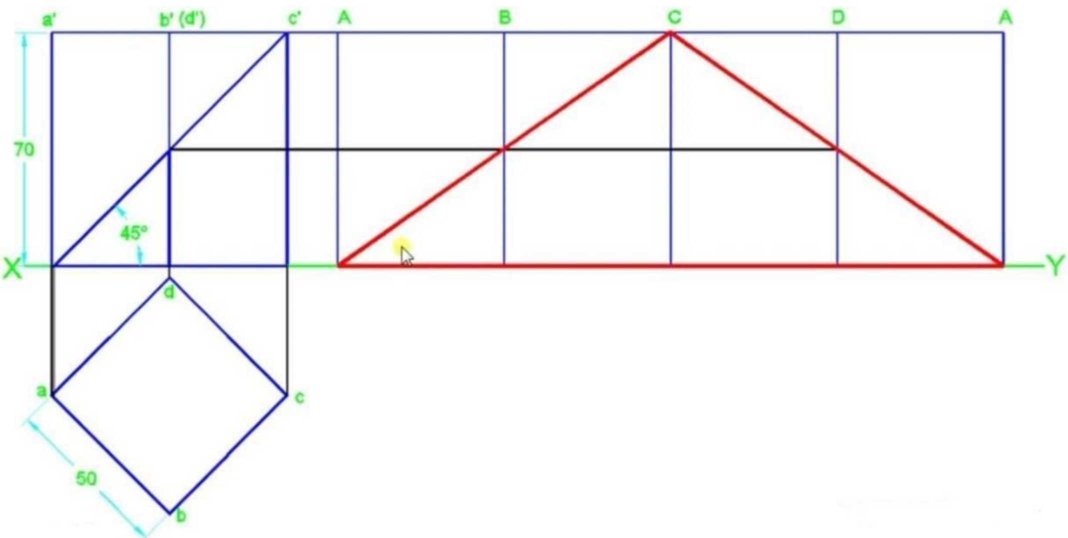


Top view	**(3 M)**
front view	**(2 M)**
Stretch out line equal to circumference of polygon	**(3 M)**
Equal divisions of development area as per polygon	**(2 M)**
Marking and drawing of lateral development	**(7 M)**
Lettering and dimensioning	**(3 M)**

9

A square prism of base edge is 50mm and 70mm long is standing on its base with its face equally inclined to the VP. Its cut by a section plane is inclined at 45^0 to HP and passing through the intersection of the top surface and the face of the solid. Draw the development of the lateral surfaces of the lower portion of the truncated solid. (Jn2019)(20 M) BTL3

Answer: Page: 347 – K.V. Natarajan

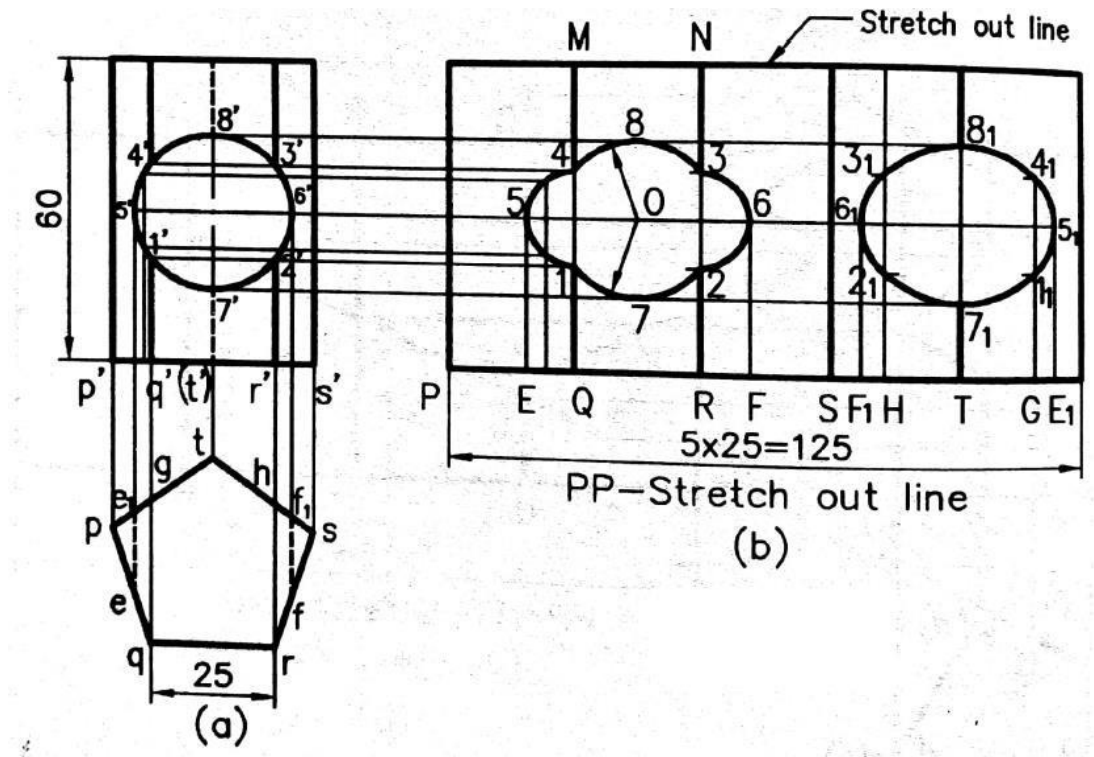


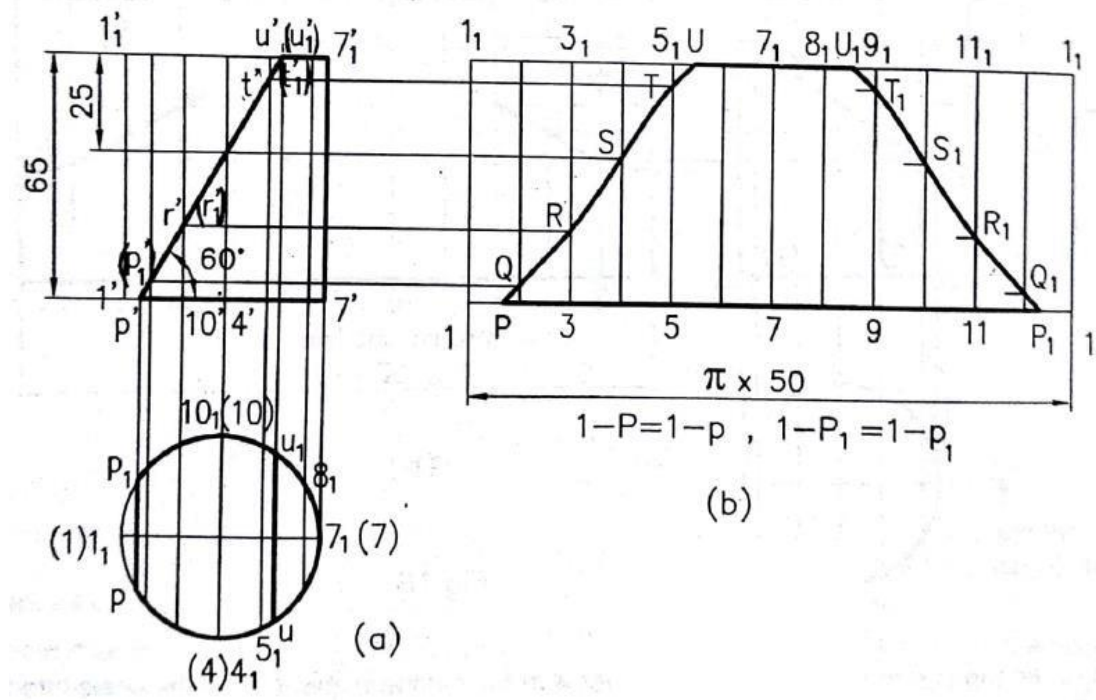
Top view	**(3 M)**
front view	**(2 M)**
Stretch out line equal to circumference of polygon	**(3 M)**
Equal divisions of development area as per polygon	**(2 M)**
Marking and drawing of lateral development	**(7 M)**
Lettering and dimensioning	**(3 M)**

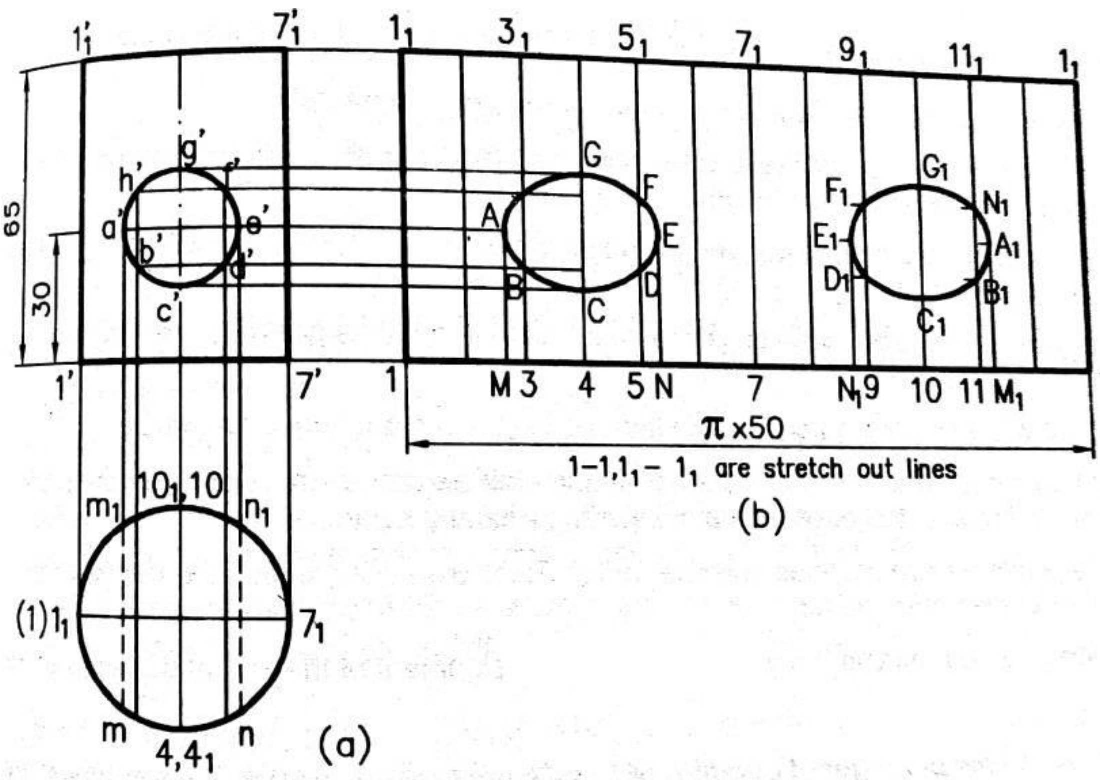
10

A pentagonal prism of base side 25mm and height 60mm stands on one of its ends on the HP with a rectangular face parallel to the VP. A hole of diameter 30mm is drilled centrally through the prism in such a way that the axis of the hole bisects the axis of the prism at right angles. The axis of the hole is perpendicular to the VP. Draw the development of the lateral surfaces of the prism. (20 M) BTL3

Answer: Page: 358 – K.V. Natarajan (May-2018)

	 Top view **(3 M)** front view **(2 M)** Stretch out line equal to circumference of polygon **(3 M)** Equal divisions of development area as per polygon **(2 M)** Marking and drawing of lateral development **(7 M)** Lettering and dimensioning **(3 M)**
11	**Draw the development of the lateral surface of the right portion of the cylinder of diameter 50mm and height 65mm cut by a plane perpendicular to the VP and inclined at 60°to the base and passing through the axis at a height of 40mm above base. (20M)**BTL3 **Answer: Page: 360 – K.V. Natarajan (Nov-2017)**

	 Top view **(3 M)** front view **(2 M)** Stretch out line equal to circumference of polygon **(3 M)** Equal divisions of development area as per polygon **(2 M)** Marking and drawing of lateral development **(7 M)** Lettering and dimensioning **(3 M)**
12	**A circular hole of diameter 30mm is drilled through a vertical cylinder of diameter 50mm and 65mm. The axis of the hole is perpendicular to the VP and meets the axis of the cylinder at right angles at a height of 30mm above the base Draw the development of the lateral surface of the cylinder. (20 M)** BTL3 **Answer: Page: 363 – K.V. Natarajan (Nov-2017)**



	Top view **(3 M)** front view **(2 M)** Stretch out line equal to circumference of polygon **(3 M)** Equal divisions of development area as per polygon **(2 M)** Marking and drawing of lateral development **(7 M)** Lettering and dimensioning **(3 M)**
13	**A hexagonal pyramid of base 25mm and altitude 50mm is resting vertically on its base on the ground with two of the side of the base perpendicular to the VP. It is cut by a plane perpendicular to the VP and inclined at 40º to the HP. The plane bisects the axis of the pyramid. Draw the development of the lateral surface of the pyramid. (20 M)** BT L3 **Answer: Page: 367 – K.V. Natarajan (May-2017)**

<table>
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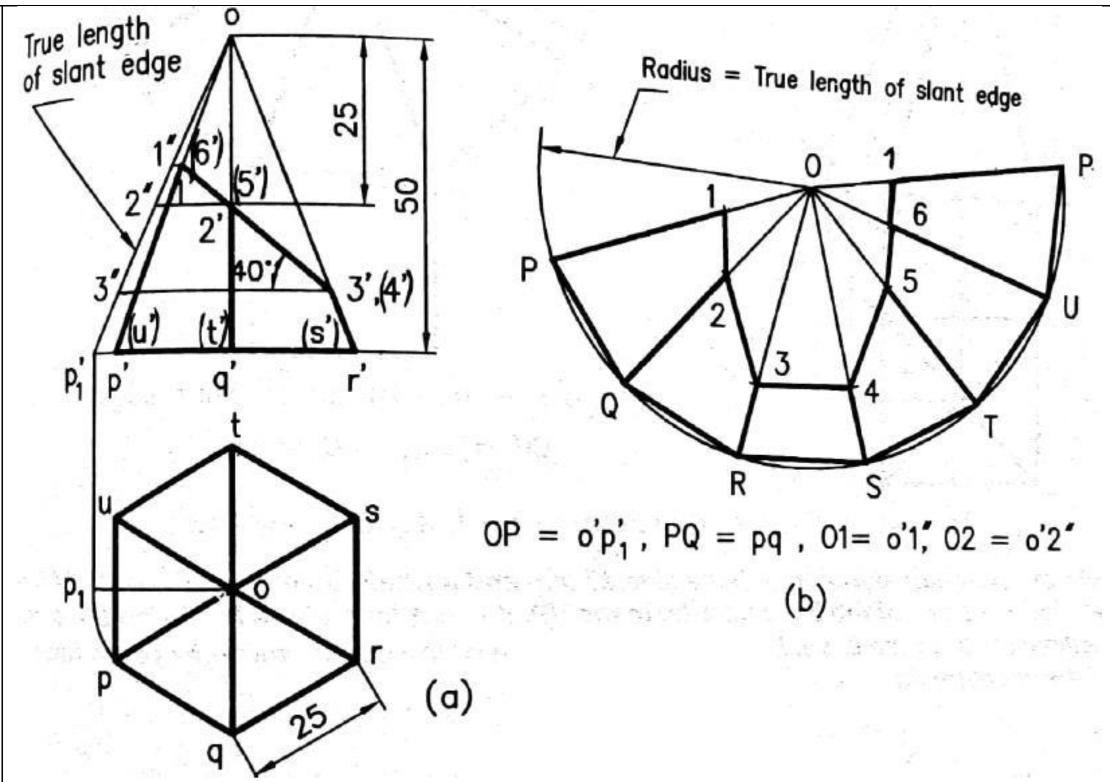
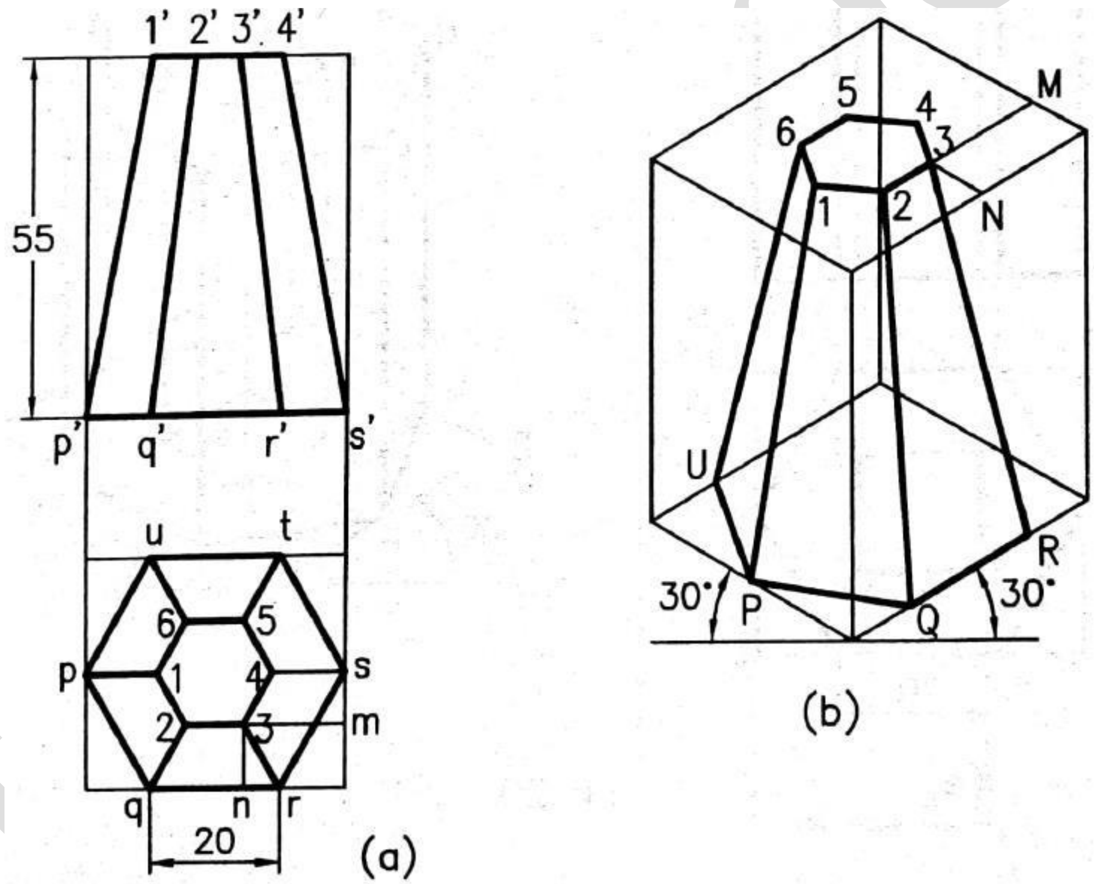
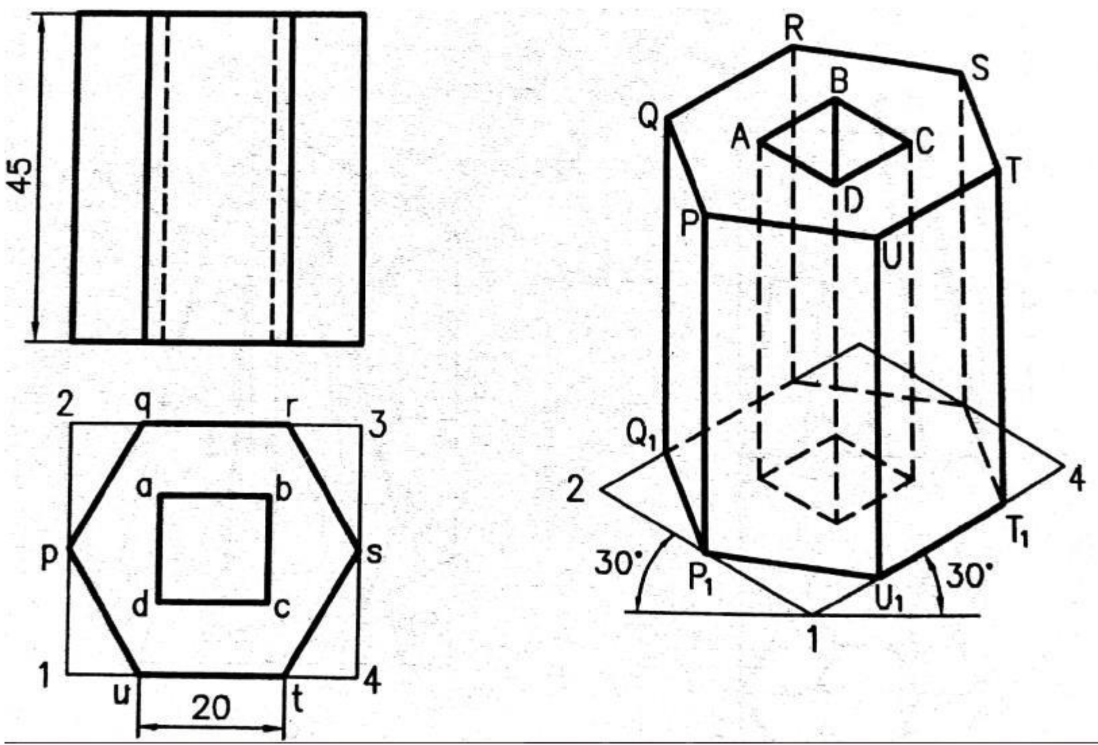
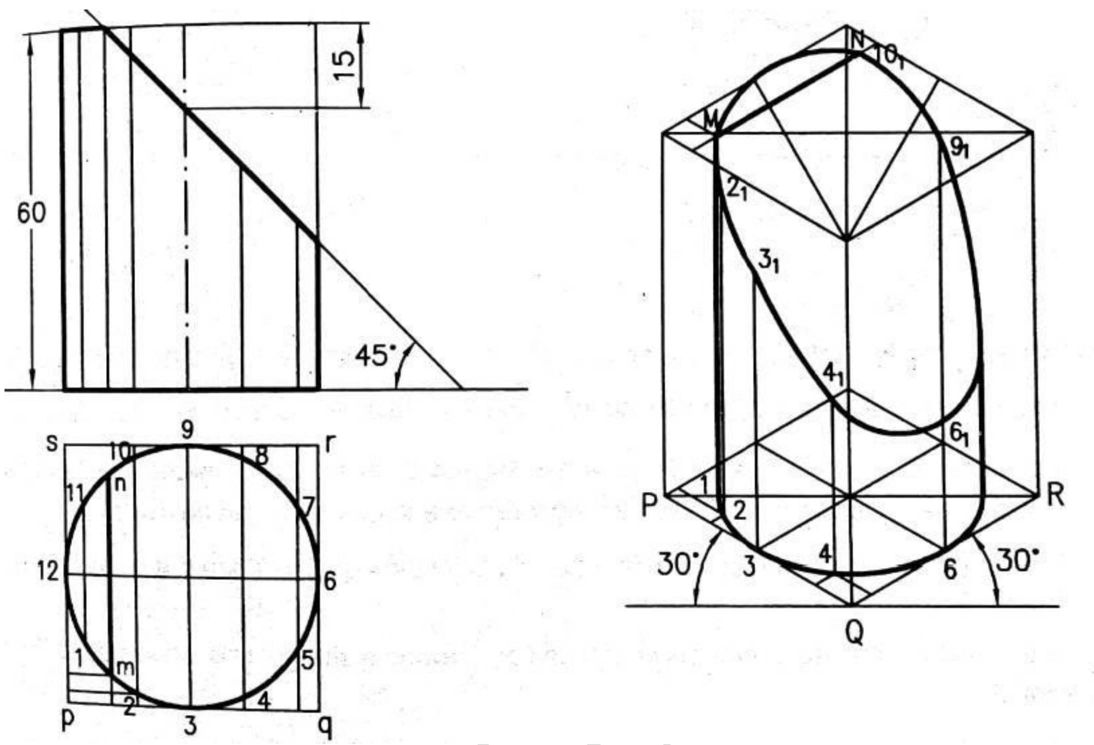


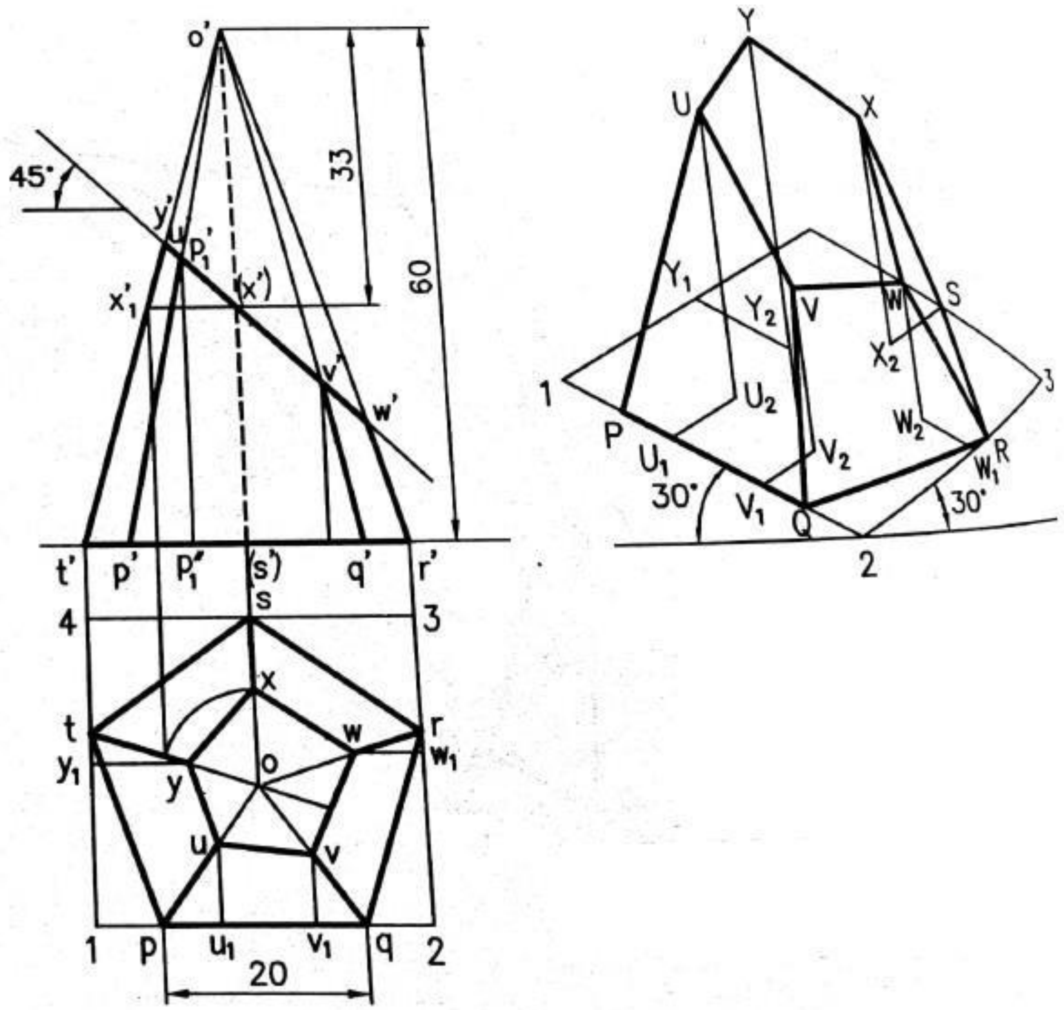
Top view **(3 M)**
front view **(2 M)**
Stretch out line equal to circumference of polygon **(3 M)**
Equal divisions of development area as per polygon **(2 M)**
Marking and drawing of lateral development **(7 M)**
Lettering and dimensioning **(3 M)**
</td>
</tr>
<tr>
<td>14</td>
<td>
A right circular cone if base diameter 60mm and height 70mm is resting on its base on the ground. It is cut by a plane perpendicular to the VP and inclined at 30°to the HP. The cutting plane bisects the axis of the cone. Draw the development of the lateral surface of the truncated cone. (20 M) BTL3
Answer: Page: 374 – K.V. Natarajan (May-2017)
Top view (3 M)
front view (2 M)
Stretch out line equal to circumference of polygon (3 M)
Equal divisions of development area as per polygon (2 M)
Marking and drawing of lateral development (7 M)
Lettering and dimensioning (3 M)
</td>
</tr>
</table>

	UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS
	Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids- Prisms, pyramids and cylinders by visual ray method .
Q.No.	**Questions**
1	**Draw the isometric view of a frustum of a hexagonal pyramid when it is resting on its base on the HP with two sides of the base parallel to the VP. The side of base is 20 mm and top 8 mm. The height of the frustum is 55 mm**. **(20 M)** BTL3 **Answer: Page: 448 – K.V. Natarajan (Jan-2019)**  Top view **(3 M)** front view **(2 M)** isometric box **(5 M)** Completion of isometric object **(7 M)** Lettering and dimensioning **(3 M)**
2	**A hexagonal prism of base side 20 mm and height 45 mm has a square hole of side 16 mm at the centre. The axes of the square and hexagon coincide. One of the**

	faces of the square hole is parallel to a face of the hexagon. Draw the isometric view of the prism with hole to full scale. (20 M) BTL3 **Answer: Page: 449 – K.V. Natarajan (Jan-2019)**  Top view **(3 M)** front view **(2 M)** isometric box **(5 M)** Completion of isometric object **(7 M)** Lettering and dimensioning **(3 M)**
3	**Draw the isometric view of a cylinder of diameter 46 mm and height 60 mm when it is resting on one of its ends on the HP. It is cut by a plane perpendicular to the VP and inclined at 45 ° to the HP. The plane passes through a point on the axis located at 15 mm from the top. (20 M)** BTL3 **Answer: Page: 452 – K.V. Natarajan (Nov-2018)**

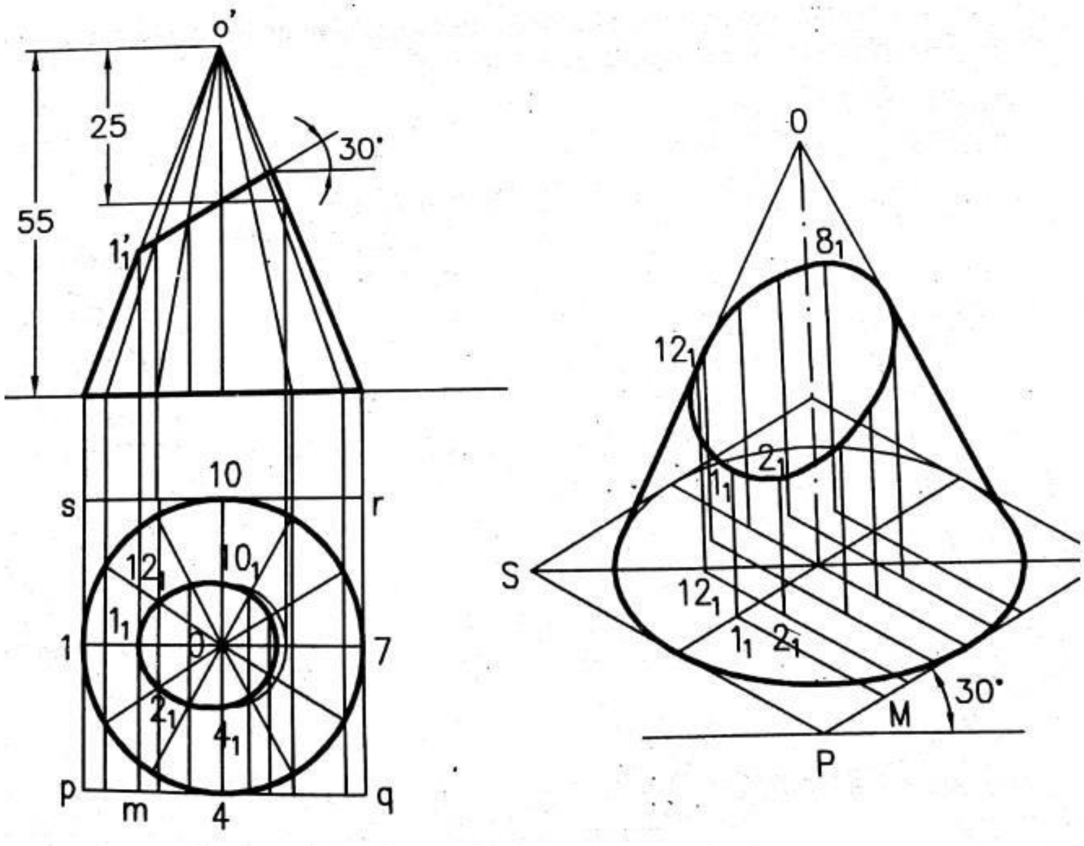
<table>
<tr><td></td><td>

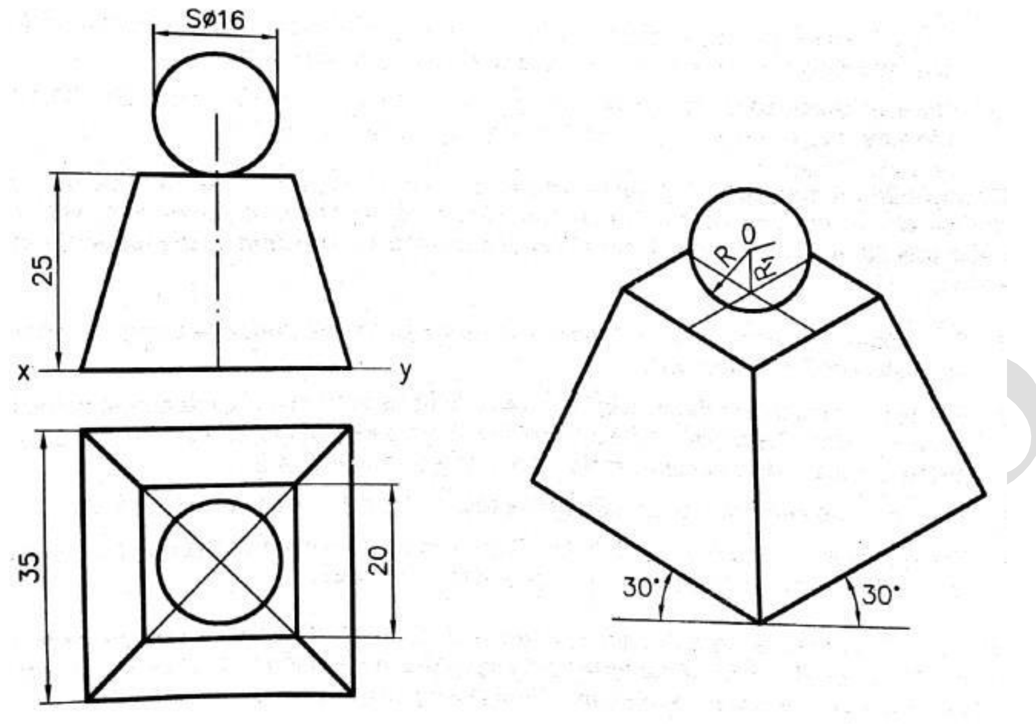
Top view (3 M)
front view (2 M)
isometric box (5 M)
Completion of isometric object (7 M)
Lettering and dimensioning (3 M)</td></tr>
<tr><td>4</td><td>A pentagonal pyramid of base edge 20 mm and height 60 mm rests on its base on the HP with a base edge parallel to the VP and farther away from the VP. A section plane perpendicular to the VP and inclined at 45° to the HP cuts the axis of the pyramid at a point 33 mm from the vertex. Draw the isometric view of the truncated pyramid such that the cut surface is visible. (20 M) BTL3
Answer: Page: 374 – K.V. Natarajan (Nov-2018)</td></tr>
</table>

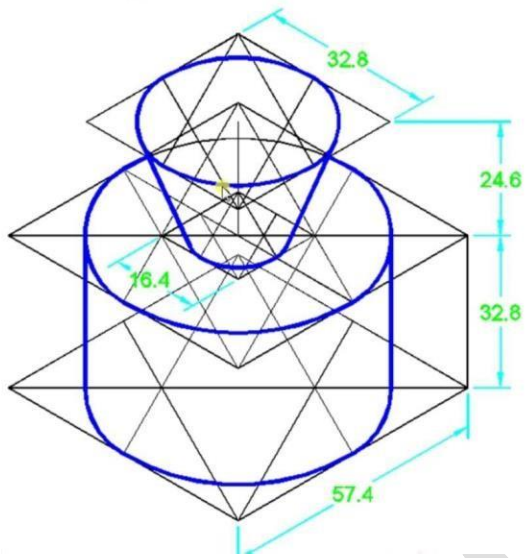


Top view **(3 M)**
front view **(2 M)**
isometric box **(5 M)**
Completion of isometric object **(7 M)**
Lettering and dimensioning **(3 M)**

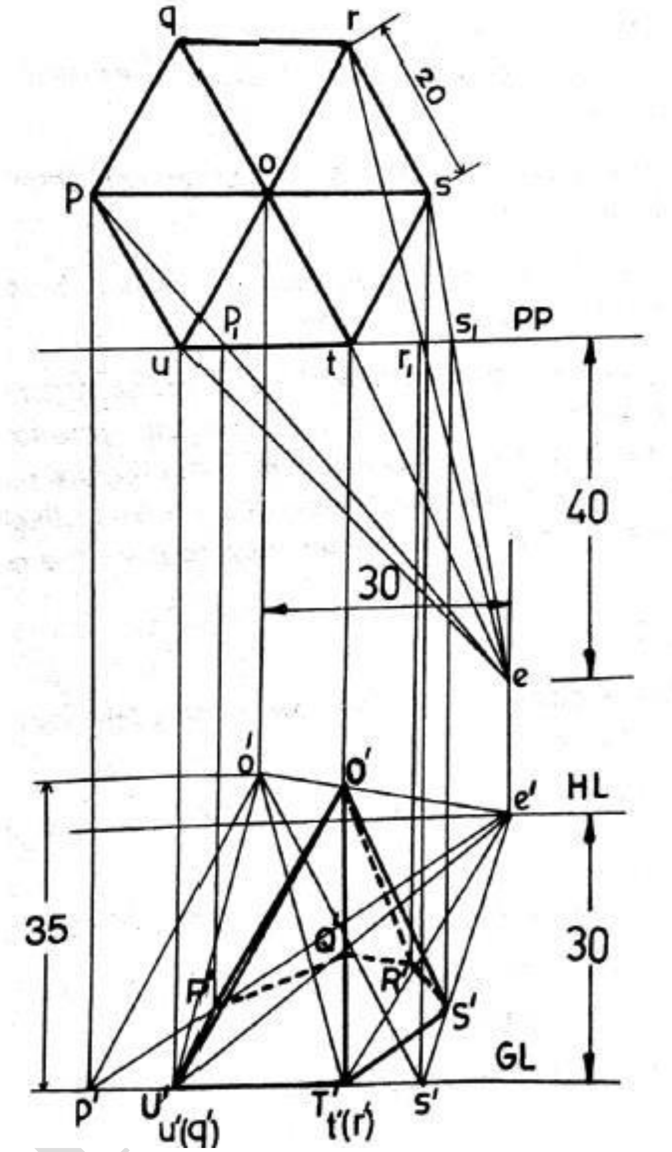
5 **A cone of base diameter 50 mm and height 55 mm is resting on its base on the HP. It is cut by a plane perpendicular to the VP and inclined at 30° to the HP. The plane meets the axis at a distance of 25 mm from the apex. Draw the isometric view of the truncated cone. (20 M)** BTL3
Answer: Page: 459 – K.V. Natarajan (May-2018)

	 Top view **(3 M)** front view **(2 M)** isometric box **(5 M)** Completion of isometric object **(7 M)** Lettering and dimensioning **(3 M)**
6	**Draw the isometric projection of a sphere of diameter 16 mm kept centrally over a frustum of a square pyramid of height 25 mm. The frustum has a base of side 35 mm and top of side 20 mm. (20 M)** BTL3 **Answer: Page: 462 – K.V. Natarajan (May-2018)**

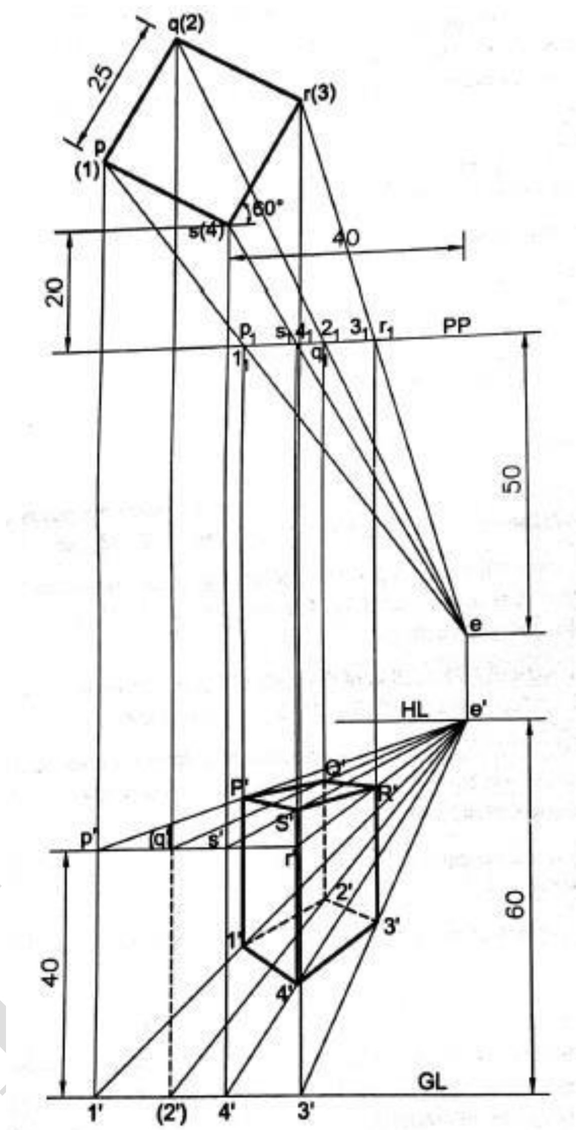
	 Top view **(3 M)** front view **(2 M)** isometric box **(5 M)** Completion of isometric object **(7 M)** Lettering and dimensioning **(3 M)**
7	**An inverted Frustum of a cone of base diameter 40mm and top diameter 20mm and 30mm long axis is placed centrally over a cylinder of diameter 70mm and 40mm height. Draw an isometric projection of the combined solids. (20 M)** BTL3 **Answer: Page: 460 – K.V. Natarajan (Jan2019)**



	Top view **(3 M)** front view **(2 M)** isometric box **(5 M)** Completion of isometric object **(7 M)** Lettering and dimensioning **(3 M)**
8	**A regular hexagonal pyramid of base edge 20 mm and height 35 mm rests on its base on the ground plane with one of its base edges touching the picture plane. The station point is 30 mm above the ground plane and 40 mm in front of the PP. The central plane is 30 mm to the right of the axis. Draw the perspective projection of the pyramid by visual ray method. Use the top view and the front view. (20 M)** BTL3 **Answer: Page: 489 – K.V. Natarajan (May-2018)**

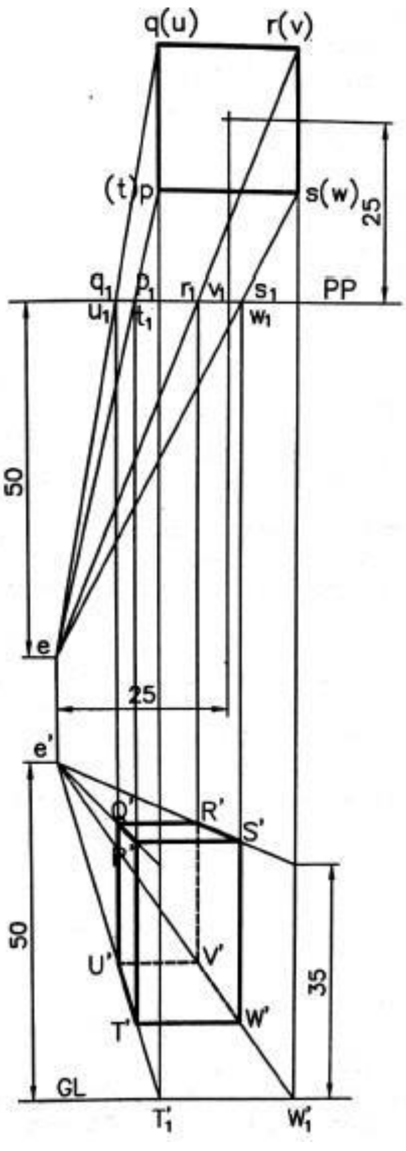
	
	Marking of PP,HL, GL and station point **(5 M)** Visual rays from each corner points of object to station point **(5 M)** Marking of piercing points on PP **(3 M)** Completion of perspective view **(5 M)** Lettering and dimensioning **(2 M)**
9	**A square prism of base 25×25 mm and height 40 mm rests on the GP on one of its ends with a rectangular face receding away from the PP towards right making 60 ° with PP. The corner nearest to the PP is 40 mm to the left of the station point and 20 mm behind the PP. The station point is 60 mm above the GP and 50 mm in front of the PP. Draw the perspective view of the prism by visual ray method. Use the top view and the front view. (20 M)** BTL3 **(Nov-2017)**

Answer: Page: 493 – K.V. Natarajan



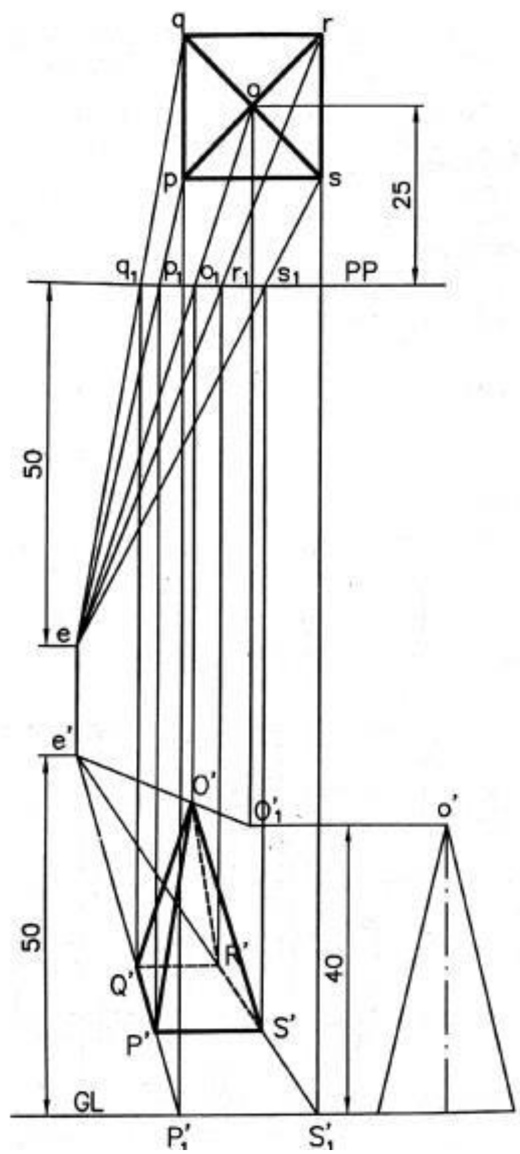
Marking of PP,HL, GL and station point	**(5 M)**
Visual rays from each corner points of object to station point	**(5 M)**
Marking of piercing points on PP	**(3 M)**
Completion of perspective view	**(5 M)**
Lettering and dimensioning	**(2 M)**

10 **Draw the perspective view of a square prism of base side 20 mm and height 35 mm resting on an end on the ground with a rectangular face parallel to the picture plane. The axis of the prism is 25 mm behind the PP and 25 mm to the right of**

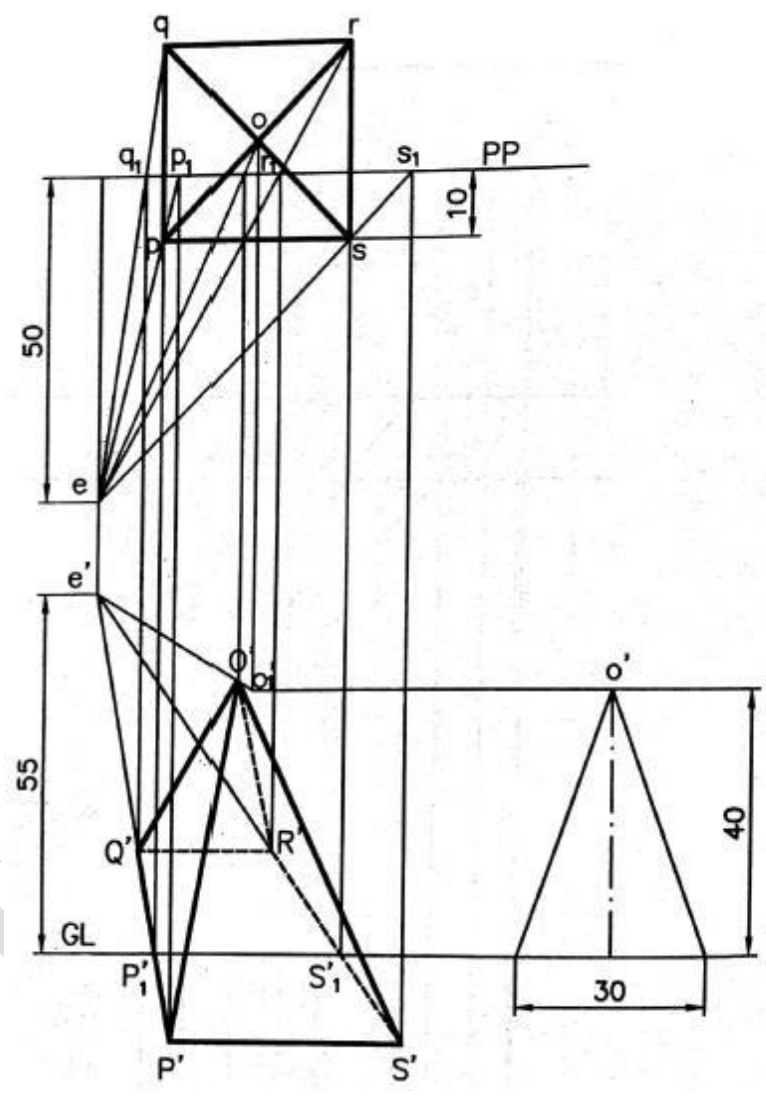
	the eye. The eye is 50 mm in front of the PP and 50 mm above the ground. (20 M) BTL3 **Answer: Page: 506 – K.V. Natarajan (Nov-2017)**  Marking of PP,HL, GL and station point **(5 M)** Visual rays from each corner points of object to station point **(5 M)** Marking of piercing points on PP **(3 M)** Completion of perspective view **(5 M)** Lettering and dimensioning **(2 M)**

11 **A square pyramid of base edge 20 mm and altitude 40 mm rests on its base on the ground with a base edge parallel to the picture plane. The axis of the pyramid is 25 mm behind the PP and 25 mm to the right of the eye. The eye is 50 mm in front of the PP and 50 mm above the ground. Draw the perspective view of the square pyramid. (20 M)** BTL3

Answer: Page: 506 – K.V. Natarajan (Nov-2017)



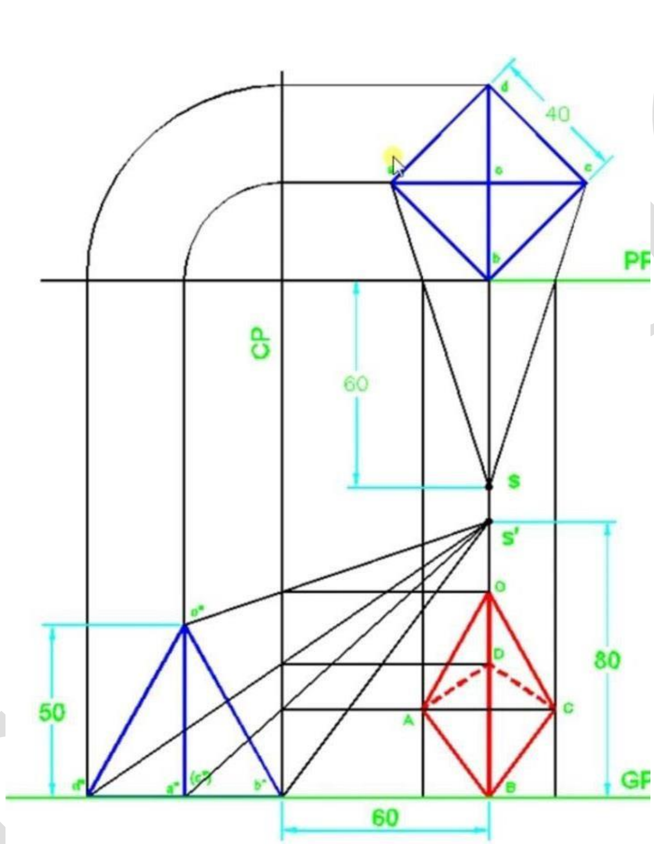
Marking of PP,HL, GL and station point	**(5 M)**
Visual rays from each corner points of object to station point	**(5 M)**
Marking of piercing points on PP	**(3 M)**
Completion of perspective view	**(5 M)**

	Lettering and dimensioning	**(2 M)**
12	**A square pyramid of base side 30 mm and altitude 40 mm rests on its base on the ground such that one of its base sides is parallel to the picture plane and 10 mm in front of it. The station point is 50 mm in front of the picture plane, 25 mm to the left of the axis of the pyramid and 55 mm above the ground. Draw the perspective view of the pyramid. (20 M)** BTL3 **Answer: Page: 511– K.V. Natarajan (Jan-2017)**  Marking of PP,HL, GL and station point **(5 M)** Visual rays from each corner points of object to station point **(5 M)** Marking of piercing points on PP **(3 M)** Completion of perspective view **(5 M)** Lettering and dimensioning **(2 M)**	

<table>
<tr>
<td>13</td>
<td>

A square pyramid of base 40mm altitude 50mm, rest with its base on the ground plane such that all the edges of the base equally inclined to the PP. one of the corner of the base is touching to the PP. the station point is 60mm in front of the PP, 80mm above the ground plane and lies in a central plane which passes through the axis of the pyramid. Draw the perspective projection. (20 M) BTL3

Answer: Page: 505 – K.V. Natarajan (Jan-2019)



Marking of PP,HL, GL and station point **(5 M)**
Visual rays from each corner points of object to station point **(5 M)**
Marking of piercing points on PP **(3 M)**
Completion of perspective view **(5 M)**
Lettering and dimensioning **(2 M)**

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<tr>
<td>14</td>
<td>

A circle of diameter 40 mm lies on the ground plane with its center 30 mm behind the picture plane. Draw its perspective view as seen from a station 50 mm in front of the PP, 40 mm above the ground and 40 mm to the left of the centre of the circle. (20 M) BTL3

Answer: Page: 509 – K.V. Natarajan (Jan-2017)

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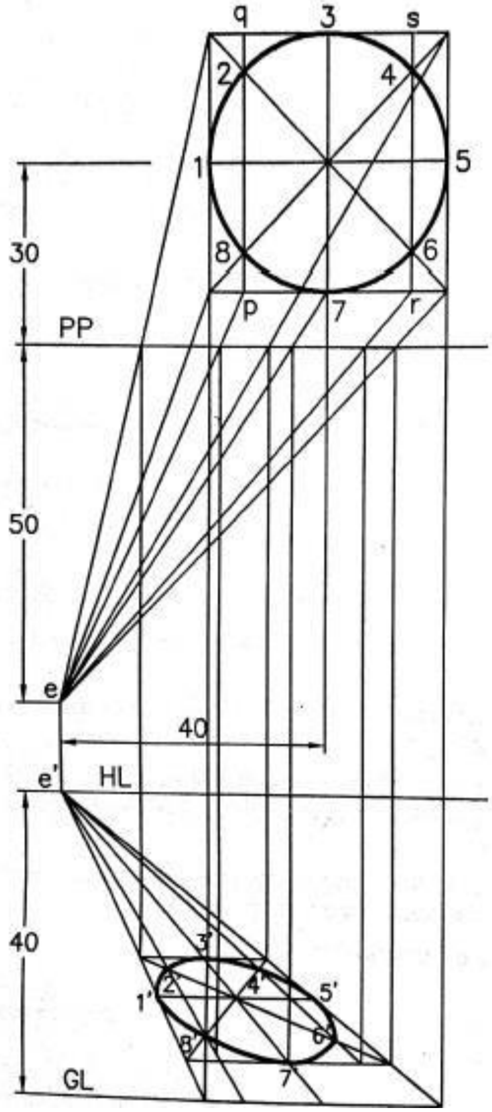

Marking of PP,HL, GL and station point	**(5 M)**
Visual rays from each corner points of object to station point	**(5 M)**
Marking of piercing points on PP	**(3 M)**
Completion of perspective view	**(5 M)**
Lettering and dimensioning	**(2 M)**