JEPPIAAR INSTITUTE OF TECHNOLOGY

"Self Belief | Self Discipline | Self Respect"

QUESTION BANK

Regulation : 2013

Year/Semester : IV

Semester : 08

Batch : 2016 - 2020

DEPARTMENT OF ELECTRONICS AND COMMUNICATION 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.

DEPARTMENTVISION

To enhance and impart futuristic and innovative technological education for the excellence of Electronics and Communication Engineering with new ideas and innovation to meet industrial expectation and social needs with ethical and global awareness reinforced by an efficiency through research platform for the advancement of humanity.\

MISSION

M1: To produce competent and high-quality professional Engineers in the field of Electronics and Communication Engineering for the benefit of the society globally.

M2: To provide a conducive infrastructure and environment for faculty and students with enhanced laboratories, to create high quality professionals

M3: To provide Prerequisite Skills in multidisciplinary areas for the needs of Industries, higher education and research establishments and entrepreneurship

M4: To handle Socio Economic Challenges of Society by Imparting Human Values and Ethical Responsibilities.

Program Educational Objectives (PEOs)

PEO 1: Graduate Engineers will have knowledge and skills required for employment and an advantage platform for lifelong learning process.

PEO 2: Graduate Engineers will be provided with futuristic education along with the perspective research and application based on global requirements.

PEO 3: Graduate Engineers will have effective communication skills and work in multidisciplinary team.

PEO 4: Graduate Engineers will develop entrepreneurship skills and practice the profession with integrity, leadership, ethics and social responsibility.

Program Specific Outcomes (PSOs)

PSO 1 : Ability to develop and utilize novel, compact and power efficient coherent theoretical and practical methodologies in the field of analog and digital electronics.

PSO 2: Ability to implement analog, digital and hybrid communication Protocol to aspect the challenges in the field of Telecommunication and Networking.

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.

TABLE OF CONTENT

EC6801 WIRELESS COMMUNICATION L T P C
3 0 0 3

OBJECTIVES: The student should be made to:

- Know the characteristic of wireless channel
- Learn the various cellular architectures
- Understand the concepts behind various digital signaling schemes for fading channels
- Be familiar the various multipath mitigation techniques
- Understand the various multiple antenna systems

UNIT I WIRELESS CHANNELS 9

Large scale path loss – Path loss models: Free Space and Two-Ray models -Link Budget design – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters-Coherence bandwidth – Doppler spread & Coherence time, Fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Doppler spread – fast fading – slow fading.

UNIT II CELLULAR ARCHITECTURE 9

Multiple Access techniques – FDMA, TDMA, CDMA – Capacity calculations–Cellular concept- Frequency reuse – channel assignment- hand off- interference & system capacity- trunking & grade of service – Coverage and capacity improvement.

UNIT III DIGITAL SIGNALING FOR FADING CHANNELS 9

Structure of a wireless communication link, Principles of Offset-QPSK, p/4-DQPSK, Minimum Shift Keying, Gaussian Minimum Shift Keying, Error performance in fading channels, OFDM principle – Cyclic prefix, Windowing, PAPR.

UNIT IV MULTIPATH MITIGATION TECHNIQUES 9

Equalisation – Adaptive equalization, Linear and Non-Linear equalization, Zero forcing and LMS Algorithms. Diversity – Micro and Macrodiversity, Diversity combining techniques, Error probability in fading channels with diversity reception, Rake receiver,

UNIT V MULTIPLE ANTENNA TECHNIQUES 9

MIMO systems – spatial multiplexing -System model -Pre-coding – Beam forming – transmitter diversity, receiver diversity- Channel state information-capacity in fading and non-fading channels.

OUTCOMES: At the end of the course, the student should be able to:

- Characterize wireless channels
- Design and implement various signaling schemes for fading channels
- Design a cellular system
- Compare multipath mitigation techniques and analyze their performance
- Design and implement systems with transmit/receive diversity and MIMO systems and analyze their performance

TEXTBOOKS:

1. Rappaport,T.S., “Wireless communications”, Second Edition, Pearson Education, 2010.
2. Andreas.F. Molisch, “Wireless Communications”, John Wiley – India, 2006.

REFERENCES:

1. David Tse and Pramod Viswanath, “Fundamentals of Wireless Communication”, Cambridge University Press, 2005.
2. Upena Dalal, “ Wireless Communication”, Oxford University Press, 2009.
3. Van Nee, R. and Ramji Prasad, “OFDM for wireless multimedia communications”, Artech House, 2000.

Subject Code: EC8652 **Year/Semester: III /06**

Subject Name: Wireless communication **Subject Handler: Mrs.M.Benisha/Ms.R.Rubala**

UNIT I - WIRELESS CHANNELS

Large scale path loss – Path loss models: Free Space and Two-Ray models -Link Budget design – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters- Coherence bandwidth – Doppler spread & Coherence time, Fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Doppler spread – fast fading – slow fading.

PART * A

Q.No.	Questions
1.	**Write the effects of fading. - BTL2** 1. Rapid changes in signal strength over a small travel distance or time interval. 2. Random frequency modulation due to varying Doppler shifts on different multipath signals 3. Time dispersion caused by multipath propagation delays.
2	**Define coherence bandwidth. - BTL1** The coherence bandwidth is related to the specific multipath structure of the channel. The coherence bandwidth is a measure of the maximum frequency difference for which signals are still strongly correlated in amplitude. This bandwidth is inversely proportional to the rms value of time delay spread.
3	**What is coherence time? - BTL1** It is defined as the required time interval to obtain an envelope correlation of 0.9 or less.
4	**Define Doppler shift. - BTL1** The shift in received signal frequency due to motion is called the Doppler shift.
5	**What is Doppler spread? - BTL1** It is defined as the range of frequencies over which the received Doppler spectrum is essentially non-zero.
6	**What are the effects of multipath propagation? – BTL2** Slow fading and fast fading
7	**Write the conditions for flat fading. – BTL3** BW of signal<<BW of channel $B_s << B_c$ Symbol period>>Delay spread $T_s >> \sigma\lambda$
8	**What is frequency selective fading? - BTL1** If the channel possesses a constant gain and linear phase response over a bandwidth that is, smaller than the bandwidth of transmitted signal, then the channel creates frequency selective fading on the received signal.
9	**Write the conditions for frequency selective fading. - BTL1** BW of signal>BW of channel $B_s > B_c$, Symbol period< Delay spread $T_s < \sigma\lambda$
10	**What is meant by link budget? - BTL1** A link budget is the clearest and the most intuitive way of computing the required transmit power.

<table>
<tr><td>11</td><td>What is the need of path loss models in link budget design? – BTL2
The path loss models are used to estimate the received signal level as the function of distance it becomes possible to predict the SNR for a mobile communication system.</td></tr>
<tr><td>12</td><td>What is the need of propagation model? – BTL2
Propagation models have traditionally focused on predicting the average received signal strength at a given distance from the transmitter, as well as the variability of the signal strength in close spatial proximity to a particular location. Propagation models that predict the mean signal strength for an arbitrary transmitter-receiver separation distance are useful in estimating the radio coverage area of a transmitter.</td></tr>
<tr><td>13</td><td>What is ISI? - BTL1
Intersymbol interference (ISI) is a form of distortion of a signal in which one symbol interferes with subsequent symbols</td></tr>
<tr><td>14</td><td>Differentiate Flat fading & Frequency selective fading. – BTL3
<table>
<tr><th>Flat Fading</th><th>Frequency Selective Fading</th></tr>
<tr><td>Bandwidth of the signal is lesser than the bandwidth of the channel.</td><td>Bandwidth of the signal is greater than the bandwidth of channel.</td></tr>
<tr><td>Delay spread is lesser than symbol period.</td><td>Delay spread is greater than symbol period.</td></tr>
</table></td></tr>
<tr><td>15</td><td>Differentiate Fast fading & slow fading. – BTL3
<table>
<tr><th>Fast Fading</th><th>Slow Fading</th></tr>
<tr><td>High Doppler spread</td><td>Low Doppler Spread</td></tr>
<tr><td>Coherence time is lesser than symbol period.</td><td>Coherence time is greater than symbol period.</td></tr>
<tr><td>Channel variations faster than base band signal variations</td><td>Channel variations slower than base band signal variations</td></tr>
</table></td></tr>
<tr><td>16</td><td>What is meant by small scale fading? (May 2013) - BTL1
The rapid fluctuations of the amplitudes, phases; or multipath delays of a radio signal over a short period of time or travel distance is known as small scale fading.</td></tr>
<tr><td>17</td><td>What is meant by large scale fading? (May 2013) - BTL1
The rapid fluctuations of the amplitudes, phases, or multipath delays of a radio signal over a long period of time or travel distance is known as large scale fading.</td></tr>
<tr><td>18</td><td>What are the factors influencing small scale fading? - BTL1
Speed of surrounding objects, Multipath propagation, Speed of the mobile, Transmission bandwidth of the signal</td></tr>
<tr><td>19</td><td>What is meant by time dispersion? - BTL1
The received signal has a longer duration than that of the transmitted signal, due to the different delays of the signal paths. This is known as time dispersion.</td></tr>
<tr><td>20</td><td>What is meant by frequency dispersion? - BTL1
The received signal has a larger bandwidth than that of the transmitted signal, due to the different Doppler shifts introduced by the components of the multipath. This is known as frequency dispersion.</td></tr>
<tr><td>21</td><td>Classify the wireless channels. – BTL2
Time-flat channels, Frequency -flat channels, Frequency-selective channels</td></tr>
</table>

<table>
<tr><td>22</td><td>What is free space propagation model? - BTL1
It is a model which is used to predict received signal strength, when unobstructed line of sight path between transmitter and receiver.</td></tr>
<tr><td>23</td><td>What are Fresnel zones? - BTL1
The concentric circles on the transparent plane located between a transmitter and receiver represent the loci of the origins of secondary wavelets which propagate to the receiver such that the total path length increases by λ/2 for successive circles. These circles are called Fresnel zones.</td></tr>
<tr><td>24</td><td>Explain knife-edge diffraction model. - BTL1
Knife edge is the simplest of diffraction models, and the diffraction loss can be readily estimated using the classical Fresnel solution for the field behind the knife edge.</td></tr>
<tr><td>25</td><td>What is the need of path loss models in link budget design? – BTL3
The path loss models are used to estimate the received signal level as the function of distance it becomes possible to predict the SNR for a mobile communication system.</td></tr>
<tr><td>26</td><td>State the difference between small scale and large scale fading? (May/June2013) – BTL3
<table>
<tr><th>Small scale fading</th><th>Large scale fading</th></tr>
<tr><td>The rapid fluctuations of the amplitudes, phases; or multipath delays of a radio signal over a short period of time or travel distance is known as small scale fading.</td><td>The rapid fluctuations of the amplitudes, phases, or multipath delays of a radio signal over a long period of time or travel distance is known as large scale fading.</td></tr>
</table></td></tr>
<tr><td>27</td><td>State the difference between Narrow band and Wide band systems?(Nov/Dec 2013) – BTL3
<table>
<tr><th>Narrow band</th><th>Wide band</th></tr>
<tr><td>For a narrowband channel, the impulse response is a delta function with a time-varying attenuation</td><td>The most commonly used wideband model is an N-tap Rayleigh-fading model</td></tr>
<tr><td>The variations in amplitude over a small area are typically modeled as a random process, with an autocorrelation function that is determined by the Doppler spectrum</td><td>This is a fairly generic structure, and is basically just the tapped delay line structure with the added restriction that the amplitudes of all taps are subject to Rayleigh fading.</td></tr>
</table></td></tr>
<tr><td>28</td><td>Define Snell’s law. (May/June 2013) - BTL1
Snell's law states that the ratio of the sines of the angles of incidence and refraction is equivalent to the ratio of phase velocities in the two media, or equivalent to the reciprocal of the ratio of the indices of refraction:
$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2} = \frac{n_2}{n_1}$$</td></tr>
<tr><td>29</td><td>What is fading and Doppler spread? (Nov/Dec 2013) - BTL1
In wireless communications, fading is deviation of the attenuation affecting a signal over certain propagation media. The fading may vary with time, geographical position or radio frequency, and is often modeled as a random process. A fading channel is a communication</td></tr>
</table>

channel comprising fading.
The coherence time of the channel is related to a quantity known as the Doppler spread of the channel. When a user (or reflectors in its environment) is moving, the user's velocity causes a shift in the frequency of the signal transmitted along each signal path. This phenomenon is known as the Doppler shift.

30 **What are the different fading effects due to Doppler spread?(Nov/Dec 2014) – BTL3**
The fading effects due to Doppler spread are: Fast fading and slow fading
Fast fading (time selective fading): the channel impulse response changes rapidly within the symbol duration.
Slow fading: the channel impulse response changes at a rate much slower than the transmitted baseband signal s (t).

31 **What is flat fading? (nov//dec 2017).**
Bandwidth of the signal is lesser than the bandwidth of the channel.
Delay spread is lesser than symbol period.

32 **Compare fast and slow fading(apr/may 2018)**

Fast Fading	Slow Fading
High Doppler spread	Low Doppler Spread
Coherence time is lesser than symbol period.	Coherence time is greater than symbol period.
Channel variations faster than base band signal variations	Channel variations slower than base band signal variations

33 **Give the difference between frequency flat and frequency selective fading. (apr/may 2018)**

Flat Fading	Frequency Selective Fading
Bandwidth of the signal is lesser than the bandwidth of the channel.	Bandwidth of the signal is greater than the bandwidth of channel.
Delay spread is lesser than symbol period.	Delay spread is greater than symbol period.

34 **Differentiate small from large scale fading**(Apr/May 2019)

Small scale fading	**Large scale fading**
The rapid fluctuations of the amplitudes, phases; or multipath delays of a radio signal over a short period of time or travel distance is known as small scale fading.	The rapid fluctuations of the amplitudes, phases, or multipath delays of a radio signal over a long period of time or travel distance is known as large scale fading.

PART * B

1. **Explain the path loss model, and describe the following (1) – BTL2 (13)**
a) Log-distance path loss model, (4)
b) Log-normal shading path loss model (4)
c) Indoor Propagation Mechanism (4)

free space path loss model (1)
path loss models to estimate the received signal level as a function of distance

Log Distance Path Loss Model **(4)**

The average large-scale path loss for an arbitrary T-R separation is expressed as a function of distance by using a path loss exponent, n.

$$PL(d) \propto \left(\frac{d}{d0}\right)^n$$

In dB format: (PL)dB = PL(*do*) + *10nlog(d/do)*

Environment	Path oss Exponent, n
Free space	2
Urban area cellular radio	2.7 to 3.5

Log-Normal Shadowing **(4)**

The log-normal distribution describes the random shadowing effects which occur over a large number of measurement locations which have the same T-R separation, but have different levels of clutter on the propagation path. This phenomenon is referred to as log-normal shadowing.

[PL(d)] dB = PL(*d*) + *Xσ* = PL(*do*) + *10nlog(d/do)* + *Xσ*

Pr(d) [dBm] = P_t [dBm] - PL(d)[dB]

Indoor Propagation Models **(4)**

The indoor radio channel differs from the traditional radio channel in two aspects:

1. The distances covered are much smaller.
2. The variability of the environment is much greater for a much smaller range of T - R separation distances.

Answer: Page No. 157-161 in Rappaport

2

Explain power delay profile, mean excess delay , RMS delay spread & Maximum excess delay. (13) – BTL2 (Each Type – 3 Marks + Diagram 1 Mark)

Power delay profile: Integrating the scattering function over the Doppler shift gives the **multipath intensity profile**, or **power delay profile** (PDP).

$$P_h(\tau) = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} |h(t,\tau)|^2 \, dt$$

The **mean delay** or **mean excess delay** μ_τ is the first moment of the power delay profile and is defined to be

$$\bar{\tau} = \frac{\sum_k a_k^2 \tau_k}{\sum_k a_k^2} = \frac{\sum_k P(\tau_k)(\tau_k)}{\sum_k P(\tau_k)}$$

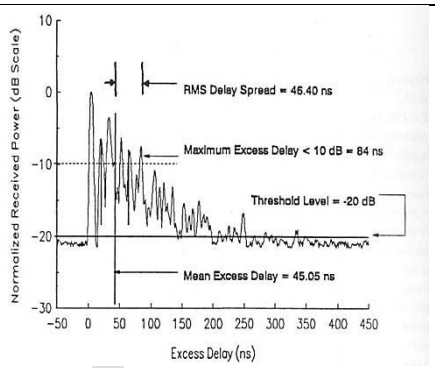
$$\sigma_\tau = \sqrt{\overline{\tau^2} - (\bar{\tau})^2}$$

$$\overline{\tau^2} = \frac{\sum_k a_k^2 \tau_k^2}{\sum_k a_k^2} = \frac{\sum_k P(\tau_k)(\tau_k^2)}{\sum_k P(\tau_k)}$$

The **rms delay spread** σ_τ is the square root of the second central moment of the power delay profile and is defined to be

Maximum Excess Delay (X dB):

Defined as the time delay value after which the multipath energy falls to X dB below the maximum multipath energy. It is also called ***excess delay spread.***



Answer: Page No. 199 in Rappaport

3

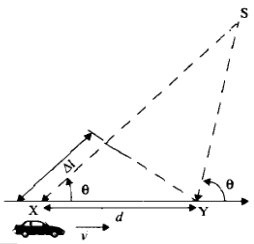
Summarize the following (13) (Apr/may 2019)
Doppler shift (5) , Doppler spread (4) and Coherence time (4) – BTL2

DOPPLER SHIFT

The phase change in the received signal due to the difference in path lengths is

$$\Delta\phi = \frac{2\pi\Delta l}{\lambda} = \frac{2\pi v \Delta t \cos\theta}{\lambda}$$ (Dia- 2 M + Exp – 3 M)

Doppler shift is given by $f_d = \frac{1}{2\pi}\frac{\Delta\phi}{\Delta t} = \frac{v}{\lambda}\cos\theta$



$f=f_c+f_d$, $f=f_c-f_d$

DOPPLER SPREAD & COHERENCE TIME *(Each – 4 M)*

Doppler spread is defined as the range of frequencies over which the received Doppler spectrum is essentially non-zero.

Coherence time T_c is the time duration over which two received signals have a strong potential for amplitude correlation.

$$T_C \approx \sqrt{\frac{9}{16\pi f_m^2}} = \frac{0.423}{f_m}$$

Answer: Page No. 179, 202-203 in Rappaport

4

Assume a receiver is located 10 km from a 50 W transmitter. The carrier frequency is 900 MHz, free space propagation is assumed, $G_T = 1$, and $G_R = 2$, find (a) the power at the receiver, (b) the magnitude of the E-field at the receiver antenna. (c) The RMS voltage applied to the receiver input assuming that the receiver antenna has a purely real impedance of 50 Ω and is matched to the receiver. (13) – BTL4

a)

$$P_R(d) = P_T G_T G_R \left(\frac{\lambda}{4\pi d}\right)^2$$

$$= 50 \times 1 \times 2\left(\frac{0.33}{4\pi \times 10000}\right)^2 = 7 \times 10^{-10} \text{ W}$$ (2)

	$P_R(d)\ \text{dBm} = 10\log\left(\frac{P_R(d)}{1\times10^{-3}}\right) = -61.5\ \text{dBm}$ (2) b) $\lvert E\rvert = \sqrt{\frac{120\pi P_R(d)}{\lambda^2 G_R/4\pi}} = \sqrt{\frac{120\pi\times7\times10^{-10}}{0.33^2\times2/4\pi}} = 0.0039\ \text{V/m}$ (5) c) $v_{ant} = \sqrt{P_r(d) * 4R_{ant}} = \sqrt{7*10^{-10}*4*50} = 0.374\ mV$ (4) Answer: Page No. 112 in Rappaport
5	**If a transmitter produces 50 watts of power, express the transmit power in units of (a) dBm, and (b) dBW. If 50 watts is applied to a unity gain antenna with a 900 MHz carrier frequency, find the received power in dBm at a free space distance of 100 m from the antenna. What is P_r (10 km)? Assume unity gain for the receiver antenna. (13) – BTL3** a) $P_t\ (\text{dBm}) = 10\log\left(\frac{P_t}{1\times10^{-3}}\right) = 10\log\left(\frac{50}{1\times10^{-3}}\right) = 47\ \text{dBm}$ (2) b) $P_t\ (\text{dB}) = 10\log(P_t) = 10\log(50) = 47\ \text{dBW}$ (2) $P_R(d) = P_T G_T G_R\left(\frac{\lambda}{4\pi d}\right)^2$ $= 50\times1\times1\left(\frac{0.33}{4\pi\times100}\right)^2$ $= 3.5\times10^{-6}\ \text{W}$ $P_R(d)\ \text{dBm} = 10\log\left(\frac{P_R(d)}{1\times10^{-3}}\right) = 10\log\left(\frac{3.5\times10^{-6}}{1\times10^{-3}}\right) = -24.5\ \text{dBm}$ (5) Now d=10km, d_0=100m (4) $P_r(d)\ \text{dBm} = 10\log\left(\frac{P_r(d_0)}{0.001\,\text{W}}\right) + 20\log\left(\frac{d_0}{d}\right) \qquad d \geq d_0 \geq d_f$ $P_r(10km) = p_r(100) + 20\ log\left(\frac{100}{10000}\right) = -24.5\ dBm - 40\ dBm = -64.5\ dbm$ Answer: Page No. 109 in Rappaport
6	**Derive the final expression for the free space path loss model, and derive the Gain expression. (13) - BTL3?** (Apr/may 2019) **(apr/may 2018)** **Free Space Path Loss Model** (2) The free space propagation model is used to predict received signal strength when the transmitter and receiver have a clear, unobstructed line-of-sight path between them. flux density $\Phi_R = \frac{P_T}{4\pi d^2}$ (1) $P_r(d) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2 L}$

	Friis free space equation (2) gain of the antenna $G = \frac{4\pi A_e}{\lambda^2}$ (2) Antenna Efficiency $\eta = \frac{A_e}{A}$ Effective isotropic radiated power (EIRP) $EIRP = P_t G_t$ (2) Path loss for the free space model $PL(dB) = 10\log\frac{P_t}{P_r} = -10\log\left(\frac{G_t G_r \lambda^2}{(4\pi)^2 d^2}\right)$ (1) $d_f = \frac{2D^2}{\lambda}$ far-field distance = $2D^2/\lambda$ (1) received power (2) $P_r(d)\,\text{dBm} = 10\log\left(\frac{P_r(d_0)}{0.001\,\text{W}}\right) + 20\log\left(\frac{d_0}{d}\right)$ Answer: Page No. 107 in Rappaport
7	**An aircraft is headed towards an airport control tower with a speed of 500 km/h at an elevation of 20°. safety communications between the aircraft tower and the plane occurs at a frequency of approximately 128 MHz. What is the expected Doppler shift of the received signal? (13) BTL – 4** Given Data (1) wavelength $\lambda = \frac{c}{f_c} = \frac{3\times10^8}{128\times10^6} = 2.34\text{m}$ (4) Aircraft speed v = 500 × 1000/3600 m/s = 138.89 m/s (4) The Doppler shift of the received signal is $f_d = \frac{v}{\lambda}\cos\theta = \frac{138.89}{2.34}\cos 20^\circ = 55.775$ (4)
8	**Consider a transmitter which radiates a sinusoidal carrier frequency of 900 MHz. For a vehicle moving 70 km/h, compute the received carrier frequency if the mobile is moving (a) directly towards the transmitter, (b) directly away from the transmitter, (c) in a direction which is perpendicular to the direction of arrival of the transmitted signal. (13) BTL - 4(apr/may 2018)**

wavelength $\lambda = \frac{c}{f_c} = \frac{3\times10^8}{900\times10^6} = 0.33\text{m}$

Vehicle speed v = 70 × 1000/3600 = 19.44 m/s (2)

a) $f_d = \frac{v}{\lambda}\cos\theta$

$= \frac{19.44}{0.33}\cos 0 = 58.9091$ (2)

$f = f_c + f_d = 900\times10^6 + 58.9091 = 900.0000589$ MHz (3)

b) $f = f_c - f_d = 900\times10^6 - 58.9091 = 899.9999411$ MHz (3)

c) θ = 90°, cos 90° = 0,, and there is no Doppler shift. (3)

9.

a)What do you mean by pathloss model?Explain in detail about log- distance pathloss model?Refer Part-B Question no 1

b)What is the need for link calculation?Explain with suitable examples? (nov//dec 2017)

A)Log Distance Path Loss Model (4)

The average large-scale path loss for an arbitrary T-R separation is expressed as a function of distance by using a path loss exponent, n.

$$\text{PL(d)} \propto \left(\frac{\text{d}}{d0}\right)^n$$

In dB format: (PL)dB = PL(*do)* + *10nlog(d/do)*

Environment	Path oss Exponent, n
Free space	2
Urban area cellular radio	2.7 to 3.5

B)Link budjet

free space path loss model (1)

path loss models to estimate the received signal level as a function of distance

Log Distance Path Loss Model (4)

The average large-scale path loss for an arbitrary T-R separation is expressed as a function of distance by using a path loss exponent, n.

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In dB format: (PL)dB = PL(*do)* + *10nlog(d/do)*

Environment	Path oss Exponent, n
Free space	2

	Urban area cellular radio | 2.7 to 3.5

Log-Normal Shadowing **(4)**

The log-normal distribution describes the random shadowing effects which occur over a large number of measurement locations which have the same T-R separation, but have different levels of clutter on the propagation path. This phenomenon is referred to as log-normal shadowing.

$$[PL(d)]\ dB = PL(d) + X\sigma = PL(do) + 10n\log(d/do) + X\sigma$$

$$Pr(d)\ [dBm] = P_t\ [dBm] - PL(d)[dB]$$

Indoor Propagation Models **(4)**

The indoor radio channel differs from the traditional radio channel in two aspects:

1. The distances covered are much smaller.
2. The variability of the environment is much greater for a much smaller range of T - R separation distances.

Answer: Page No. 157-161 in Rappaport

10. **Distinguish fast fading and slow fading in wireless channel and explain in detail. (nov//dec 2017).** (Apr/may 2019)

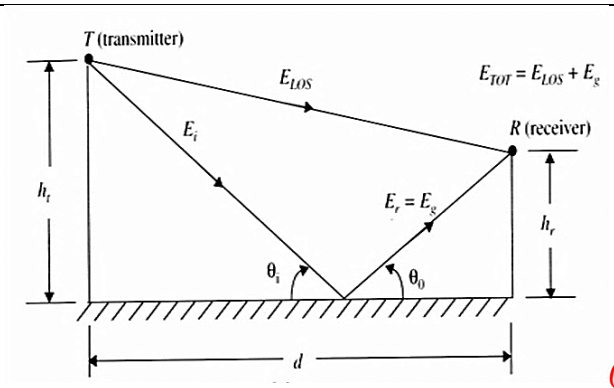
Fast Fading	Slow Fading
High Doppler spread	Low Doppler Spread
Coherence time is lesser than symbol period.	Coherence time is greater than symbol period.
Channel variations faster than base band signal variations	Channel variations slower than base band signal variations

1.Diagram
2.with respect to base band period
3 with respect to symbol period

PART * C

1. **Derive the final expression for Two Ray Model propagation mechanisms. (15)**

(Apr/may 2019)



(2)

The 2-ray ground reflection model consists of both the direct path and a ground reflected propagation path between transmitter and receiver

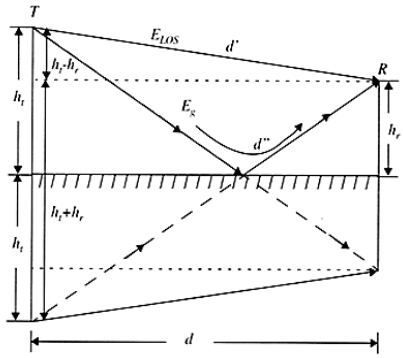
$$\vec{E}_{TOT} = \vec{E}_{LOS} + \vec{E}_g \quad (4)$$

$$\vec{E}_{TOT} = \left(\frac{E_0 d_0}{d}\right)\cos\left(w_c\left(t - \frac{d'}{c}\right)\right) + \Gamma\left(\frac{E_0 d_0}{d}\right)\cos\left(w_c\left(t - \frac{d''}{c}\right)\right)$$

$$\Delta = d'' - d' = \sqrt{(h_t + h_r)^2 + d^2} - \sqrt{(h_t - h_r)^2 + d^2} \quad (2)$$

$$\left|\frac{E_0 d_0}{d}\right| \approx \left|\frac{E_0 d_0}{d'}\right| \approx \left|\frac{E_0 d_0}{d''}\right| \quad (1)$$

Diagram – 2



$$P_r(d) = P_r(d_0)\left(\frac{d_0}{d}\right)^4 \quad (2)$$

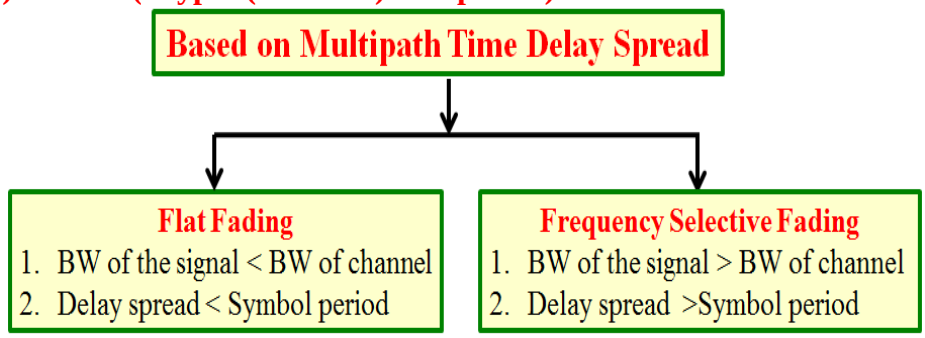
$$P_L(dB) = 40\log d - [10\log G_t + 10\log G_r + 20\log h_t + 20\log h_r$$

$$P_r = P_t G_t G_r \frac{h_t^2 h_r^2}{d^4} \quad (2)$$

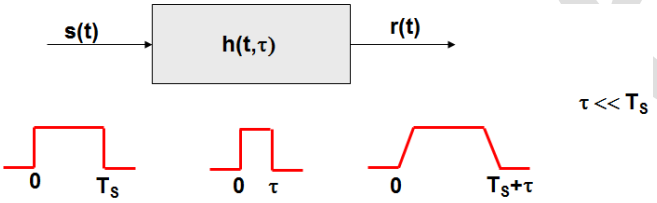
Answer: Page No. 120 in Rappaport

2

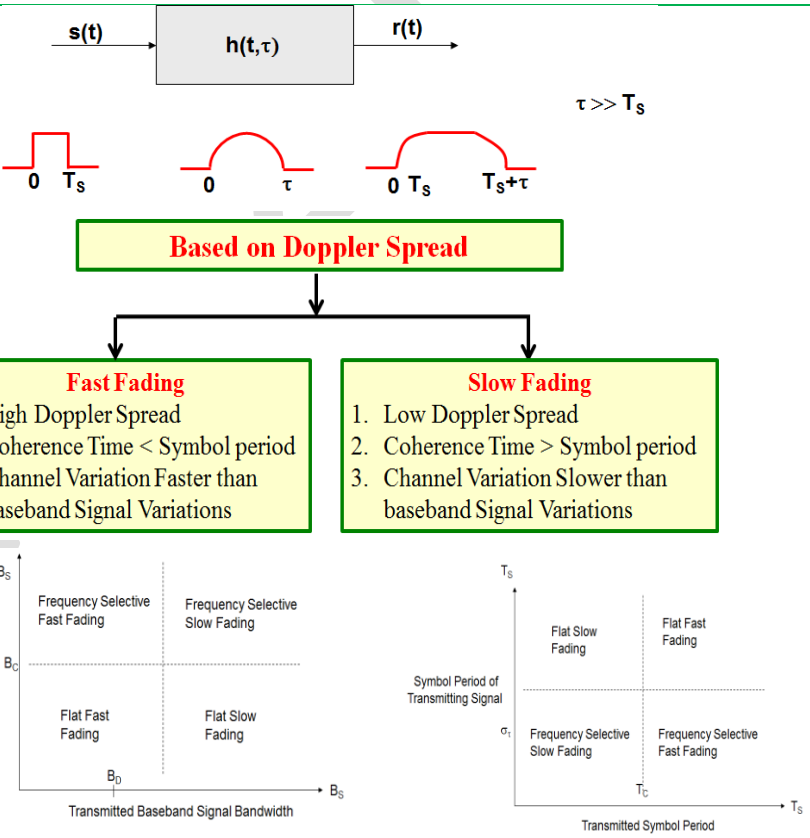
Describe in detail about small scale fading based on multipath delay spread and Doppler spread (15) – BTL2 (4 types (Dia 2 M) + Exp 7 M)



FLAT FADING CHANNEL



FREQUENCY SELECTIVE FADING CHANNEL



Answer: Page No. 205 in Rappaport

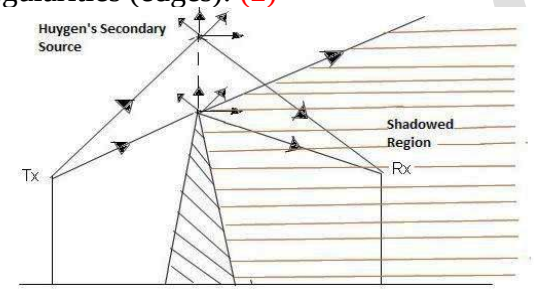
3

Describe the basic propagation mechanisms in detail. – BTL2 (15)

Reflection occurs when a propagating electromagnetic wave impinges upon an object which has very large dimensions when compared to the wavelength of the propagating wave. Reflections occur from the surface of the earth and from buildings and walls. (3)

The **Brewster angle** is the angle at which no reflection occurs in the medium of origin. $\theta_B = \sin^{-1}\sqrt{\frac{\varepsilon_1}{\varepsilon_1 + \varepsilon_2}}$ (3)

Diffraction occurs when the radio path between the transmitter and receiver is obstructed by a surface that has sharp irregularities (edges). (2)



(2)

Fresnel-Kirchhoff diffraction parameter as $v = h\sqrt{\frac{2(d_1 + d_2)}{\lambda d_1 d_2}}$ (2)

Scattering occurs when the medium through which the wave travels consists of objects with dimensions that are small compared to the wavelength, and where the number of obstacles per unit volume is large. Scattered waves are produced by rough surfaces, small objects, or by other irregularities in the channel. (2) $h_c = \frac{\lambda}{8\sin\theta_i}$ (1)

Answer: Page No. 113, 114, 126, 135 in Rappaport

UNIT II CELLULAR ARCHITECTURE	
Multiple Access techniques – FDMA, TDMA, CDMA – Capacity calculations–Cellular concept- Frequency reuse – channel assignment- hand off- interference & system capacity- trunking & grade of service – Coverage and capacity improvement.	
PART * A	
Q.No.	**Questions**
1.	**What are the different types of multiple access schemes? (Nov/Dec 13) - BTL1** FDMA-Frequency division multiple access-different frequencies are assigned to different users TDMA-Time division multiple access-different time slots are assigned to different users. CDMA-Code division multiple access-each user is assigned a different code.
2	**What are the advantages of FDMA? - BTL1** The transmitter and receiver require much less digital signal processing, Synchronization is simple.
3	**What are the disadvantages of FDMA? - BTL1** 1. Sensitivity to fading 2. Sensitivity to random frequency modulation 3. Inter modulation
4	**Define SAMA. - BTL1** Spread Aloha Multiple Access is a combination of CDMA and TDMA. The CDMA better suits for connection oriented services only and not for connection less burst data traffic because it requires to program both sender and receiver to access different users with different codes.
5	**Define CDMA. - BTL1** Code Division Multiple Access systems use codes with certain characteristics to separate different users. To enable access to the shared medium without interference. The users use the same frequency and time to transmit data. The main problem is to find good codes and to separate this signal from noise. The good code can be found the following 2 characteristic 1.Orthogonal. 2. Autocorrelation.
6	**What is SDMA? - BTL1** Space Division Multiple Access (SDMA) is used for allocating separated spaces to users in wireless networks. The basis for the SDMA algorithm is formed by cells and sectorized antennas which constitute the infrastructure implementing space division multiplexing (SDM).
7	**What is FDD? - BTL1** In FDMA, the base station and the mobile station establish a duplex channel. The two directions, mobile station to base station and vice versa are separated using different frequencies. This Scheme is called Frequency Division Duplex (FDD)
8	**What is guard space? - BTL1** Guard spaces are needed to avoid frequency band overlapping is also called channel interference.
9	**What is called burst and normal burst? - BTL1** Data is transmitted in small portions called bursts, normal burst are used for data transmission inside a slot (user and signalling data).
10	**What limits the number of user in TDM and FDM compared to CDM? – BTL3** The code space is huge compared to the frequency space and time space. Because of the limited time space and frequency space, the number of user in TDM and FDM are limited.

11	**How does near and far effect influence CDMA? What are counter measurements? – BTL3** The near and far effect is a server problem of wireless networks using CDM**.** All signals should arrive at the receiver with more or less the same strength**.** Precise power control is needed to λ. λ receive all senders with the same strength at a receiver**.**
12	**Define FCA and DCA. - BTL1** Allocating a fixed frequencies for a channel is called as Fixed channel Allocation (FCA). In Dynamic Channel Allocation (DCA) scheme frequencies can only be borrowed, but it is also possible to freely allocate frequencies to cells. With dynamic assignment of frequencies to cells, the danger of the interference with cells with same frequency exists. Thus the borrowed frequencies in the surroundings cells can be blocked.
13	**What is meant by frequency reuse?(May/June2013) - BTL1)(apr/may 2018)** Cellular systems should rely on frequency reuse pattern, Band of frequencies should be allotted to each cell Use same frequency in nearby cells for multiple conversations. To avoid interference or cross talk different frequencies should be allotted to adjacent cells. *E.g.N* cells all using same number of frequencies, *K total* number of frequencies used in systems, Each cell has *K/N* frequencies
14	**When handoff occurs? - BTL1**(Apr/may 2019) Hand-off occurs when a received signal from its serving cell becomes weak and another cell site can provide a stronger signal to the mobile subscriber. If the new cell-site has some free voice channels then its assigns one of them to the handed-off call.
15	**Differentiate soft and hard handoff. – BTL3** Hard handoff mode is characterized by a mobile having a radio link with only AP at any time. Thus, the old connection is terminated before a new connection is activated. This mode of operation is referred to as break before make. In Soft handoff, the mobile can simultaneously communicate with more than one AP during the handoff. This new connection is made before breaking the old connection, and is referred to as make before break.
16	**What is the function of Medium Access Control Layer? - BTL1** The functions of Medium Access Control Layer are responsible for establishes, maintains, and releases channels for higher layers by activating and deactivating physical channels.
17	**What are the 2 sub layers in DLC? - BTL1** Logical Link Control(LLC), Media Access Control (MAC)
18	**What do you mean by Polling? - BTL1** Polling is a strictly centralized scheme with one master and several slave stations. The master can collect the list of stations during the contention phase and can poll these slaves according to many schemes like round robin, random access, reservation scheme etc.
19	**Define traffic multi frame and control multi frame? - BTL1** The periodic pattern of 26 slots occurs in all TDMA frames with a TCH. The combination of these frames is called traffic multi frame TDMA frames containing data for the other logical channels are combined to a control multi frame.
20	**How does near and far effect influence CDMA? What are counter measurements? – BTL4** The near and far effect is a server problem of wireless networks using CDM**.** All signals should arrive at the receiver with more or less the same strength**.** Precise power control is needed to receive all senders with the same strength at a receiver**.**

21	**What is meant by vertical handoff? - BTL1** Moving between different wireless technologies.
22	**Differentiate inter and intra cell handoff. – BTL3** Inter-cell hand-off means in which present serving ant the new target cells are different cells. The purpose of this hand-off is to maintain the call as the mobile subscriber is moving out of the area covered by the present serving cell and entering the area of the new target cell. Intra-cell hand-off means in which present serving ant the new target cells are one and the same cell. The purpose of this hand-off is to change one channel, which may be interfered or affected by fading, with a new clearer or lest fading channel.
23	**How does a p-persistent CSMA different from non-persistent CSMA? – BTL4** In non-persistent CSMA, stations sense the carrier and start sending immediately if the medium is idle. If the medium is busy, the station pauses a random amount of time before sensing the medium again and repeating this pattern. In p-persistent CSMA systems nodes also sense the medium, but only transmit with a probability of p, with the station deferring to the next slot with the probability 1-p, i.e., access is slotted in addition
24	**What are the benefits of reservation schemes? - BTL1** The benefits of reservation schemes are reserves future slots, higher throughput, less collisions.
25	**What is the function of Medium Access Control Layer? - BTL1** The functions of Medium Access Control Layer which are responsible for establishes, maintains, and releases channels for higher layers by activating and deactivating physical channels.
26	**Define Set-up time. - BTL1** The time required to allocate a trunked radio channel to a requesting user.
27	**What is a blocked call? - BTL1** Call which cannot be completed at time of request, due to congestion.Also referred to as lost call.
28	**What is orthogonality? - BTL1** Orthogonality mean if we have “n” users and n-bit sequences, then a set of vectors in n-space are orthogonal if any point in n-space may be expressed as only linear combination of these vectors. CDMA is a communication technique that allows multiple users to communicate over one frequency. This is achieved through the use of spreading codes, whereby a single data bit is spread over a longer sequence of transmitted bits. These codes known as chip sequence, must be carefully chosen so that data may be correctly despread at the receiver. Such codes are known as orthogonal codes.
29	**Define Holding-time. - BTL1** Average duration of a typical call.Denoted by ‘H’ (in seconds).
30	**State advantages of CDMA over FDMA?(Nov/Dec2014) - BTL1(apr/may 2018)** CDMA technology has bandwidth thirteen times efficient than FDMA and forty times efficient than analog systems. CDMA also have better security and higher data and voice transmission quality because of the spread spectrum technology it uses, which has increased resistance to multipath distortion. CDMA has greater coverage area when compared to FDMA. The main advantage of the CDMA is that, in the single detection method it is more flexible than FDMA or joint detection. CDMA is said to have higher capacity than FDMA.

	PART * B
1.	**An urban area has a population of two million residents. Three competing trunked mobile networks (systems A, B, and C) provide cellular service in this area. System A has 394 cells with 19 channels each, system B has 98 cells with 57 channels each, and system C has 49 cells, each with 100 channels. Find the number of users that can be supported at 2% blocking if each user averages two calls per hour at average call duration of three minutes. Assuming that all three trunked systems are operated at maximum capacity, compute the percentage market penetration of each cellular provider. (13) - BTL5** **System A (3)** Probability of blocking = 2% = 0.02, C = 19, Au = λH = 2 × (3/60) = 0.1 Erlangs For GOS = 0.02 and C = 19, from the Erlang B chart, the total carried traffic, A, is obtained as 12 Erlangs. U = A/Au = 12/0.1 = 120 The total number of subscribers, supported by System A is equal to 120 × 394 = 47280 **System B (3)** Probability of blocking = 2% = 0.02, C = 57, Au = λH = 2 × (3/60) = 0.1 Erlangs For GOS = 0.02 and C = 57, from the Erlang B chart, the total carried traffic, A, is obtained as 45 Erlangs. U = A/Au = 45/0.1 = 450 The total number of subscribers, supported by System B is equal to 450 × 98 = 44,100 **System C (3)** Probability of blocking = 2% = 0.02, C = 100, Au = λH = 2 × (3/60) = 0.1 Erlangs For GOS = 0.02 and C = 100, from the Erlang B chart, the total carried traffic, A, is obtained as 88 Erlangs. U = A/Au = 88/0.1 = 880 The total number of subscribers, supported by System C is equal to 880 × 49 = 43,120 Total numbers of cellular subscribers 47,280 + 44,100 + 43,120 = 134,500 users. **(2)** In System A the percentage market penetration is equal to 47,280/2,000,000 = 2.36% Similarly, market penetration of System B is equal to 44,100/2,000,000 = 2.205% and the market penetration of System C is equal to 43,120/2,000,000 = 2.156% The market penetration of the three systems combined is equal to 134,500/2,000,000 = 6.725% **(2)** Answer: Page No. 83 in Rappaport

2

Compare TDMA, FDMA and CDMA - BTL3 (Any 6 Points – 13 M)

	FDMA	*TDMA*	*CDMA*
Modulation	▪ Relies on bandwidth-efficient modulation	▪ Relies on bandwidth-efficient modulation	▪ Simple modulation
Diversity	▪ Requires multiple transmitters or receivers	▪ Requires multiple transmitters or receivers ▪ Can be frequency-hopped	▪ Includes frequency diversity when implemented with a RAKE receiver
User terminal complexity	▪ Simple	▪ Medium complexity	▪ More complex
Handover	▪ Hard	▪ hard	▪ Soft
System complexity	▪ Large number of simple components	▪ Reduced number of channel units	▪ Large number of complex interacting components
Multiple-Access interference	▪ Limited by system planning	▪ Limited by system planning	▪ Dynamic power control
Fading	▪ Flat-fading ▪ No diversity ▪ Simple to track	▪ May be frequency-selective ▪ May need equalizer	▪ Frequency-selective diversity via RAKE receiver

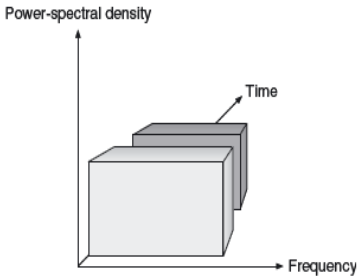
Answer: Page No. 447 - 458 in Rappaport

3

Write short notes on TDMA, FDMA CDMA in cell system. (13) - BTL2 3 Types (Exp - 7 M + Dia – 2M) (nov//dec 2017) (Apr/may 2019)

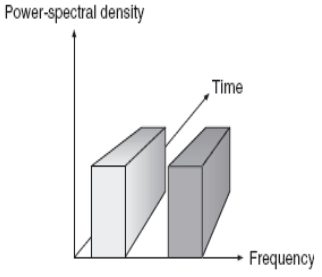
TDMA

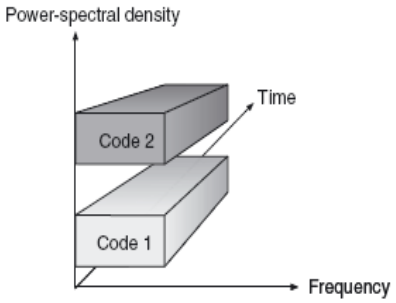
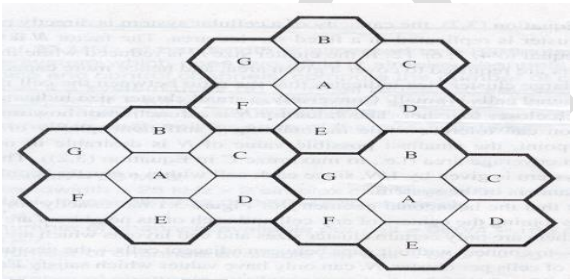
single carrier frequency with several users
System is not continuous, but occurs in bursts.
The handoff process is much simpler for a subscriber unit
Duplexers are not required.
High transmission rates compared to FDMA channels.
High synchronization overhead is required

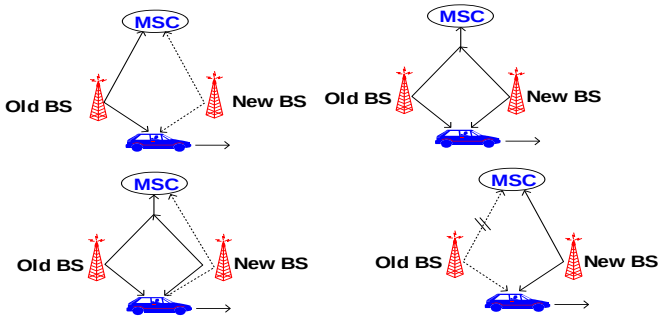


FDMA

Channel carries only one phone circuit at a time.
If channel is not in use, then it cannot be used by other users
Continuous transmission scheme
Narrowband systems.
Inter-symbol interference is low.
Mobile unit uses duplexers.



	Requires RF filtering to minimize adjacent channel interference **CDMA** Many users of a CDMA system share the same frequency. Soft capacity limit. Frequency-dependent transmission impairments Multipath fading may be substantially reduced Channel data rates are very high Macroscopic spatial diversity to provide soft handoff. The near-far problem occurs at a CDMA receiver. Answer: Page No. 447 - 458 in Rappaport 
4	**Write short notes on frequency reuse - BTL2 (13)** **(Diagram 3 M + Formula 4 M + Exp 6)** The design process of selecting and allocating channels groups for all of the cellular base stations within a system is called frequency reuse or frequency planning S=kN. C = MkN = MS. & $N=i^2 + ij + j^2$  $\frac{D}{R} = \sqrt{3N}$ Answer: Page No. 58 in Rappaport
5	**Describe channel assignment strategies in detail - BTL2 (13)** **Channel assignment strategies** can be classified as Static and Dynamic. (1) When fixed numbers of channels are assigned to a cell, it is called fixed channel assignment. (6) In case of dynamic channel assignment, voice channels are assigned by MSC based on request from the Base stations.(6) Answer: Page No. 62 in Rappaport
6	**Explain the process of Handoff and its strategies (13) - BTL2 (Dia 4 M + Exp 9 M) apr/may 2018)** Handoff process, which allows users to remain in touch, even while breaking the connection with one BS and establishing connection with another BS. (3)



(4)

Handoff detection strategies (3)

- ❖ Mobile-Controlled handoff (MCHO)
- ❖ Network-Controlled handoff (NCHO)
- ❖ Mobile-Assisted handoff (MAHO)

Handoff types with reference to the network (3)

- ❖ Intra-system handoff or Inter-BS handoff
  The new and the old BSs are connected to the same MSC.
- ❖ Intersystem handoff or Inter-MSC handoff
  The new and the old BSs are connected to different MSCs.

Answer: Page No. 62 in Rappaport

7 **Drive the expressions for interference systems. (13) BTL - 3**

Interference is the major limiting factor in the performance of cellular radio systems. (3)

Several cell that use the same set of frequencies, these cells are called co channels cells and the interference form these cells called **co channel interference. (5)**

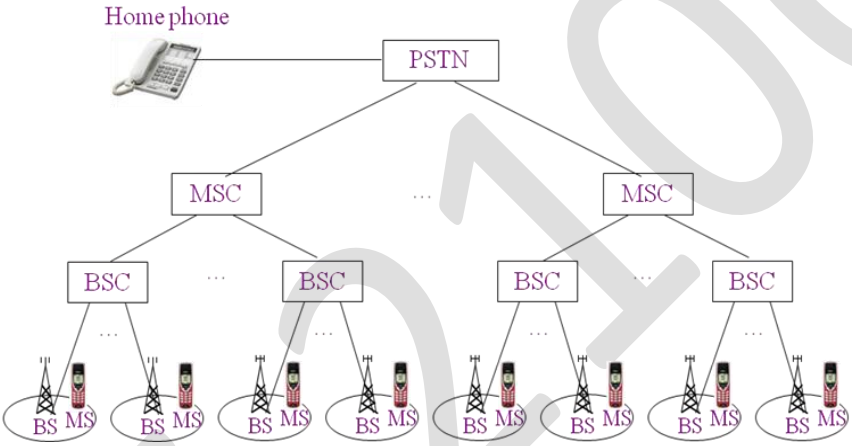
$$\frac{S}{I} = \frac{S}{\sum_{i=1}^{i=io} Ii}$$

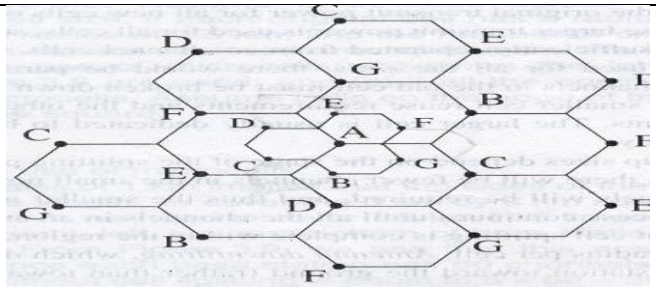
The average power $Pr \alpha \frac{1}{r^n}$

Interference resulting from signals which are adjusted in frequency to the desired signal is called **Adjacent channel interference. (5)** Answer: Page No. 67 in Rappaport

8 **If a signal to interference ratio of 15 db is required for satisfactory forward channel performance of a cellular system, what is the frequency reuse factor and cluster size should be used for maximum capacity if the path loss exponent is a) n = 4 and b.) n=3. Assume that there are six co channel cells in the first tier and all of them are at the same distance from the mobile. . Use suitable assumption. (13) (5 M + 8 M) - BTL4** (Apr/may 2019)

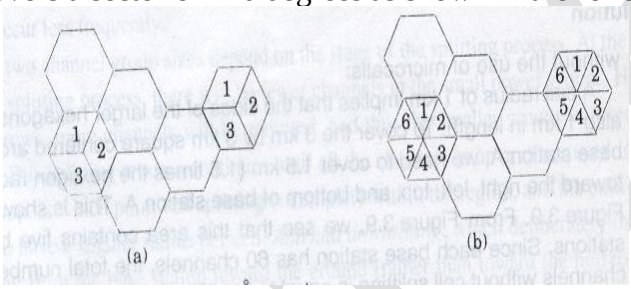
a) **n= 4,** consider N=7, D / R = 4.583. (5)
S / I = (1 / 6) * $(4.583)^4$ = 75.3 = 18.66 db

	Since this is greater than the minimum required S / I, N = 7 can be used. **b) n = 3, N=7, (8)** S / I = (1 / 6) * $(4.583)^3$ = 16.04 = 12.06 db Since this is less than the minimum required S / I , we need to use a larger N. Using the N = 12, D/ R becomes 6.0 S / I = (1 / 6) * $(6)^3$ = 36 = 15.56 db Since this is greater than the minimum required S / I, N = 12 is used. Answer: Page No. 72 in Rappaport
9	**Illustrate the principles of cellular networks (13) – BTL – 3** Explanation of each blocks (7) Diagram (6) 
10	**If a particular FDD cellular telephone system has a total bandwidth of 33mhz and if the phone system uses two 25khz simplex channel to provide the no/- of channels per cell if n=4,7,12 (13) – BTL 3(apr/may 2018)** Formulas (3) Channel bandwidth = 25 KHz x 2 = 50 KHz (2) Total available channels = 33 MHz / 50 KHz = 660 (2) N = 4 Channel per cell = 660 / 4 = 165 channels (2) N = 7 Channel per cell = 660 / 7 = 95 channels (2) N = 12 Channel per cell = 660 / 12 = 55 channels (2)
	PART * C
1.	**How to improve coverage and capacity of cellular system, analyze the concept. (15) - BTL4** **Cell Splitting: (5)** It is the process of subdividing a congested cell into smaller cells, each with its own base station and a corresponding reduction in antenna height and transmitter power.



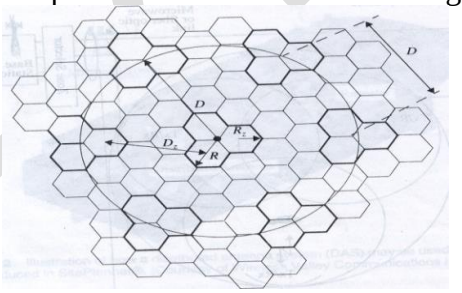
Sectoring: (5)

It replaces the omni directional antenna at the center or directional antennas at the corner with three directional antenna at the center if the cell is divided into three sectors. Each of the directional antennas covers a sector of 120 degrees as shown in the following figure

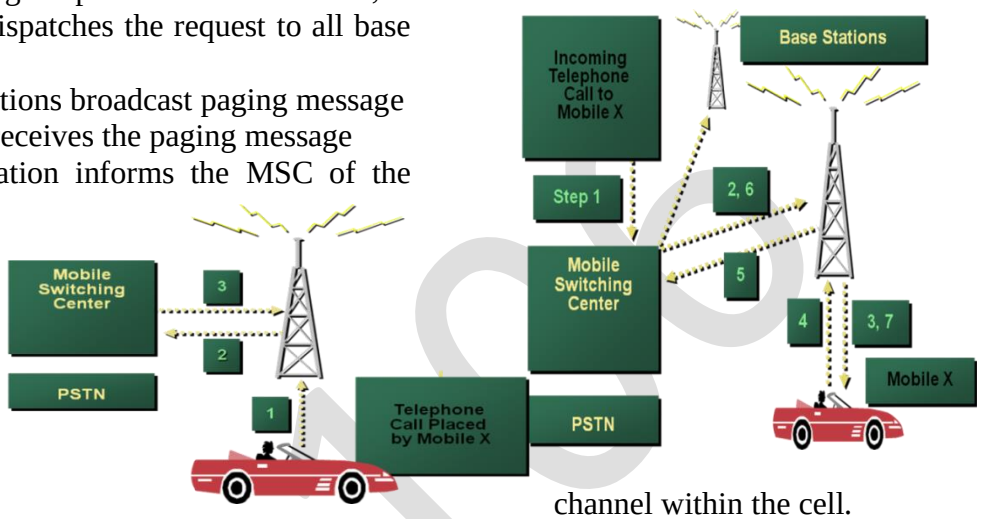


Microcell Zone: (5)

The advantage of the zone cell technique is that while the cell maintains a particular coverage radius, the co-channel interference in the cellular system is reduced such a large central base station is replaced by several lower powered transmitters on the edges of the cell.



Answer: Page No. 86 in Rappaport

2	**Write short notes on** **i. Telephone Call Made To Mobile User (10)** **ii. Telephone Call Placed by Mobile (5)– BTL3** **Telephone Call Made To Mobile User (Dia – 3m + Exp 7)** **Step 1:** The incoming telephone call to Mobile X, **Step 2:** The MSC dispatches the request to all base stations **Step 3:** The base stations broadcast paging message **Step 4:**The mobile receives the paging message **Step 5:**The base station informs the MSC of the handshake . **Step 6:** The MSC move the call to an available voice channel within the cell.  **Step 7:**The base station signals the mobile to change frequencies **Telephone Call Placed by Mobile (Dia – 2 M+ Exp 3 M)** **Step 1:** Mobile originates a call and it sends MIN, ESN, SCM **Step 2:** Cell base station receives the data and sends it to the MSC. **Step 3:** The MSC validates the request, and allow the conversation to begin. Answer: Page No. 13 in Rappaport
3	**Write detail about trunking and grade of service of cell system (15) - BTL2(nov//dec 2017)** The concept of trunking allows a large number of users to share the relatively small number of channels in a cell by providing access to each user, on demand, from a pool of available channels. **(5)**

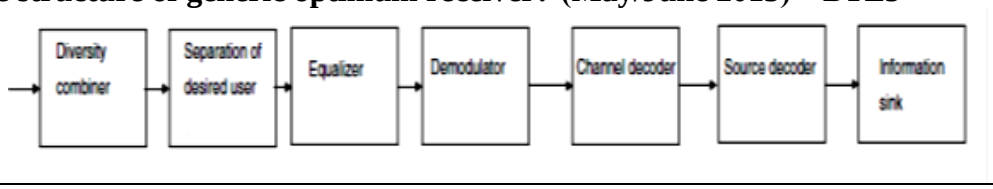
	Parameters: (8) **Set-up Time:** The time required to allocate a trunked radio channel to a requesting user. **Blocked Call:** Call which cannot be completed at time of request, due to congestion. **Holding Time:** Average duration of a typical call. Denoted by H **Traffic Intensity:** Measure of channel time utilization **Load:** Traffic intensity across the entire trunked radio system **Grade of Service (GOS):** A measure of congestion which is specified as the probability of a call being blocked (for Erlang B), or the probability of a call being delayed beyond a certain amount of time (for Erlang C). **Request Rate:** The average number of call requests per unit time. Denoted by λ seconds–1. **Erlangs formula** $A_u = \lambda H$ **(2)** Answer: Page No. 77 in Rappaport

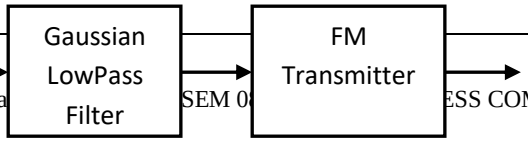
UNIT III – DIGITAL SIGNALING FOR FADING CHANNELS	
Structure of a wireless communication link, Principles of Offset-QPSK, p/4-DQPSK, Minimum Shift Keying, Gaussian Minimum Shift Keying, Error performance in fading channels, OFDM principle – Cyclic prefix, Windowing, PAPR.	
PART * A	
Q.No.	**Questions**
1.	**Define modulation. – BTL1** It is defined as the process by which some parameters of a high frequency signal termed as carrier, is varied in accordance with the signal to be transmitted.
2	**What is demodulation? – BTL1** It is the process of recovering the original modulating signal from a modulated signal.
3	**Write the advantages of digital over analog modulation. – BTL1** Greater noise immunity, Robustness to channel impairments, Easier multiplexing of various forms of information, Greater security
4	**What is meant by Amplitude shift keying? – BTL1** If amplitude of the carrier is varied depending on the incoming digital signal, then it is called Amplitude shift keying.

5	**What is meant by Frequency shift keying? – BTL1** If the frequency of the sinusoidal carrier frequency is varied depending on the incoming digital signal, then it is called Frequency shift keying.
6	**What is meant by Phase shift keying? – BTL1** If phase of the carrier is varied depending on the input digital signal, then it is called phase shift keying.
7	**Define M-ary transmission system – BTL1** In digital modulation instead of transmitting one bit at a time, two or more bits are transmitted simultaneously. This is called M-ary transmission.
8	**What is Quadrature modulation? – BTL1** Sometimes two or more Quadrature carriers are used for modulation. It is called Quadrature modulation.
9	**Explain the following terms a) Baud rate b) Bit rate – BTL1** Baud rate: Speed at which symbols are transmitted in a digital communication system, i.e. no of symbols/second. Bit rate: Speed at which data bits is transmitted in a digital communication system, i.e. no of bits/sec.
10	**What is QAM? – BTL1** At high bit rates, a combination of ASK and PSK is employed in order to minimize the errors in the received data. This method is known as Quadrature amplitude modulation.
11	**What is meant by QPSK? – BTL1** QPSK is a multi-level modulation in which four phase shifts are used for representing four different symbols.
12	**What is linear modulation? – BTL1** In linear modulation technique, the amplitude of the transmitted (carrier) signal varies linearly with the modulating digital signal. In general, linear modulation does not have a constant envelope.
13	**Write the merits of linear modulation. – BTL1** Bandwidth efficient, Very attractive for use in wireless communication systems, Accommodate more and more users within a limited spectrum.
14	**What is nonlinear modulation? – BTL1** In nonlinear modulation, the amplitude of the carrier is constant regardless of the variation in the modulating signal.
15	**Mention the merits and demerits of nonlinear modulation. – BTL2** Merits: a. Lower efficient class c amplifiers can be used without introducing degradation in the spectrum occupancy of the transmitted signal. b. Low out of band radiation of the order of -60dB to -70dB can be achieved. c. Limiter-discriminator detection can be used, which simplifies receiver design and providesHigh immunity against random FM noise and signal fluctuations due to Rayleigh fading. Demerits: a. Constant envelope modulations occupy a larger bandwidth than linear modulation scheme b. In situations where bandwidth efficiency is more important than power efficiency, constantEnvelopemodulation is not well suited.

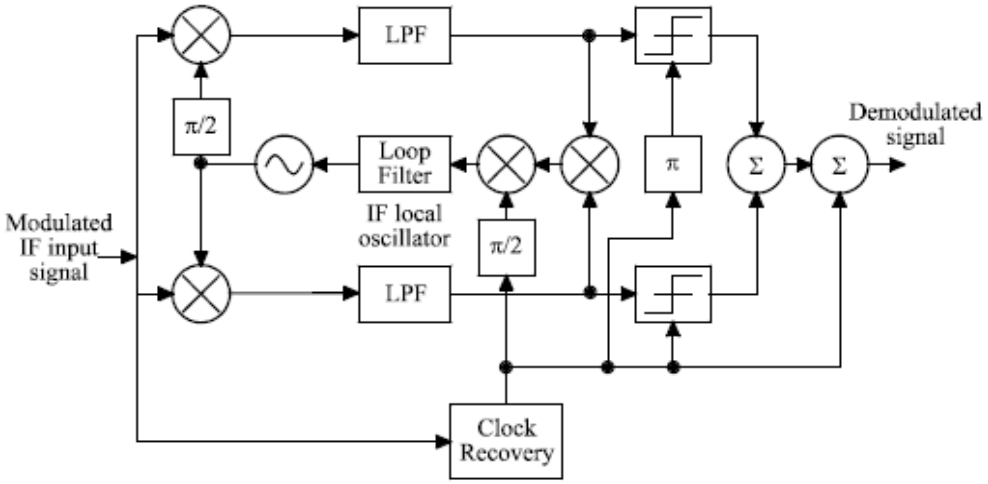
16	**What is the advantage of MSK over QPSK? – BTL2** In QPSK the phase changes by 90 or 180 degrees. This creates abrupt amplitude variations in the waveform. Therefore bandwidth requirement of QPSK is more. MSK overcomes this problem. In MSK, the output waveform is continuous in phase hence there are no abrupt changes in amplitude.
17	**Why MSK is called as fast FSK? – BTL3** MSK is called fast FSK, as the frequency spacing used is only half as much as that used in conventional non-coherent FSK
18	**Mention some merits of MSK. – BTL1** Constant envelope, Spectral efficiency, Good BER performance, Self-synchronizing capability
19	**Why MSK cannot be directly used in multi user communications? - BTL3** 1. The main lobe of MSK is wide. This makes MSK unsuitable for the applications where extremely narrow bandwidths and sharp cutoffs are required. 2. Slow decay of MSK power spectral density curve creates adjacent channel interference. Hence MSK cannot be used for multiuser communications.
20	**What is the need of Gaussian filter? (Nov/Dec 13) – BTL3** Gaussian filters used before the modulator to reduce the transmitted bandwidth of the signal. It uses less bandwidth than conventional FSK.
21	**Give some examples of linear modulation. – BTL1** Pulse shaped QPSK, OQPSK, and π/4QPSK
22	**Give some examples for constant envelope modulation. – BTL1** BFSK, MSK, GMSK
23	**Define QAM. – BTL1** Quadrature amplitude modulation is in which both the amplitude and phase of the transmitted signals are varied by the baseband signal.

24	**Define M-ary FSK. – BTL1** In M-ary system, M=2N different symbols are used and N no of bits per symbol. Every symbol uses separate frequency for transmission.
25	**Write the applications of MFSK and OFDM. – BTL2** They are used for high speed data connections as part of the IEEE 802.11a standards activities to provide 54mbps WLAN connections, as well as for high speed line of sight and non-line of sight connections for Multi-channel Multipoint Distribution service (MMDS) operation.
26	**What are the modulations suitable for frequency selective mobile channels? – BTL1** Both filtered and unfiltered BPSK, QPSK, OQPSK and MSK modulations are suitable for frequency selective mobile channels.
27	**Mention any two criteria for choosing a modulation technique for a specific wireless application? (May/June 2013) – BTL1** The spectral efficiency of the modulation format should be as high as possible. This can best be achieved by a higher order modulation format. This allows the transmission of many data bits with each symbol. Adjacent channel interference must be small. This entails that the power spectrum of the signal should show a strong roll-off outside the desired band. Furthermore, the signal must be filtered before transmission.

28	**Draw the structure of generic optimum receiver? (May/June 2013) – BTL3** 
29	**Define cyclic prefix. – BTL1** In OFDM, delay dispersion leads to a loss of orthogonality between the subcarriers and thus leads to Inter Carrier Interference (ICI). These negative effects can be eliminated by a special type of guard interval called the cyclic prefix.
30	**Define Windowing. – BTL1** Windowing is a technique proposed to help reduce sensitivity to frequency offsets in an OFDM system.This process involves cyclically extending the time domain signal with each symbol by 'v' samples.The resulting signal is then shaped with a window function.
31	**Define PAPR. – BTL1(Nov//Dec 2017)** The peak to average power ratio PAPR is an important attribute of a communication system. A low PAPR allows the transmit power amplifier to operate efficiently,whereas a high PAPR forces the transmit power amplifier to have a large backoff in order to ensure linear amplification of the signal.
32	**State advantages of Offset-QPSK.(Nov/Dec 2014) – BTL1**(Apr/may 2019) i. OQPSK is close to a constant envelope modulation scheme that is attractive for systems using nonlinear transponders, e.g., satellite communication ii. Envelope fluctuations in OQPSK is much smaller than in QPSK iii. Since sudden 180 degree phase changes cannot occur in OQPSK, this problem is reduced to a certain extent.

33	**List the advantages of GMSK.(Nov/Dec 2014) – BTL1** Modulated carrier in MSK contains no phase discontinuities and frequency changes occur at zero crossing of carrier. This helps in keeping PAPR low hence do not require highly linear power amplifier. GMSK spectral efficiency is better than MSK. Also it has reasonably less demodulator complexity.
	PART * B
1.	**Explain GMSK transmitter and receiver with signal spacing diagram and give an expression for spectral efficiency (13) – BTL2(nov//dec 2017)** **GMSK** **(3)** GMSK is a simple binary modulation scheme which may be viewed as a derivative of MSK. The GMSK premodulation filter has an impulse response given by $$h_G(t) = \frac{\sqrt{\pi}}{\alpha}\exp\left(-\frac{\pi^2}{\alpha^2}t^2\right)$$ **GMSK TRANSMITTER** **(Diagram 2 M+ Exp 3 M)** 

GMSK RECEIVER **(Diagram 2 M+ Exp 3 M)**



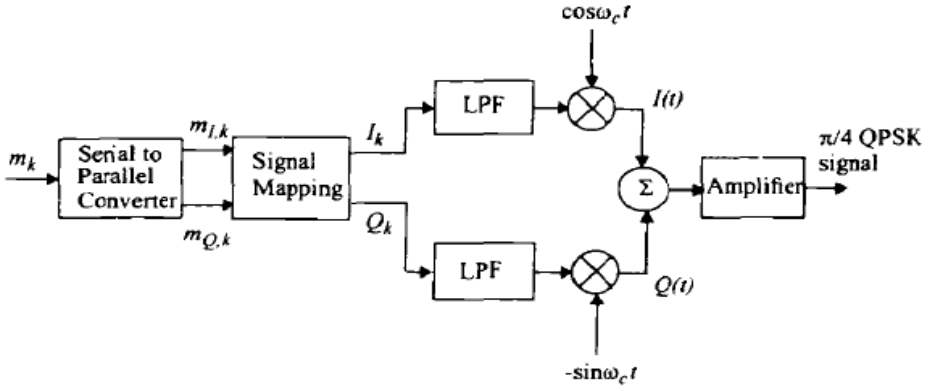
Answer: Page No. 318 in Rappaport

2

Describe π/4 QPSK and its advantages with neat block diagram. (13) – BTL2

Even though QPSK is a constant envelope format, it has amplitude dips at bit transitions. This can be reduced by using ***π/4*-DQPSK** (3)

***π/4* QPSK transmitter** (Diagram 2 M+ Exp 3 M)



$I_k = \cos\theta_k$ $Q_k = \sin\theta_k$ $\theta_k = \theta_{k-1} + \phi_k$

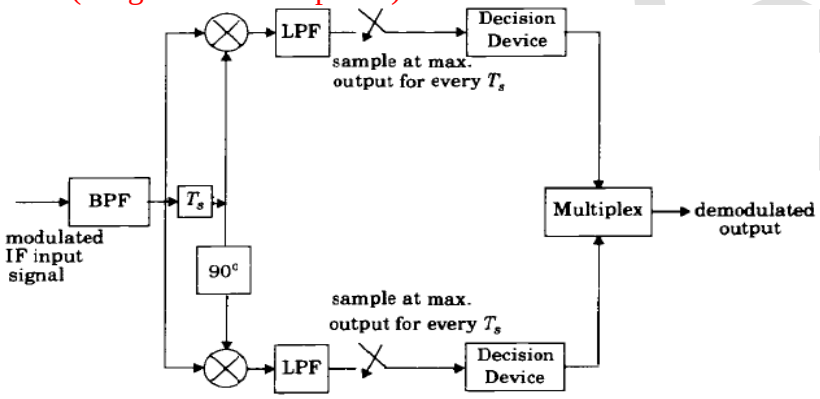
Information bits $m_{I,k}$, $m_{Q,k}$	Phase shift ϕ_k

11	$\pi/4$
01	$3\pi/4$
00	$-3\pi/4$
10	$-\pi/4$

QPSK waveform given by

$$S_{\pi/4-DQPSK} = I(t)\cos\omega_c t - Q(t)\sin\omega_c t$$

π/4 QPSK Detection(Diagram 2 M+ Exp 3 M)



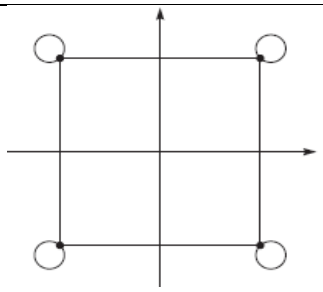
The received signal is converted to IF and is bandpass filtered. The bandpass filter is designed to match the transmitted pulse shape, so that the carrier phase is preserved and noise power is minimized. The received IF signal is differentially decoded using a delay line and two mixers.
Answer: Page No. 305 in Rappaport

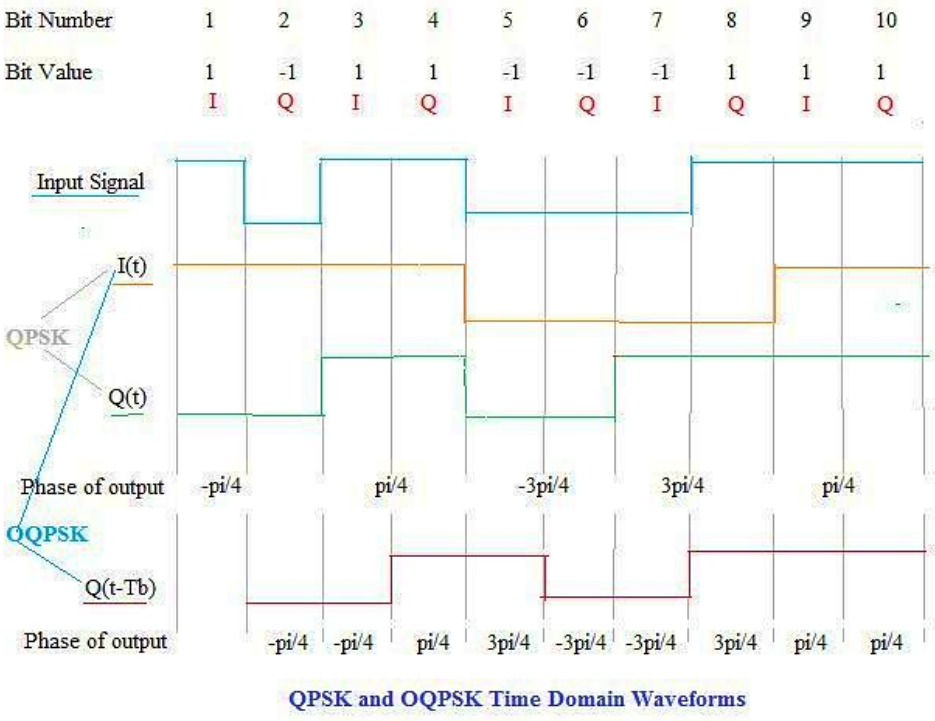
3

Describe the OFFSET QPSK (OQPSK)with suitable diagrams *(13)* – **BTL2** *(nov//dec 2017)*
(Diagram 6 M+ Exp 7 M)

A modified form of QPSK, called offset QPSK (OQPSK) or staggered QPSK is less susceptible to these deleterious effects. The 180° phase transition in QPSK causes abrupt changes in the signal, resulting in large spectral side lobes. To prevent 180° phase changes in QPSK, **offset QPSK (OQPSK)** or **staggered QPSK (SQPSK)** is used.

The phase transition diagram for OQPSK is shown in figure below. It is clear that there are no transitions passing through the origin of the coordinate system. Maximum phase transition is ±90°





QPSK and OQPSK Time Domain Waveforms

Advantages of offset QPSK: maximum phase shift 90 degree, nonlinear amplification does not generate high frequency side lobes, spectral occupancy is reduced.

Answer: Page No. 303 in Rappaport

4

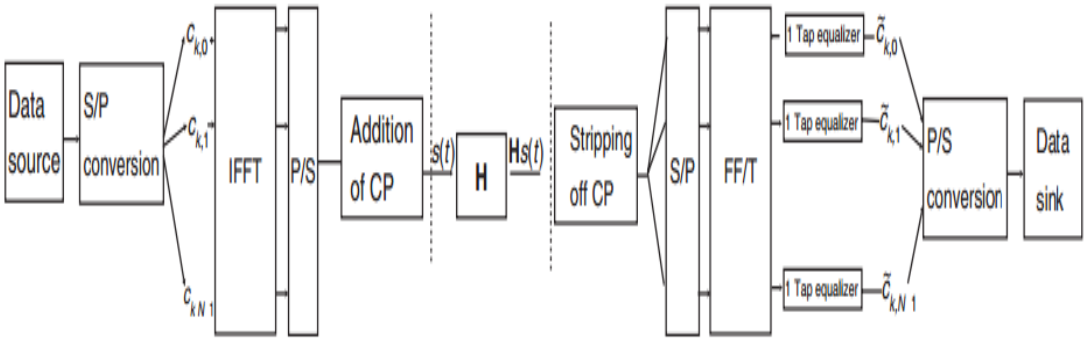
Briefly explain Peak Average Power Ratio(PAPR) and cyclic prefixing in OFDM (13) – BTL2

Cyclic Prefix (Diagram 3 M+ Exp 4 M)

Delay dispersion leads to

1. appreciable errors even when delay spread < symbol duration.
2. loss of orthogonality between the subcarriers, and thus leads to **Inter Carrier Interference.**

The cyclic prefix converts this linear convolution into a cyclical convolution.



Peak-to-Average Power Ratio (PAPR) (6 M)

Peak-to-average power ratio (PAPR) is proportional to the number of subcarriers used for OFDM systems.

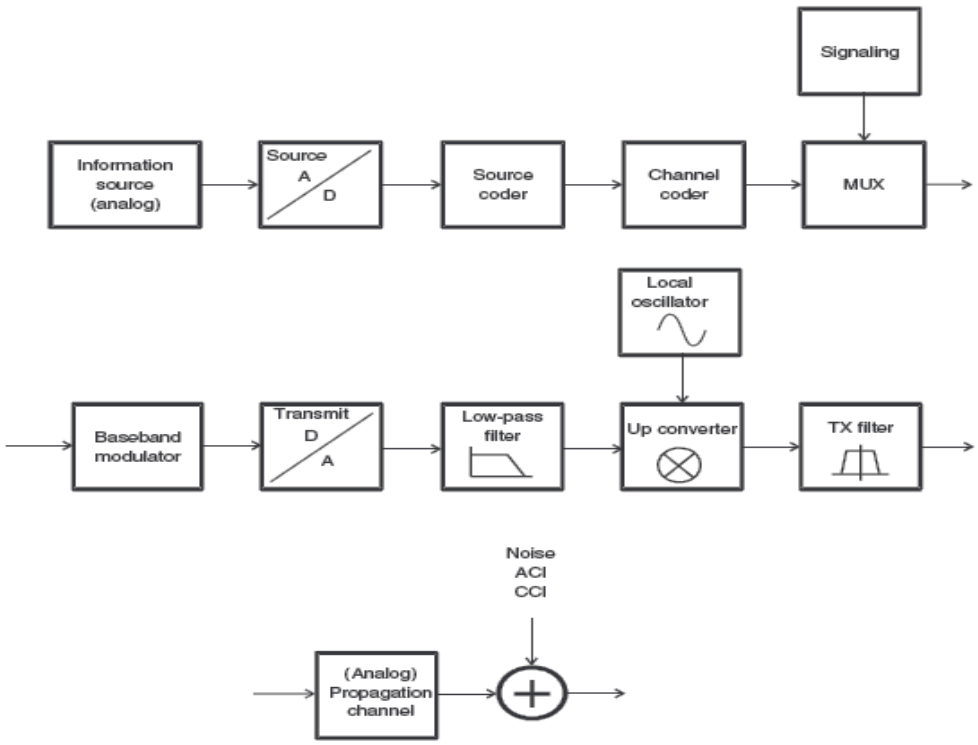
An OFDM system with large number of subcarriers will thus have a very large PAPR when the subcarriers add up coherently.

Large PAPR of a system makes the implementation of digital-to-analog converter (DAC) and analog-to-digital converter (ADC) extremely difficult.

The design of RF amplifier also becomes increasingly difficult as the PAPR increases.

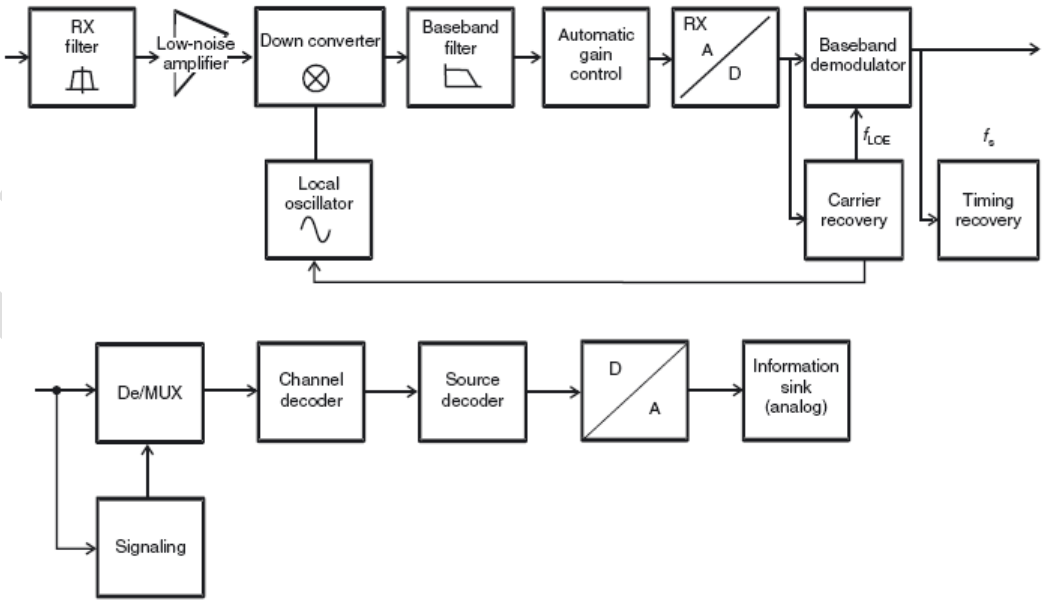
Answer: Page No. 420, 431 in Andreas F Molisch

5	**Describe the block diagram of transmitter and receiver block diagram in detail. (13) – BTL2** Transmitter: (Diagram 3 M+ Exp 4 M)



Explanation of each blocks

Receiver: (Diagram 3 M+ Exp 3 M)



Explanation of each block

Answer: Page No. 181 in Andreas F Molisch

6

Compare QPSK, OQPSK and QPSK (13) – BTL 3 Any 6 points – 13 M

QPSK	OQPSK	pi/4 QPSK
phase changes of +/- 90 and +/-180 degrees	phase changes of +/- 90 exist	+/-45 and +/-135
+/-180 degree transitions of the both bits change the phase at the same time.	One of the bits changes the phase at a time and occurs twice during the symbol period with half the intensity of QPSK	Phase transitions avoid zero crossing.
Null Bandwidth is 1.0 X Data rate	Same as QPSK	Same as QPSK
Bandwidth containing 90% of power is in 0.8 X Data rate	Same as QPSK	Same as QPSK
Power spectral density falls of as inverse second power of frequency	Same as QPSK	Same as QPSK
Amplitude variations are of the order of 30dB	Amplitude variation are of the order of 3 dB	-
Main lobe to side lobe suppression is poor	Same as QPSK	Same as QPSK

7

Assume that $\Theta_0 = 0^\ominus$. The bit stream 0 0 1 0 1 1 is to be sent using Π/4 DQPSK. The leftmost bits are first applied to the transmitter. Determine the phase of Θ_K and the values of I_k, Q_k during transmission. (13) – BTL 4 (Apr/may 2019) (apr/may 2018)

Formula used $I_k = \cos\theta_k$ $Q_k = \sin\theta_k$ (2)

$\theta_k = \theta_{k-1} + \phi_k$ Table (2)

Information bits $m_{I,k}$, $m_{Q,k}$	Phase shift ϕ_k
11	$\pi/4$
01	$3\pi/4$
00	$-3\pi/4$
10	$-\pi/4$

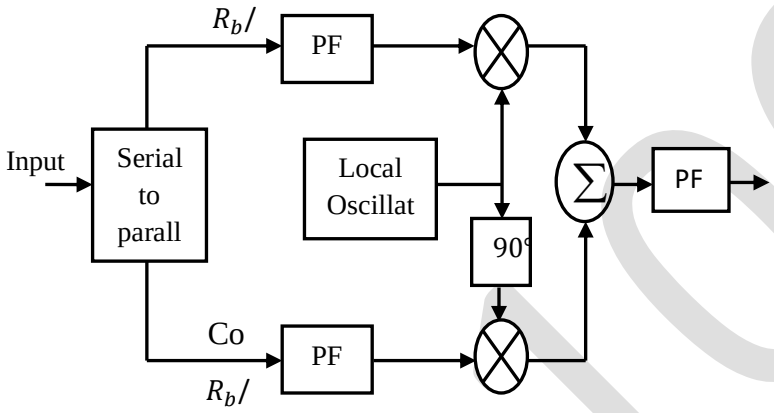
The first two bits are 0 0, which implies that $\phi_1 = -3\pi/4$ (3)

$\theta_k = \theta_{k-1} + \phi_k$

	$\Theta_1 = \Theta_0 + \phi_1 = -3\pi/4$ (from table) $I_k = \cos\theta_k$ $Q_k = \sin\theta_k$ $I_1 = -0.707$ $Q_1 = -0.707$ The second two bits are 10, which implies that **$\phi_2 = -\pi/4$** (3) **$\Theta_2 = \Theta_1 + \phi_2 = -3\pi/4 - \pi/4 = -\pi$** $I_2 = -1$ $Q_2 = 0$ The third two bits are 11, which implies that **$\phi_3 = \pi/4$** (3) **$\Theta_3 = \Theta_2 + \phi_3 = -\pi + \pi/4 = -3\pi/4$** $I_3 = -0.707$ $Q_3 = -0.707$ Answer: Page No. 307 in Rappaport
8	**Identify the Methods for Computation of Error Probability** *(13)* **– BTL 1 (Any 4 Types With Formula 13 M)** Error Probability for Coherent Receivers – General Case Error Probability for Coherent Receivers – Binary Orthogonal Signals Error Probability for Coherent Receivers – Antipodal Signaling Error Probability for Differential Detection Error Probability for Noncoherent Detection
9	**Drive the Error Probability In Flat-Fading Channels** *(13)* **– BTL 3** For a mathematical computation of the BER in a channel, (6) 1. Determine the BER for any arbitrary SNR. 2. Determine the probability that a certain SNR occurs in the channel. 3. Average the BER over the distribution of SNRs $\overline{BER} = \int pdf_{\gamma_B}(\gamma_B) BER(\gamma_B)\, d\gamma_B$ (7) $pdf_{\gamma_B}(\gamma_B) = \frac{1}{\overline{\gamma}_B} \exp\left(-\frac{\gamma_B}{\overline{\gamma}_B}\right)$ $\overline{BER} = \frac{1}{2+\overline{\gamma}_B} \cong \frac{1}{\overline{\gamma}_B}$
10	**Enumerate the Advantages and Disadvantages of OFDM** *(13)* **– BTL 2** Advantages (7) • Immunity to selective fading • Resilience to interference • Spectrum efficiency • Resilient to ISI • Resilient to narrow-band effects • Simpler channel Equalization Disadvantages (6) • High peak to average power ratio • Sensitive to carrier offset and drift

	PART * C
1.	**Discuss about QPSK transmitter and receiver with signal space diagram and give an expression for spatial effect (15) – BTL2**

QPSK TRANSMITTER (Diagram 3 M+ Exp 3 M)

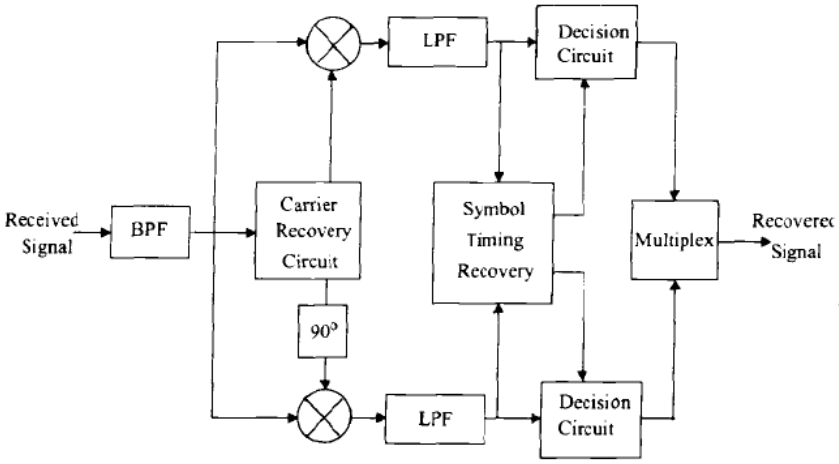


$$S_{QPSK}(t) = \sqrt{\frac{E_b}{T_b}}\left\{p1_D(t)\cos(2\pi f_c t) - p2_D(t)\sin(2\pi f_c t)\right\}$$

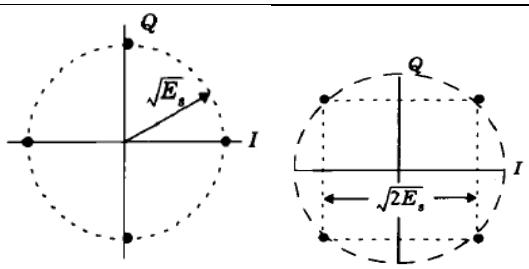
The baseband signal is

$$S_{QPSK}(t) = \sqrt{\frac{E_b}{T_b}}[p1_D(t) + jp2_D(t)]$$

QPSK RECEIVER (Diagram 3 M+ Exp 3 M)



The constellation diagram of QPSK **(3)**



$$P_{e,\,QPSK} = Q\left(\sqrt{\frac{2E_b}{N_0}}\right)$$

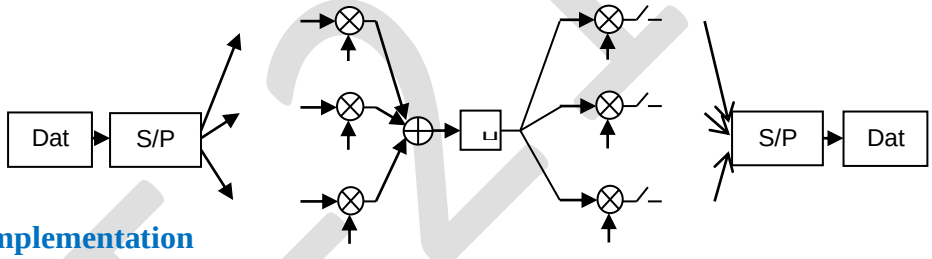
Answer: Page No. 300 in Rappaport

2

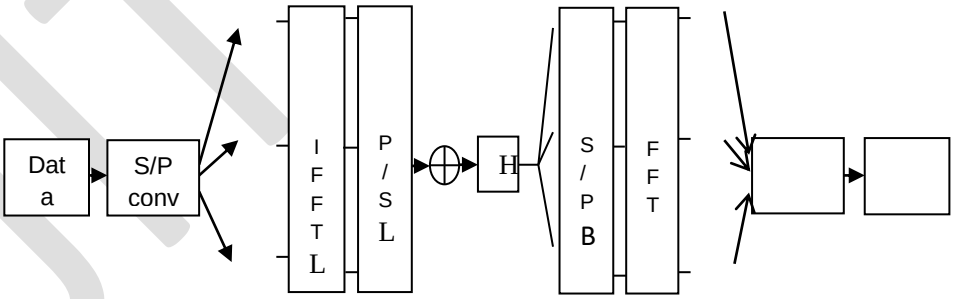
Interpret the implementation of transceivers in OFDM (15) – BTL2 (Diagram 8 M+ Exp 7 M) (Apr/may 2019) (Apr/may 2018)

The OFDM scheme differs from traditional FDM in the following interrelated ways: Multiple carriers carry the information stream, The subcarriers are orthogonal to each other, and guard interval is added to each symbol to minimize the channel delay spread and intersymbol interference

Analog implementation



Digital implementation



Answer: Page No. 417 in Andreas F Molisch

3

What is MSK , explain with transmitter and receiver diagram . Explain the various types of demodulation of MSK. (15) – BTL2

1. Minimum shift keying (MSK) is a special type of continuous phase FSK **(4)**

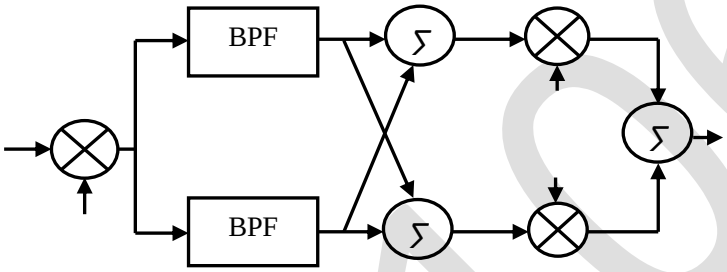
$$\Delta f = \frac{1}{4}R_b = \frac{1}{4T_b}$$ MSK is sometimes referred to as **fast FSK**

2. MSK signal, where the baseband rectangular pulses are replaced with half-sinusoidal pulses.

$$S_{MSK} = \sum_{i=0}^{N-1} m_I(t) g(t - 2iT_b)\cos(2\pi f_c t) + \sum_{i=0}^{N-1} m_Q(t) g(t - 2iT_b - T_b)\sin(2\pi f_c t)$$

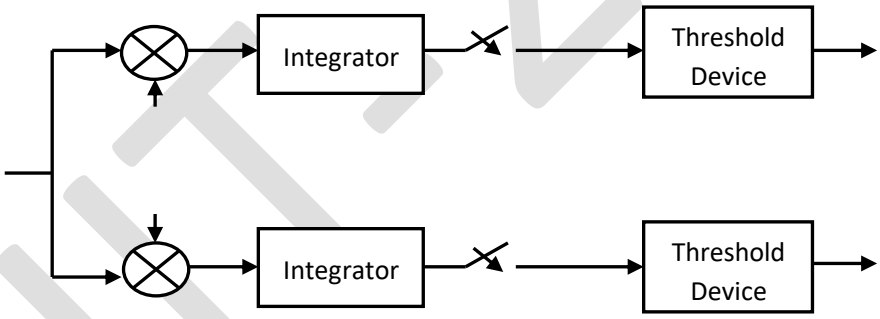
$$g(t) = \begin{cases} \sin\left(\dfrac{\pi t}{2T_b}\right) & 0 \le t \le 2T_b \\ 0 & elsewhere \end{cases}$$

MSK Modulator (Diagram 3 M+ Exp 3 M)



Demodulation of Minimum Shift Keying (3)

1. ***Frequency discriminator detection***
2. ***Differential detection:***
3. ***Matched filter reception***



Properties of MSK (2)

- constant envelope
- good spectral efficiency
- good BER performance
- self-synchronizing capability
- relatively narrow bandwidth
- coherent detection performance equivalent to that of QPSK

Answer: Page No. 314 in Rappaport

UNIT IV MULTIPATH MITIGATION TECHNIQUES	
Equalisation – Adaptive equalization, Linear and Non-Linear equalization, Zero forcing and LMS Algorithms. Diversity – Micro and Macrodiversity, Diversity combining techniques, Error probability in fading channels with diversity reception, Rake receiver	
PART * A	
Q.No.	**Questions**
1.	**What are the techniques used to improve the received signal quality? – BTL1**(Apr/may 2019) Equalization, Diversity and Channel coding
2	**What is the need of equalization? – BTL1** Equalization is used to compensate the inter-symbol interference created by multipath within time dispersion channel.
3	**Write the functions of diversity. (Nov/Dec 13) – BTL1** i. Diversity is used to compensate for fading channel impairments, and is usually implemented by using two or more receiving antennas. ii. Diversity improves transmission performance by making use of more than one independently faded version of the transmitted signal.
4	**Define spatial diversity. – BTL1(nov/dec 2017)** The most common diversity technique is called spatial diversity, whereby multiple antennas are strategically spaced and connected to a common receiving system. While one antenna sees a signal null, one of the other antennas may see a signal peak, and the receiver is able to select the antenna with the best signals at any time.
5	**What is equalizer? (Nov/Dec 13) – BTL1** The device which equalizes the dispersive effect of a channel is referred to as an equalizer.
6	**Define adaptive equalizer. – BTL1** To combat ISI, the equalizer coefficients should change according to the channel status so as to track the channel variations. Such an equalizer is called an adaptive equalizer since it adapts to the channel variations.
7	**What are the operating modes available in an adaptive equalizer? – BTL1** Training and tracking modes.
8	**What is training mode in an adaptive equalizer? – BTL1** First, a known fixed length training sequence is sent by the transmitter, then the receiver's equalizer may adapt to a proper setting of minimum bit error rate detection, where the training sequence is pseudorandom binary signal or a fixed and prescribed bit pattern.
9	**What is tracking mode in an adaptive equalizer? – BTL1** Immediately following the training sequence, the user data is sent, and the adaptive equalizer at the receiver utilizes a recursive algorithm to evaluate the channel and estimate filter coefficients to compensate for the distortion created by multipath in the channel.
10	**Write a short note on i) linear equalizers ii) non-linear equalizers – BTL1** If the output is not used in the feedback path to adapt, then this type of equalizer is called linear equalizer. If the output is fed back to change the subsequent outputs of the equalizer, this type of equalizer is called nonlinear equalizers.
11	**Write the advantages of lattice equalizer. – BTL1** It is simplest and easily available, Numerical stability, Faster convergence, Unique structure of

	the lattice filter allows the dynamic assignment of the most effective length of the lattice equalizer and When the channel becomes more time dispersive, the length of the equalizer can be increased by the algorithm without stopping the operation of the equalizer.
12	**Mention the disadvantages of lattice equalizer. – BTL1** i. If the channel is not very time dispersive, only a fraction of stages are used. ii. It is more complicated than a linear transversal equalizer.
13	**Why nonlinear equalizers are preferred? – BTL1** The linear equalizers are very effective in equalizing channels where ISI is not severe. The severity of ISI is directly related to the spectral characteristics. In this case there are spectral nulls in the transfer function of the effective channel; the additive noise at the receiver input will be dramatically enhanced by the linear equalizer. To overcome this problem, nonlinear equalizers can be used.
14	**What are the nonlinear equalization methods used? - BTL1** Decision feedback equalization (DFE), Maximum likelihood symbol detection and Maximum likelihood sequence estimation (MLSE).
15	**Where DFEs are used? – BTL1** DFE is particularly useful for channels with severe amplitude distortions and is widely used in wireless communications.
16	**What are the factors used in adaptive algorithms? – BTL1** Rate of convergence, Misadjustment, Computational complexity and numerical properties.
17	**Define rate of convergence. – BTL1** The no of iterations required for the algorithm in response to stationary inputs to converge close enough to the optimum solution.
18	**Write the basic algorithms used for adaptive equalization. – BTL1** Zero forcing algorithm (ZF), least mean square algorithm (LMS) and recursive least square algorithm (RLS).
19	**Write the advantages of LMS algorithm. – BTL1** It maximizes the signal to distortion at its output within the constraints of the equalizer filter length, Low computational complexity and Simple program
20	**Write the advantages of RLS algorithm. – BTL1** Fast convergence, Good tracking ability
21	**Explain Diversity concept. – BTL1** If one radio path undergoes a deep fade, another independent path may have a strong signal. By having more than one path to select from, both the instantaneous and average SNRs at the receiver may be improved.
22	**List out the types of Diversity. – BTL1** Space diversity, Polarization diversity, Time diversity, Frequency diversity
23	**What is the need for diversity schemes? – BTL1** To increase signal to noise ratio, for error free digital transmission, to degrade the bit error probability.
24	**What are the two main classifications of diversity techniques? – BTL1** Microscopic diversity and Macroscopic diversity
25	**List out the four types of Combining Methods. – BTL1** Selection combining, switched combining, Equal gain combining, Maximum ratio combining

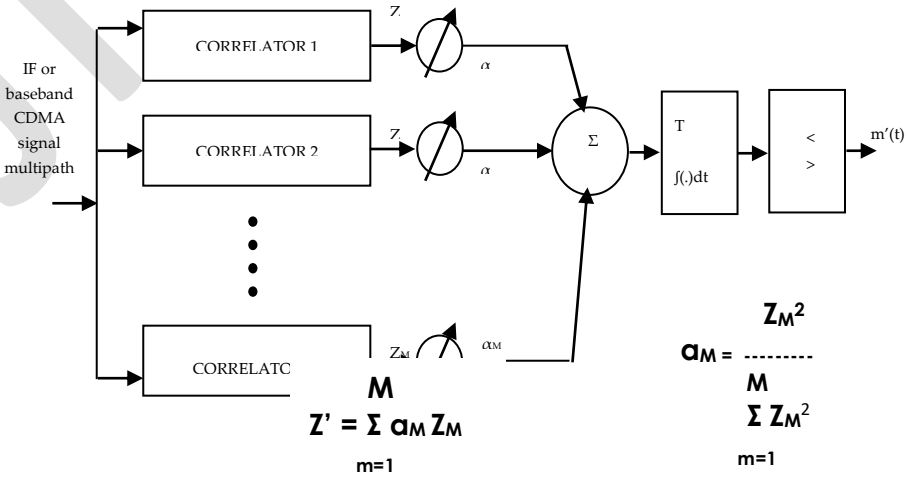
26	**Define Hamming distance. (May/June 2013) – BTL1** The Hamming distance between two strings of equal length is the number of positions at which the corresponding symbols are different. In another way, it measures the minimum number of substitutions required to change one string into the other, or the minimum number of errors that could have transformed one string into the other
7	**State the principle of diversity.(May/June 2013) – BTL1** Diversity: It is the technique used to compensate for fading channel impairments. It is implemented by using two or more receiving antennas. While Equalization is used to counter the effects of ISI, Diversity is usually employed to reduce the depth and duration of the fades experienced by a receiver in a flat fading channel. These techniques can be employed at both base station and mobile receivers. Spatial Diversity is the most widely used diversity technique.
28	**Differentiate between Macrodiversity and Microdiversity. (Nov/Dec 2014) – BTL3**(apr/may 2018) (Apr/may 2019)

Macrodiversity	**Microdiversity**
In antenna (or micro) diversity the signal from antennas mounted at separate locations are combined	In site (or macro) diversity the receiving antennas are located at different receiver sites
These antennas are located on the vehicle or at the same base station tower and their spacing is a few wavelengths. The received signal amplitude is correlated, depending on the antennas separation *d* relative to the wavelength.	Signals from within a cell may be received at the different corners of the hexagonal area. The advantage is that not only the multipath fading attenuation is independent at each branch but that the shadowing and path losses are also uncorrelated to some extent

PART * B

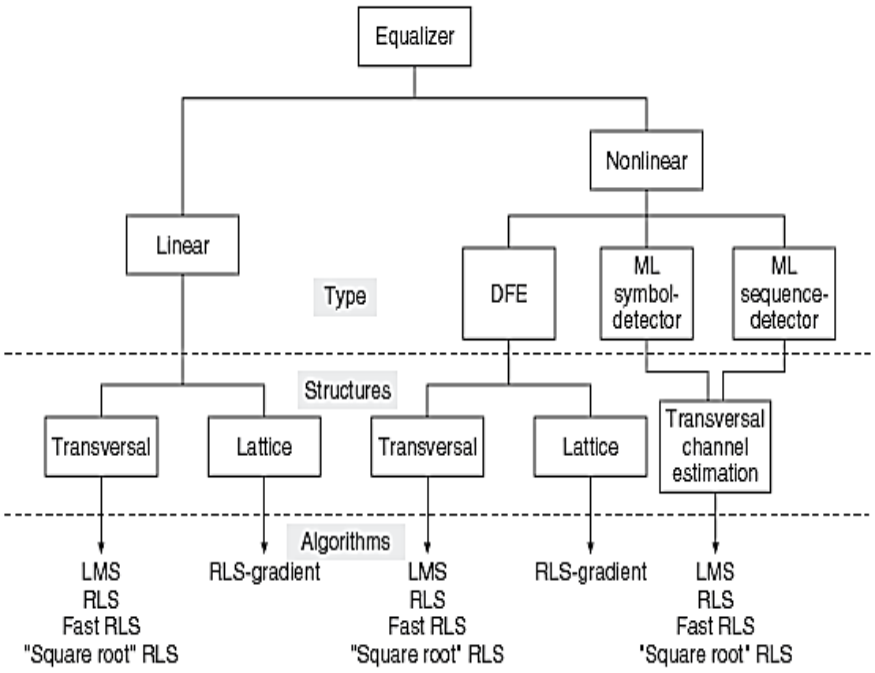
1. **Illustrate the concepts of Rake receiver (13) – BTL3 (** Dia – 5 M + Exp – 8 M) (apr/may 2018) (Apr/may 2019)

A RAKE receiver utilizes multiple correlators to separately detect the M strongest multipath components. The outputs of each correlators are then weighted to provide a better estimate of the transmitted signal than is provided by a single component. Demodulation and bit decisions are then based on the weighted outputs of the M correlators.



The basic idea of a RAKE receiver was first proposed by Price and Green.
Answer: Page No. 391 in Rappaport

2 **Describe the Algorithms used for the Adaptive Equalization (13) – BTL2(nov//dec 2017)**



(Types -10 + Difference 3 M)

LMS Algorithm	RLS Algorithm
The LMS algorithm usually converges too slowly.	The RLS algorithm converges faster, but has a larger residual error.
The LMS algorithm requires fewer (complex) operations than RLS algorithm.	The RLS algorithm requires more (complex) operations than LMS algorithm.

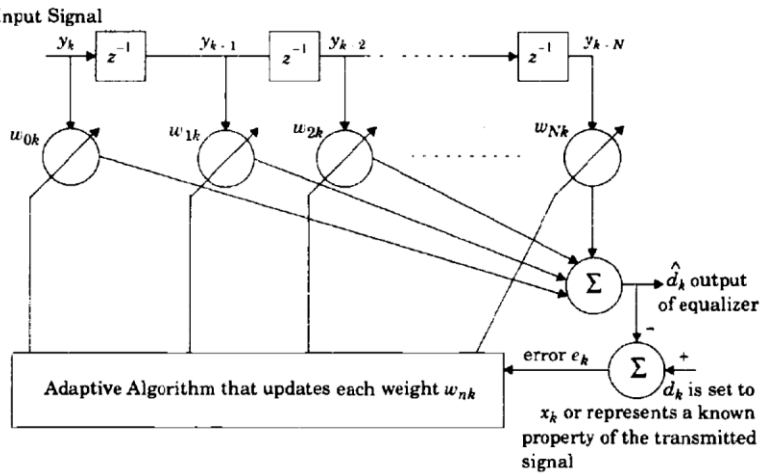
Answer: Page No. 372 in Rappaport

3 **Derive the mean square error for a generic adaptive equalizer. (13) – BTL3**

(Dia – 5 M + Exp – 8 M)

A Generic Adaptive Equalizer

An adaptive equalizer is a time-varying filter which must constantly be retuned.



The adaptive equalizer structure shown above is called a transversal filter.

New weights = Previous weights + (constant) x (Previous error) x (Current input vector)
Previous error = Previous desired output — Previous actual output

A more recent class of adaptive algorithms are able to exploit characteristics of the transmitted signal and do not require training sequences.

These modern algorithms blind algorithms, constant modulus algorithm (CMA) and the spectral coherence restoral algorithm (SCORE)

$$e_k = d_k - \overline{d_k} = x_k - \overline{d_k}$$

Answer: Page No. 359 in Rappaport

4

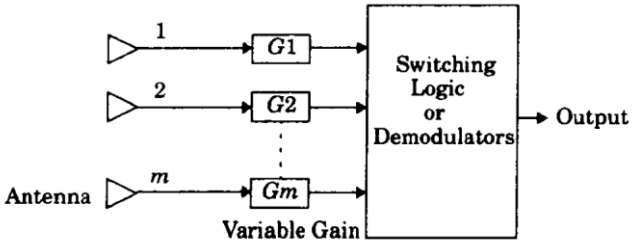
Illustrate the classification of Space/ Spatial Diversity Techniques (13) – BTL3

(4 Types – 1M + Each Type – 3M)

Space diversity reception method can be classified into four categories.

- ❖ Selection diversity
- ❖ Feedback Diversity
- ❖ Maximal Ratio Combining
- ❖ Equal Gain Diversity

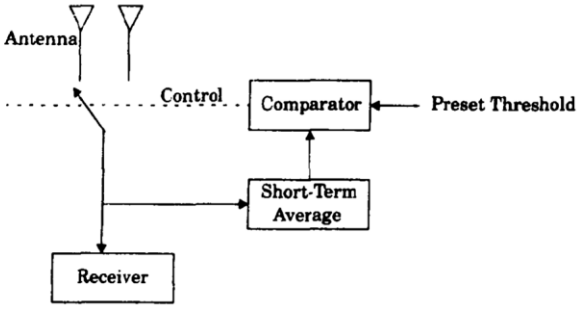
Selection diversity:



The receiver branch having the highest instantaneous SNR is connected to the demodulator.

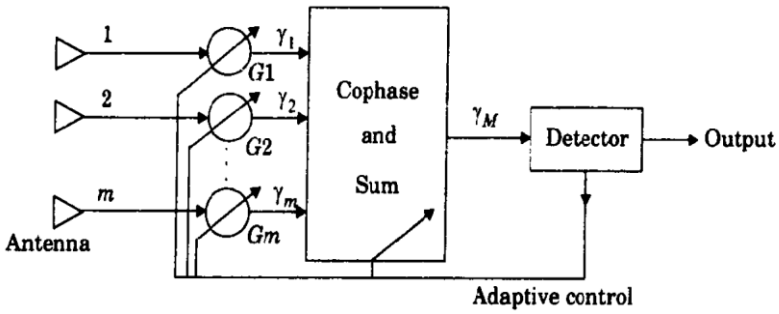
Feedback Diversity or scanning diversity

The M signals are scanned in a fixed sequence until one is found to be a above predetermined threshold.



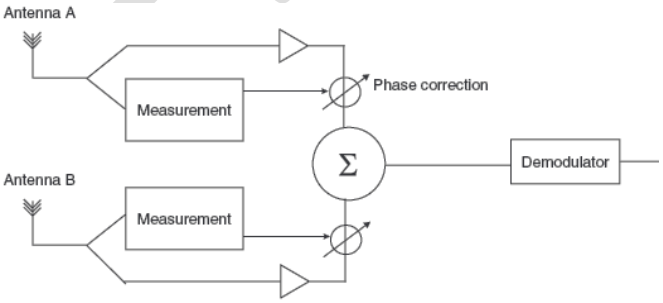
Maximal Ratio Combining

The M branches are weighted according to their individual signal voltage to noise power ratios and summed.



Equal Gain combining:

In certain cases it is not convenient to provide for the variable weighting capability required for true maximal ratio combining. In such cases, the branch weights are all set to unity, but the signals from each branch are co phased to provide the equal gain combining diversity.



Answer: Page No. 385 in Rappaport

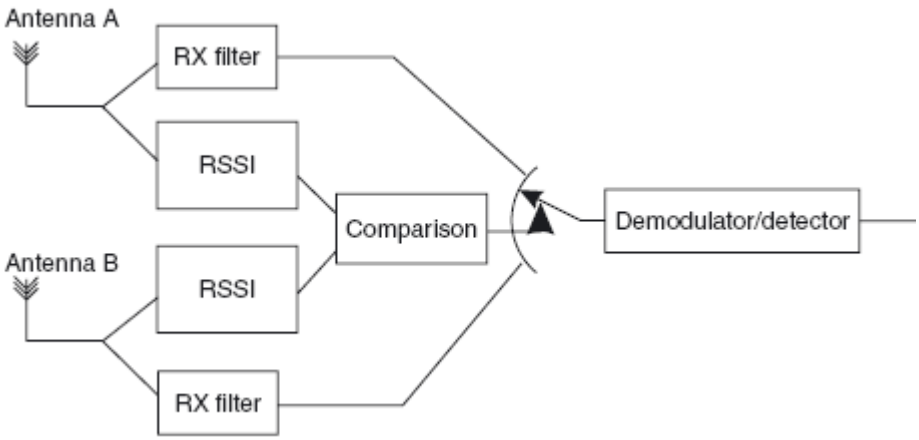
5 **Explain the selection diversity and its types** *(13)* – **BTL2** (nov//dec 2017)

(2 Types – 1M + Each Type – 6M)

In selection diversity the best signal copy is selected and processed, while all other copies are discarded.

Received-Signal-Strength-Indication-Driven Diversity

In this method, the RX selects the signal with the largest instantaneous power, and processes it further.

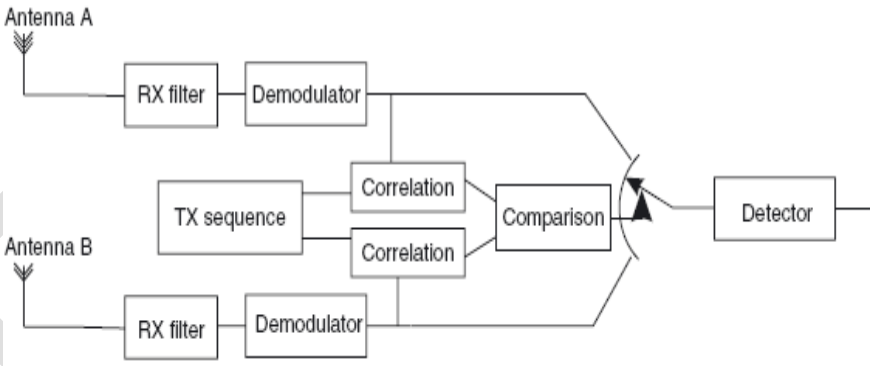


$$pdf_{\gamma_n}(\gamma_n) = \frac{1}{\overline{\gamma}} \exp\left(-\frac{\gamma_n}{\overline{\gamma}}\right)$$

$$cdf_{\gamma_n}(\gamma_n) = 1 - \exp\left(-\frac{\gamma_n}{\overline{\gamma}}\right)$$

Bit-Error-Rate-Driven Diversity

The antenna whose signal results in the smallest BER is judged to be the best, and used for the reception of data signals.

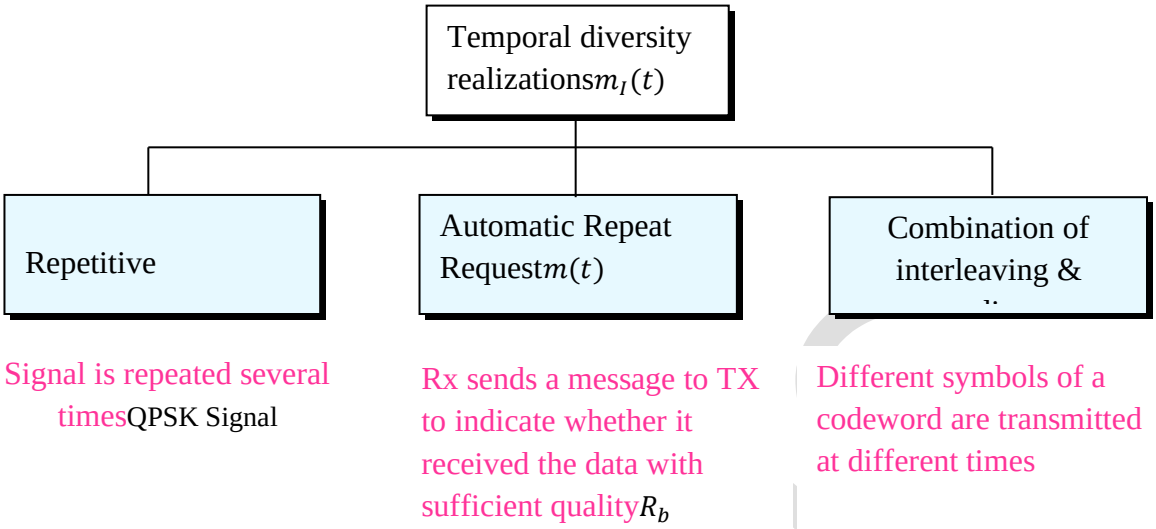


Drawbacks:

1. The RX needs either *N*r RF chains and demodulators
2. If the RX has only one demodulator, then it is not possible to continuously monitor the selection criterion of all diversity branches.
3. Since the duration of the training sequence is finite, the selection criterion

Answer: Page No. 259 in Andreas F Molisch

6	**Classify the time diversity in detail (13) – BTL 2 3 TYPES – 12 M + LIST 1 M(nov//dec 2017)**



PART*C

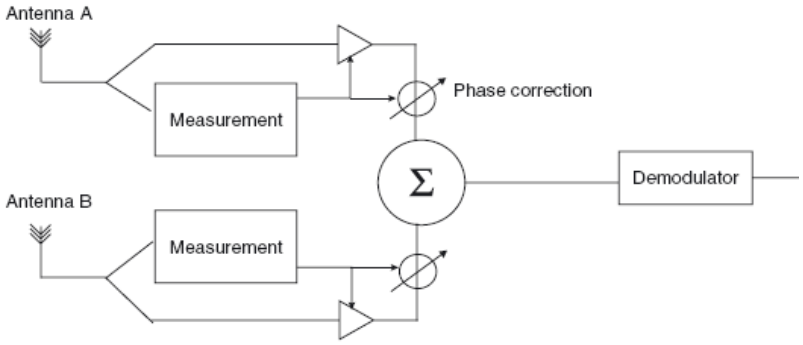
1.

Write combining techniques using combination of signal (15)

a. **Maximum ratio combining (4)**
b. **Equal gain combining (4)**
c. **optimum combining(4)**
d. **Hybrid selection –maximum ratio combining – BTL2 (3)**

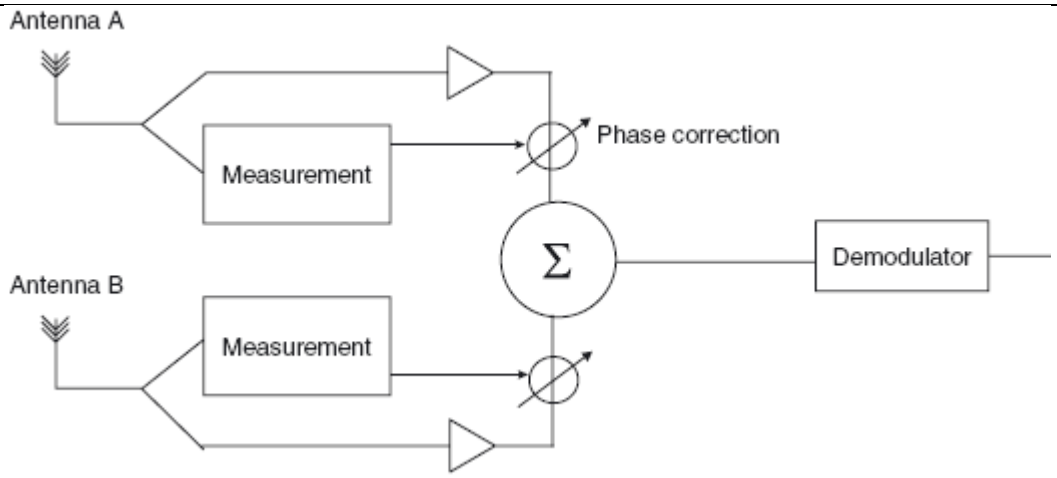
Maximum ratio combining

MRC compensates for the phases, and weights the signals from the different antenna branches according to their SNR.



Equal Gain Combining

In Equal Gain Combining, all amplitude weights are the same (in other words, there is no weighting, but just a phase correction



Optimum Combining

In order to maximize the Signal-to-Interference-and-Noise Ratio (SINR), the weights should then be determined according to a strategy called **optimum combining.**

Hybrid Selection – Maximum Ratio Combining

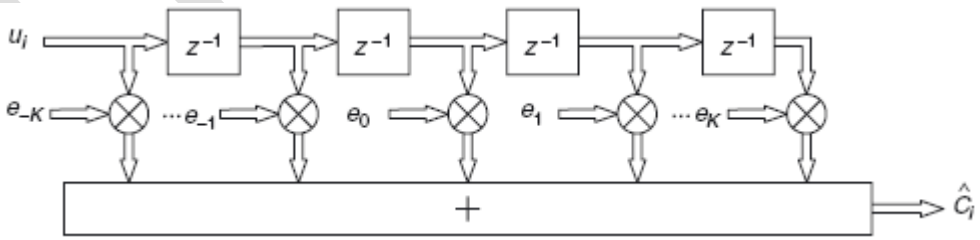
In hybrid selection scheme, the best L out of Nr antenna signals are chosen, downconverted, and processed. This reduces the number of required RF chains from N_r to L, and thus leads to significant savings.

Answer: Page No. 259-263 in Andreas F Molisch

2

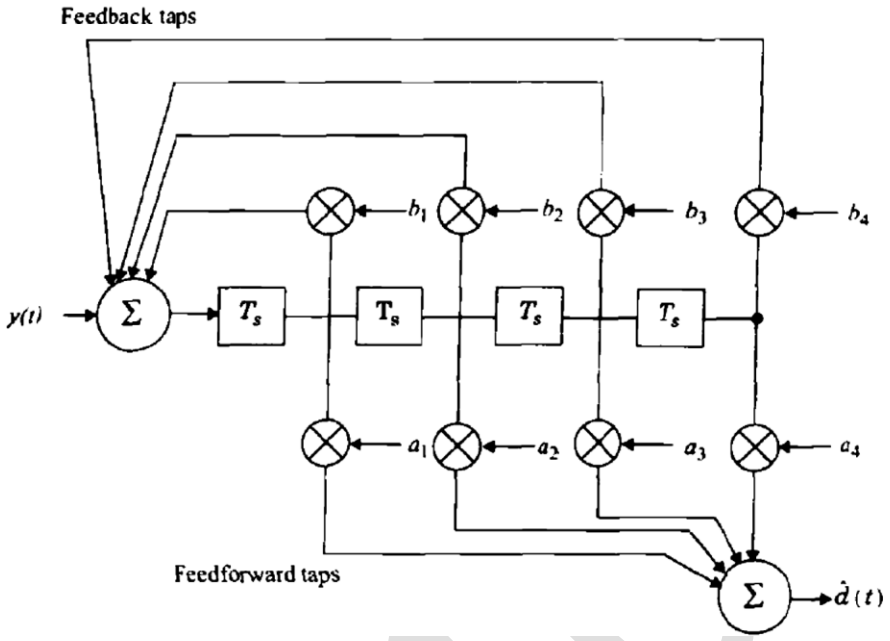
Derive for the mean square error for linear equalizer during training adaptive equalizer (15) – BTL3 (Diagram – 8 M + Explanation – 7 M)

Linear equalizers are simple linear filter structures. Linear equalizers try to invert the channel in the sense that the product of the transfer functions of channel and equalizer fulfills a certain criterion.



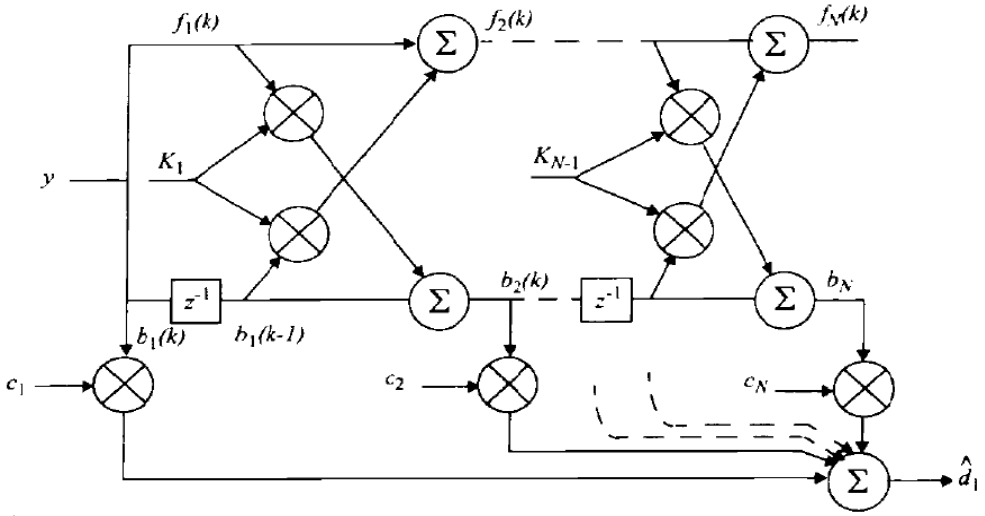
Minimum Mean Square Error (MMSE) equalizer.

Transversal Linear Equalizer



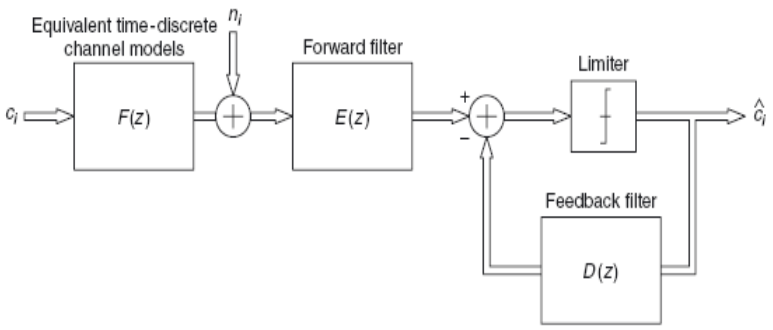
Lattice Equalizer

Two main advantages of the lattice equalizer is its numerical stability and faster convergence.

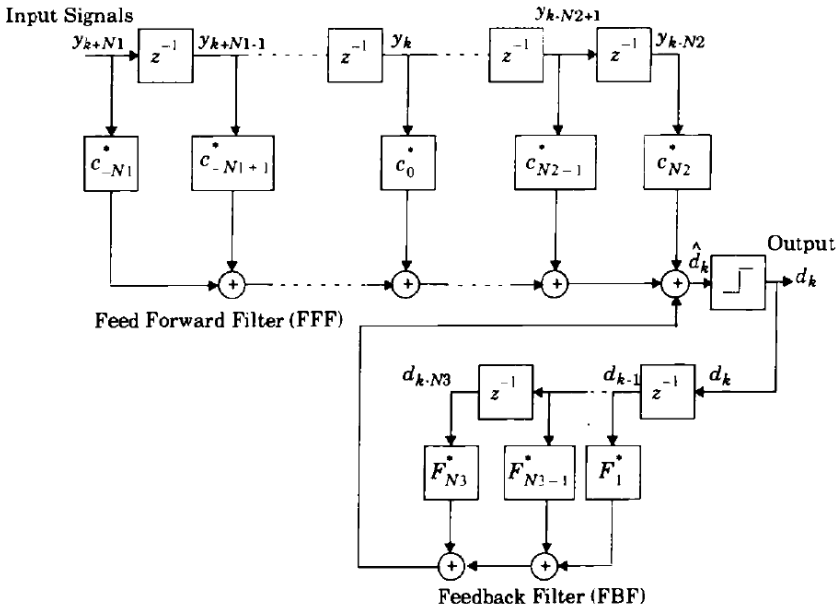


Answer: Page No. 359 in Rappaport

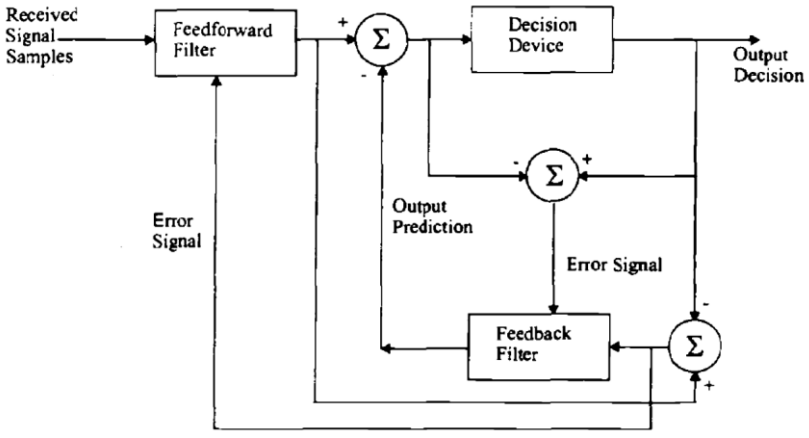
3	**Explain the working principle of nonlinear equalizer based on decision feedback equalizer (15) – BTL2 (Diagram – 8 M + Explanation – 7 M)** In decision feedback equalization, once a bit is correctly detected, the effect this bit on subsequent bit is determined. The ISI caused by each bit is then subtracted from these later samples.



It consists of a feedforward filter (FFF) and a feedback filter (FBF).

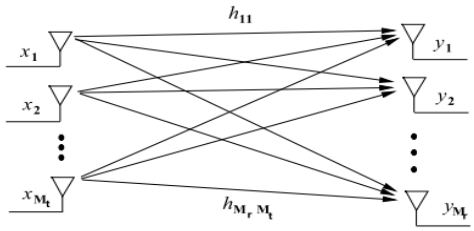


Another form of DFE proposed by Belfiore and Park is called a predictive It consists of a feed forward filter (FFF) as in the conventional DFE.



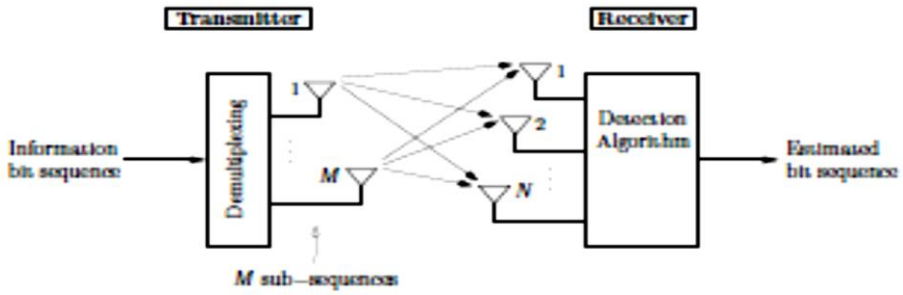
Answer: Page No. 369 in Rappaport

UNIT V - MULTIPLE ANTENNA TECHNIQUES	
MIMO systems – spatial multiplexing -System model -Pre-coding – Beam forming – transmitter diversity, receiver diversity- Channel state information-capacity in fading and non-fading channels.	
PART * A	
Q.No.	**Questions**
1.	**What is Beamforming? - BTL1**(Apr/may 2019) The multiple antennas at the transmitter and receiver can be used to obtain array and diversity gain instead of capacity gain.In this setting the same symbol weighted by a complex scale factor is sent over each transmit antenna, so that the input covariance matrix has unit rank. This scheme is also referred to as MIMO beamforming.
2	**What are the advantages of Beamforming? - BTL1** Beamforming provides diversity and array gain via coherent combining of the multiple signal paths.
3	**What is multiplexing gain? - BTL1** Multiple antennas are are used to improve wireless system performance. One option is to obtain capacity gain by decomposing the MIMO channel into parallel channels and multiplexing different data streams onto these channels.This capacity gain is also referred to as multiplexing gain.
4	**Define Transmitter diversity. - BTL1** In transmit diversity there are multiple transmit antennas, and the transmit power is divided among these antennas. Transmit diversity is desirable in systems where more space, power, and processing capability is available on the transmit side than on the receive side.Transmit diversity design depends on whether or not the complex channel gain is known to the transmitter.
5	**What is RAKE receiver? - BTL1** A more complicated receiver can have several branches, with each branch synchronized to a different multipath component. This structure is called a RAKE receiver, and it assumes there is a multipath component at each integer multiple of a chip time.
6	**Write the advantages of RAKE receiver. - BTL1** RAKE's provide a simple mechanism to obtain diversity benefits.When spread spectrum signalling is chosen for its other benefits such as multiuser or interference rejection capabilities.
7	**Explain the concept of Rake receiver. - BTL1** In Multipath environment, if the multiple versions of the signal arrive more than one chip interval apart from each other. The receiver can recover the signal from multiple paths and then combine them with suitable delays. This method achieves better performance than simply recovering dominant signal and treating remaining signals as noise.
8	**What are MIMO systems? - BTL1** Systems with multiple antennas at the transmitter and receiver, which are commonly referred to as multiple-input multiple-output (MIMO) systems. The multiple antennas can be used to increase data rates through multiplexing or to improve performance through diversity.

9	**Draw the MIMO model. – BTL3**  Mt transmit antenna and Mr receive antennas.
10	**Write the advantages of MIMO systems. - BTL1** i. Multiple-input multiple-output systems can significantly enhance performance of wireless systems through multiplexing or diversity gain. ii. For a given transmit energy per bit,multiplexing gain provides a higher data rate whereas diversity gain provides a lower BER in fading. iii. Support a higher data rate for a given energy per bit,so it transmits the bits more quickly and can then shut down to save energy.
11	**Write the disadvantages of MIMO systems. - BTL1** i. MIMO systems entail significantly more circuit energy consumption than their single antenna counterparts, because separate circuitry is required for each antenna signal path. ii. Signal processing associated with MIMO can be highly complex.
12	**Mention the applications of MIMO systems**. **- BTL1** i. MIMO can reliably connect devices in home, such as computer networking devices, cabled video devices, phone lines, music, storage devices etc. ii. The IEEE 802.16e standard and the IEEE 802.11n standard also use MIMO system. iii. MIMO is used in mobile radio telephone standard such as 3GPP and 3GPP2 standard. iv. 3GPP High Speed Packet Access Plus (HSPA+) and Long Term Evolution (LTE) standard use MIMO.
13	**How does spatial multiplexing work? – BTL2** Spatial multiplexing uses MEA's (Multiple element antennas) at the transmitter for transmission of data streams. An original high-rate datastream is multiplexed into several parallel streams, each of which is sent from one transmit antenna element. The channel mixes up these datastreams so that each of the receive antenna elements sees a combination of them.
14	**State the importance of spatial multiplexing. - BTL1(nov//dec 2017)** The basic premise of spatial multiplexing is to send Mt independent symbols per symbol period using the dimensions of space and time. To obtain full diversity order, an encoded bit stream must be transmitted over all Mt transmit antennas. This can be done through serial encoding.
15	**What is transmit diversity? - BTL1(apr/may 2018)** In transmit diversity more antennas are used on the transmitter side than on the receiver side. Transmit diversity is used to reduce the effect of fading. In transmit diversity the same information is transmitted from two different antennas. Data from the second antenna is encoded differently to differentiate it from the first antenna. This can be done to able the user equipment on the receiver side to identify that the information is coming from the different locations and properly decode it. Space-time coding is used to create redundant signals.

16	**What are smart antennas and MIMO systems? - BTL1** A MIMO system consists of several antenna elements, plus adaptive signal processing at both transmitter and receiver, the combination of which exploits the spatial dimension of the mobile radio channel. A smart antenna system is a system that has multiple antenna elements only at one link end.
17	**What is array gain? - BTL1** Array gain is defined as the average increase in the SNR and depends on the number of transmit and receive antennas. Transmit/Receive array gain needs channel information in the transmitter and receiver respectively. Channel information is typically available in the receiver whereas the channel state information in the transmitter is more difficult to maintain in general.
18	**What is diversity gain? - BTL1** Diversity is a powerful technique to reduce fading effect in wireless communications. Diversity gain is defined as the reduction in the probability of error due to multiple independent paths produced between the transmitter and receiver. In other words if there are M transmits, N receive antennas, the order of diversity is M.N. There is no diversity gain if the medium is line of sight channel.
19	**What is multiplexing gain? - BTL1** Multiplexing gain is defined as the increase in the data rate; since independent data streams are send through independent paths between multiple transmitters and multiple receivers. In other words if there are M transmit antennas and N receive antennas, the increase in the data rate is min (M, N)-fold
20	**What is meant by co-phasing? - BTL1** "Co-phase the signals" means that we need to multiply signals by ejϕi for some constant phase angle ϕi on channel i, so that the (otherwise random) phases of the signals on the different channels line up. If we don't co-phase the signals before combining them, we end up with the multipath fading problem signals sometimes add together destructively. Without co-phasing, the branch signals would not add up coherently in the combiner, so the resulting output could still exhibit significant fading due to constructive and destructive addition of the signals in all the branches.
21	**What is Selection Combining? - BTL1** Selection combining assumes we know all signal amplitudes so that we can take the maximum.Scanning combining is a simplification which says that we only have one receiver, so we can only know the signal to noise ratio on one channel at a time. But we can switch between them when one channel's SNR drops too low. We can often achieve nearly the same results using a scanning combiner as with selection combining.
22	**What is maximal ratio combining? - BTL1** For maximal ratio combining, we still co-phase the signals. But then, we weight the signals according to their SNR. The intuition is that some channels are more reliable than others, so we should "listen" to their signal more than others. The outage probability improves compared to equal gain combining.
23	**Describe threshold combining. - BTL1** Selection combining for systems that transmit continuously may require a dedicated receiver on each branch to continuously monitor branch SNR. A simpler type of combining, called threshold combining, avoids the need for a dedicated receiver on each branch by scanning each of the branches in sequential order and outputting the first signal whose SNR is above a given

	threshold γT . As in SC, co-phasing is not required because only one branch output is used at a time. Hence this technique can be used with either coherent or differential modulation.
24	**What is equal-gain combining? - BTL1** Here, we simply co-phase the signals and then add them together.The outage probability improves compared to selection combining.
25	**Define channel capacity of MIMO system. - BTL1** A very important factor for the profitability of a wireless networks is its capacity. MIMO system provides high capacity by using multiple antennas at both the transmitter and receiver end of the radio link. Multiple antennas are used to improve the capacity over SISO system when operated in multi-path environment. MIMO system capacity is measured in bits per second per hertz and is bounded by Shannon Hartley capacity. But it has become apparent that MIMO system can exceed the Shannon Hartley limit of SISO depending on the channel properties and the number of antennas.
26	**What is Precoding. - BTL1**(Apr/may 2019) Pre-coding is generalized to allow multi-layer transmission in MIMO systems. As conventional beamforming considers as linear single layer pre-coding, increasing the signal power at the output of the receiver by emitting the same signal from each of the transmit antennas with suitable weighting. When multiple antennas are used at the receiver, the signal level is not maximized simultaneously at all of the multiple receive antennas, so in that case pre-coding is used for multi-layer beamforming to increase the throughput performance of a multiple receive antennas. In pre-coding the transmit antennas transmit the multiple streams with independent and suitable weighting per each antenna such that higher link throughput is obtained at the receiver output
27	**What is Alamouti's scheme? - BTL1** Alamouti's scheme is designed for a digital communication system with two-antenna Transmit diversity. The scheme works over two symbol periods and it is assumed that the Channel gain is constant over this time. Over the first symbol period, two different symbols S1 and S2 (each with energy Es/2) are transmitted simultaneously from antennas 1 and 2, respectively. Over the next symbol period, symbol −S*2 is transmitted from antenna 1 and symbol S*1 is transmitted from antenna 2, each again with symbol energy Es/2.
	PART * B
1.	**i) Discuss about the operation of spatial multiplexing systems. (6)** (Apr/may 2019) **ii) Using diagrams explain transmit diversity and receive diversity.(7) – BTL2 (13)** **Spatial Multiplexing** defines the system is able to carry more than one data stream over one frequency, simultaneously. At the **transmitter**, the data sequence is split into M sub-sequences that are transmitted simultaneously using the same frequency band At the **receiver**, the sub-sequences are separated by means of **interference cancellation** algorithm used



Spatial Diversity Techniques

– Signal copies are transferred from multiple antennas or received at more than one antenna
– redundancy is provided by employing an array of antennas, with a minimum separation of $\lambda/2$ between neighbouring antennas

Receive diversity:

In receiver diversity, one transmitting antenna and many receiving antennas are used. It is also called space diversity.

Types of Space Diversity:

1. Selection Diversity
2. Feedback Diversity
3. Maximal Ratio Combining
4. Equal Gain Diversity

Transmit diversity:

In transmitter diversity, multiple antenna elements are required at the transmitter and one antenna element at the receiver end and provide better performance. The transmit power is divided among these antennas.

Types of Transmitter Diversity:

1. Transmitter Diversity with Channel state Information
2. Transmitter Diversity without Channel state information

Delay Diversity

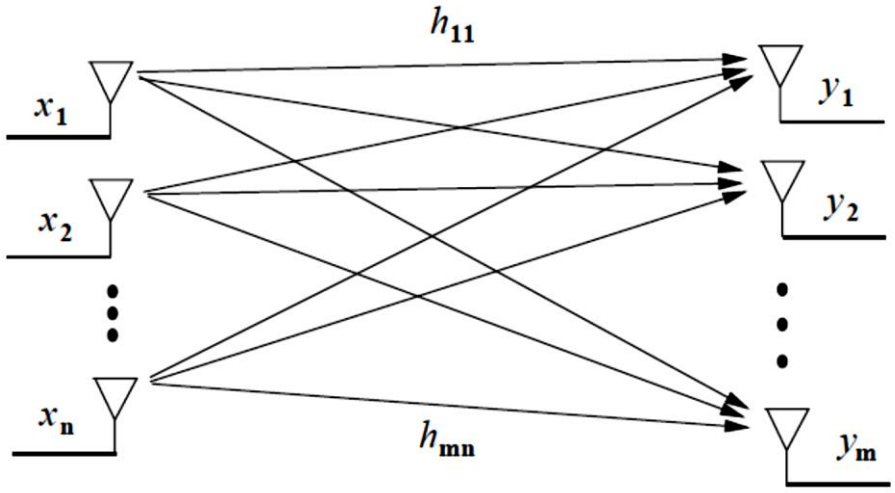
The transmit data streams with the delay of one symbol duration from each of the transmit antennas.

Answer: Page No. 480 in Andreas F Molisch

2

Describe the MIMO system model with necessary diagrams in detail (13) – BTL2 (nov/dec 2017)

(Diagram – 5 M + Explanation – 8 M)



This system can be represented by the following discrete time model:

$$\begin{bmatrix} y_1 \\ \vdots \\ y_m \end{bmatrix} = \begin{bmatrix} h_{11} & \cdots & h_{1n} \\ \vdots & \ddots & \vdots \\ h_{m1} & \cdots & h_{mn} \end{bmatrix} \begin{bmatrix} x_1 \\ \vdots \\ x_n \end{bmatrix} + \begin{bmatrix} N_1 \\ \vdots \\ N_m \end{bmatrix}$$

or simply as $y = Hx + N$.

Important parameters in MIMO system:

CSIT – Channel Side Information at the Transmitter
CSIR – Channel Side Information at the Receiver

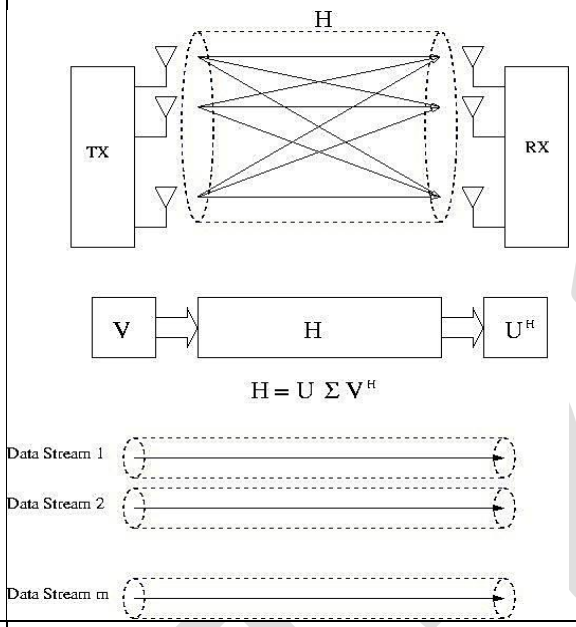
For Static Channel

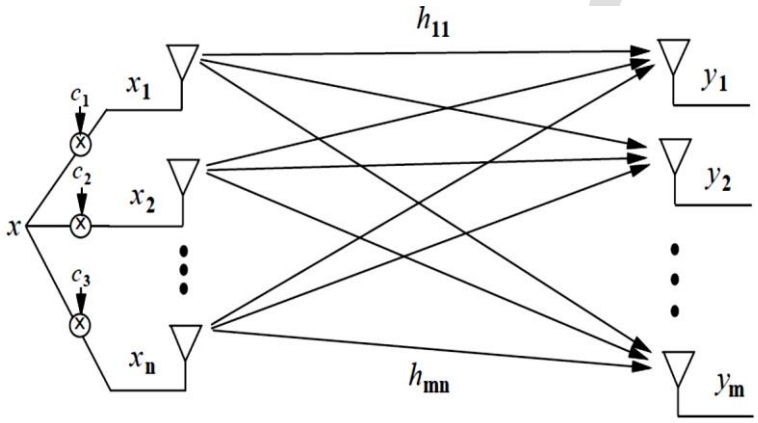
- CSIR is assumed
- Pilot sequence used for channel Estimation

If feedback path is available:

- CSIR sends feedback to CSIT

If CSIT may be available in Bidirectional system without feedback

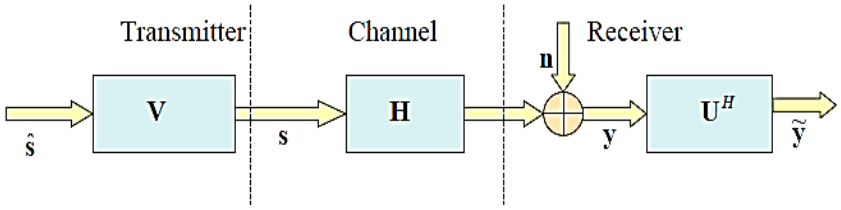
	– When reciprocal properties – Propagation are exploited **If channel not known to Transmitter and Receiver** Some distribution on the channel matrix gain must be assumed. Common Model: Zero Mean Spatially White Model (ZMSW) Answer: Page No. 466 in Andreas F Molisch
3	**Illustrate the parallel decomposition of the MIMO model (13) – BTL3(apr/may 2018)** **(Diagram – 6 M + Explanation – 7 M)** The increased data rate is called the **Multiplexing Gain.**  **Singular value decomposition (SVD)** $\boldsymbol{H = U \in V^H}$ Properties of Singular Values $\boldsymbol{\sigma_i = \sqrt{\lambda_i}}$ Rank of Matrix (R_H) $R_H \leq \min(M_t, M_r)$ The parallel decomposition of the channel is obtained by transformation on the channel input and output x and y via transmit precoding and receiver reshaping. Answer: Page No. 466 in Andreas F Molisch
4	**What are smart antennas? Why are they required for and what are the different approaches for capacity gains? (13) – BTL2** In actual, antennas are not Smart Antenna, systems are smart. **(4)** Limited by two major impairments multipath and co-channel interference. **TYPES OF SMART ANTENNA SYSTEMS (4)** Direction-of-Arrival (DOA) Switched Beam Antennas Adaptive Array Antennas **Benefits of Smart Antennas: (5)** (a) Reduction in Co-Channel Interference (b) Range Improvement © Increase in Capacity (d) Reduction in Transmitted Power (e) Reduction in Handoff Answer: Page No. 445 in Andreas F Molisch

5	**Why beamforming is important for wireless systems, With illustration explain transmit beamforming, receive beamforming and opportunistic beamforming. (13) – BTL2(nov//dec 2017)** **(Diagram – 6 M + Explanation – 7 M)** A transmit strategy where the input covariance matrix has unit rank is called ***beamforming*.** Aligning the transmit signal in the direction of the transmit antenna array pattern is called **transmit beamforming.** It takes advantages of an interference to change the directionality of the antenna.  $$\|u\| = \|v\| = 1$$ $$C = B \log_2(1 + \sigma_{max}{}^2 \rho)$$ **If H not known to Transmitter** Alamouti scheme used Advantages of Beamforming Antenna: Increase SNR and support higher user densities. Answer: Page No. 484 in Andreas F Molisch
	PART * C
1.	**Derive the capacity of a Non fading channel for information transmitted from a wireless system. (15)– BTL3 (3 Types – 5 M)** Shannon capacity of a MIMO channel, which equals the maximum data rate that can be transmitted over the channel will arbitrary small error probability. **STATIC CHANNEL** **Condition:** Channel unknown at transmitter $$\mathbf{C = B \log_2(1 + \gamma)}$$

$$I(X:Y) = H(Y) - H\left(\frac{Y}{X}\right)$$

Zero Mean Circularly Symmetric Complex Gaussian (ZMCSCG)

$$\mathrm{C} = \max_{p(x)} B \log_2 \det[I_{mr} + HR_xH^H]$$



CHANNEL KNOWN AT TRANSMITTER – WATTER FILLING METHOD

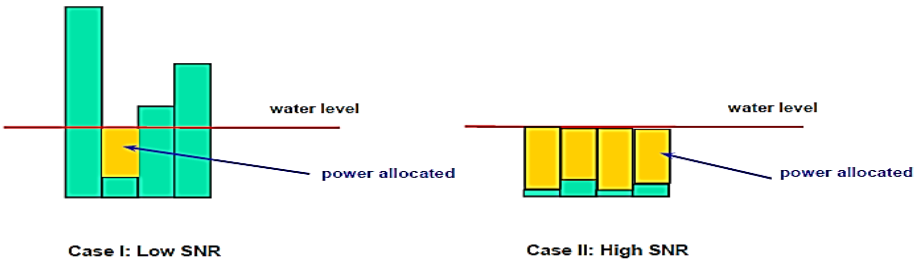
Condition: Channel (H) known to the both transmitter and receiver

$$\mathrm{C} = \max_{\rho_i : \varepsilon_i \rho_i \le \rho} \sum_{i=1}^{R_H} B \log_2 \det[1 + {\sigma_i}^2 p_i]$$

The capacity formula is similar to **flat fading & frequency selective fading**

Optimally allocating the power to several parallel channels is difficult because each has different SNR. This issue can be overcome by using **Water Filling Method.**

$$\frac{p_i}{p} = \begin{cases} \frac{1}{\gamma_0} - \frac{1}{\gamma_i} & \gamma_i \ge \gamma_0 \\ 0 & \gamma_i < \gamma_0 \end{cases}$$

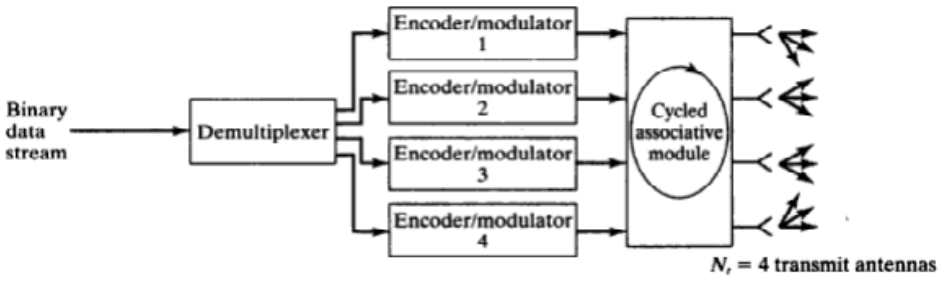


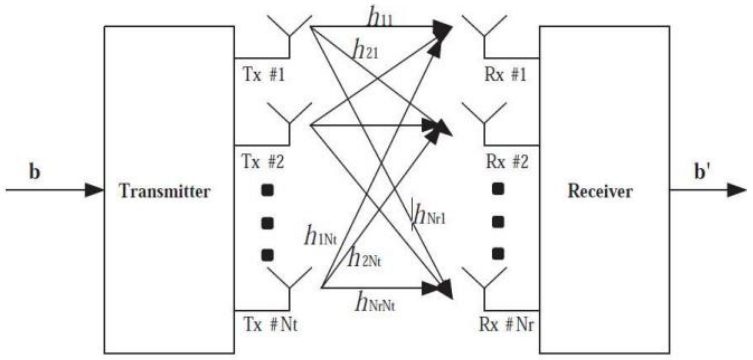
CHANNEL UNKNOWN AT TRANSMITTER UNIFORM POWER ALLOCATION

Condition:

- Receiver knows H
- Transmitter does not knows H

$$I(X:Y) = B \log_2 \det\left[IM_t + H\frac{\rho}{M_t}H^H\right]$$

	$$I(X:Y) = \sum_{i=1}^{R_H} B \log_2\left(1 + \frac{\gamma_i}{M_t}\right)$$ Transmitter don't know what rate it want to transmit to reach receiver. This is called as **channel outage.** $$R_H = M = Min\,(M_t, M_r)$$ Types: Ergodic - expected value of the capacity taken over all realization of the channel. Outage Capacity is minimum transmission rate that is achieved over a certain fraction of time. Answer: Page No. 467 in Andreas F Molisch
2	**Demonstrate the BLAST architectures used in MIMO systems (15) – BTL3** **(Types – 1 m + 2 Types – 7 M)** Three specific implementations of BLAST, depending on the type of coding employed: 1. Diagonal-BLAST (D-BLAST) 2. Vertical-BLAST (V-BLAST) D-BLAST  V-BLAST V-BLAST architecture is a simplified version of D-BLAST All the symbols of a certain stream are transmitted through the same antenna A single data stream is demultiplexed into M sub streams.



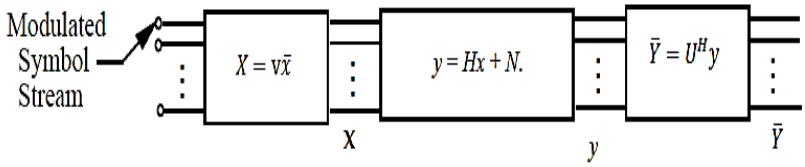
Answer: Page No. 479 in Andreas F Molisch

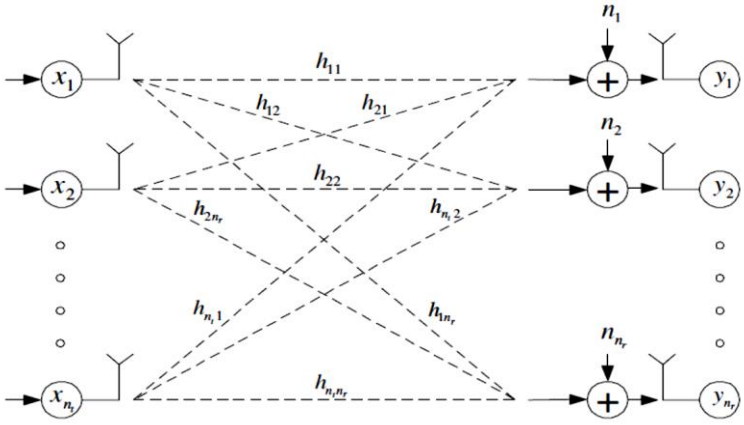
3 **Explain the operation of transmit precoding and receiver precoding schemes? (15) – BTL2**

(Diagram – 7 m + Exp – 8 M)

In transmit precoding the input x to the antennas is generated by linear transformation on input vector $\bar{x}$ $X = v\bar{x}$

This operation is sometimes called transmit precoding. $\bar{Y} = U^H y$





$$\bar{Y} = \in \bar{x} + \boldsymbol{U^H} n$$

Answer: Page No. 490 in Andreas F Molisch

EC6802 WIRELESS NETWORKS L T P C

3 0 0 3

OBJECTIVES:

- To study about Wireless networks, protocol stack and standards.
- To study about fundamentals of 3G Services, its protocols and applications.
- To study about evolution of 4G Networks, its architecture and applications.

UNIT I WIRELESS LAN 9

Introduction-WLAN technologies: Infrared, UHF narrowband, spread spectrum -IEEE802.11: System architecture, protocol architecture, physical layer, MAC layer, 802.11b, 802.11a – Hiper LAN: WATM, BRAN, HiperLAN2 – Bluetooth: Architecture, Radio Layer, Baseband layer, Link manager Protocol, security - IEEE802.16-WIMAX: Physical layer, MAC, Spectrum allocation for WIMAX

UNIT II MOBILE NETWORK LAYER 9

Introduction - Mobile IP: IP packet delivery, Agent discovery, tunneling and encapsulation, IPV6-Network layer in the internet- Mobile IP session initiation protocol - mobile ad-hoc network: Routing, Destination Sequence distance vector, Dynamic source routing

UNIT III MOBILE TRANSPORT LAYER 9

TCP enhancements for wireless protocols - Traditional TCP: Congestion control, fast retransmit/fast recovery, Implications of mobility - Classical TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, Transaction oriented TCP - TCP over 3G wireless networks**.**

UNIT IV WIRELESS WIDE AREA NETWORK 9

Overview of UTMS Terrestrial Radio access network-UMTS Core network Architecture: 3G-MSC, 3G-SGSN, 3G-GGSN, SMS-GMSC/SMS-IWMSC, Firewall, DNS/DHCP-High speed Downlink packet access (HSDPA)- LTE network architecture and protocol.

UNIT V 4G NETWORKS 9

Introduction – 4G vision – 4G features and challenges - Applications of 4G – 4G Technologies: Multicarrier Modulation, Smart antenna techniques, OFDM-MIMO systems, Adaptive Modulation and coding with time slot scheduler, Cognitive Radio.

TOTAL: 45 PERIODS

OUTCOMES: Upon completion of the course, the students will be able to

- Conversant with the latest 3G/4G and WiMAX networks and its architecture.
- Design and implement wireless network environment for any application using latest wireless protocols and standards.
- Implement different type of applications for smart phones and mobile devices with latest network strategies.

TEXT BOOKS:

1. Jochen Schiller, "Mobile Communications", Second Edition, Pearson Education 2012. (Unit I,II,III)

2. Vijay Garg, "Wireless Communications and networking", First Edition, Elsevier 2007. (Unit IV,V)

REFERENCES:

1. Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "3G Evolution HSPA and LTE for Mobile Broadband", Second Edition, Academic Press, 2008.

2. Anurag Kumar, D.Manjunath, Joy kuri, "Wireless Networking", First Edition, Elsevier 2011.

3. Simon Haykin , Michael Moher, David Koilpillai, "Modern Wireless Communications", First Edition, Pearson Education 2013

UNIT I - WIRELESS LAN	
Introduction-WLAN technologies: Infrared, UHF narrowband, spread spectrum -IEEE802.11: System architecture, protocol architecture, physical layer, MAC layer, 802.11b, 802.11a – Hiper LAN: WATM, BRAN, HiperLAN2 – Bluetooth: Architecture, Radio Layer, Baseband layer, Link manager Protocol, security - IEEE802.16-WIMAX: Physical layer, MAC, Spectrum allocation for WIMAX	
PART – A	
1.	**Define wireless LAN.** BTL 1 Local area and Built on exiting wireless communication networks and Allows cellular phone access to Internet services
2.	**Explain the Problems with Wireless Networks.** BTL 1 ▪ Operates in a less controlled environment, so is more susceptible to interference, signal loss, noise, and eavesdropping. ▪ Generally, wireless facilities have lower data rates than guided facilities. ▪ Frequencies can be more easily reused with guided media than with wireless media.

3.	**Differentiate Infra-red and Radio transmission.** BTL 1 Two different basic transmission technologies can be used to set up WLANs. One technology is based on the transmission of infra-red light the other one, which is much more popular, uses radio transmission Both technologies can be used to set up ad-hoc connections for work groups, to connect, e.g., a desktop with a printer without a wire, or to support mobility within a small area. The main advantages of infra-red technology are its simple and extremely cheap senders and receivers. Disadvantage of infra-red transmission is low bandwidth. Advantages of radio transmission include the long-term experiences made with radio transmission for wide area networks. The main advantage is also a big disadvantage of radio transmission. Shielding is not so simple.
4.	**What is HIPERLAN?** BTL 1 HIPERLAN is a set of wireless local area network communication standards primarily used in European countries. It has four specifications: HIPERLAN1, HIPERLAN2, HIPERLINK and HIPERACCESS.
5.	**Give two types of data burst in HIPERLAN?** BTL 1 The transmission format on the physical layer is a burst, which consists of a preamble and a data part. Five different PHY bursts have been defined: broadcast, downlink, uplink with short preamble, uplink with long preamble, and direct link (optional). The bursts differ in their preambles.
6.	**Differentiate centralized mode and direct mode.** BTL 1 Centralized mode is based on infrastructure-based mode. APs are associated with mobile terminals and all data is transferred between the two terminals via AP. Direct mode is based on ad-hoc mode. Here data is directly exchanged between mobile terminals.
7.	**What is scatternet?** BTL 1 Bluetooth enabled devices are organized in groups called piconets. One device in the piconet can act as master; all other devices connected to the master must act as slaves. A master unit is the device that initiates the communication. As more users join the piconets, the throughput per user drops quickly. So they move on to scatternet. It consists of two piconets both having different hopping sequences.
8.	**Explain the different types of services offered by Bluetooth?** BTL 1

	Basic profiles have been specified as: Generic access, service discovery, cordless telephony, intercom, serial port, headset, dialup networking, LAN access, generic object exchange, object push, file transfer, and synchronization. Additional profiles are: Advanced audio distribution, PAN, audio video remote control, basic printing, basic imaging, extended service discovery, generic audio video distribution, hands-free, and hardcopy cable replacement. Each profile selects a set of protocols.
9.	**Differentiate between WiFi and WiMAX.** BTL 1 WiMAX and Wi-Fi are both wireless broadband technologies, but they differ in the technical execution. Wi-Fi was developed to be used for mobile computing devices, such as laptops, in LANs, but is now increasingly used for more services, including Internet and VoIP phone access, gaming, and basic connectivity of consumer electronics such as televisions and DVD players, or digital cameras. On the other hand WiMAX was developed as a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL.
10.	**What is WLL?** BTL 1 ***Wireless local loop (WLL)***, is a term for the use of a wireless communications link. As subscribers have demanded greater capacity, particularly to support internet use traditional twisted pair tech has become inadequate. Interest being shown in competing wireless technologies for subscriber access. These generally referred to as WLL or fixed wireless access. Mainly used in Urban and rural areas.
11.	**What is Fresnel zone?** BTL 1 For effective communication at millimeter wavelength, there should be an unobstructed line of sight between transmitter and receiver. In this, if there are any obstacles near the path then it will reduce the power of the received signal (i.e.) increases signal to *noise* ratio. Fresnel Zone provided a mean to calculate where the zones are, where a given obstacle will cause mostly in phase or mostly out of phase reflections b/w the transmitter and receiver.
12.	**What is NIC?** BTL 1 A PC or workstation uses a wireless NIC to connect to the wireless network. The NIC scans the available frequency spectrum for connectivity and associates it to an access point or another wireless client. The NIC is coupled to the PC/workstation operating system using a software driver.

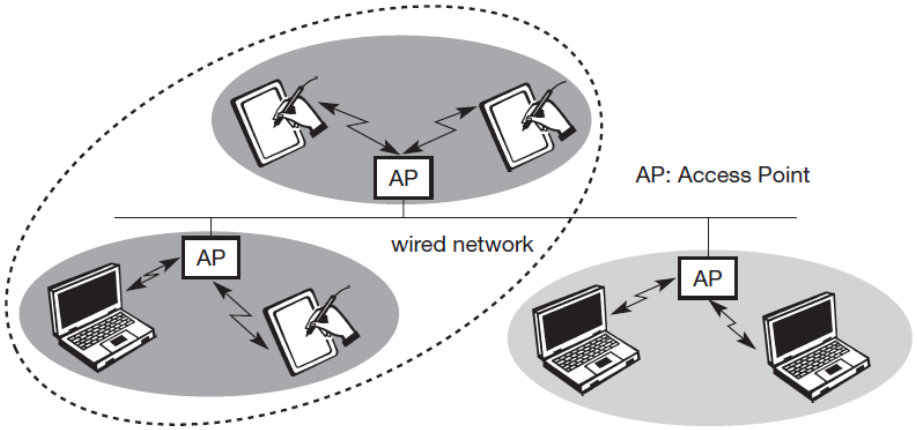
13.	**Mention the design goals of WLANs. (Nov/Dec 2014)** BTL 1 ▪ ***Global operation***: LAN equipment may be carried from one country to another and this operation should be legal (frequency regulations national and international). ▪ ***Low power*****:** Take into account that devices communicating via WLAN are typically running on battery power. Special power saving modes and power management functions. Simplified spontaneous co-operation: no complicated setup routines but operate spontaneously after power. ▪ ***Easy to use*****:** WLANs are made for simple users; they should not require complex management but rather work on a plug-and-play basis. ▪ ***Protection of investment*****:** A lot of money has been invested for wired LANs, WLANs should be able to interoperate with existing network (same data type and services). ▪ ***Safety and security:*** Safe to operate. Encryption mechanism, do not allow roaming profiles for tracking people (privacy) ▪ ***Transparency for applications:*** Existing applications should continue to work.
14.	**What is wireless networking?** BTL 1 Wireless refers to the method of transferring information between a computing device, and a data source, such as an agency database server, without a physical connection.
15.	**What is meant by MAC Protocols?** BTL 1 When an IP packet reaches its destination (sub) network, the destination IP address (a layer 3 or network layer concept) is resolved with the Address Resolution Protocol for IPv4, or by Neighbour Discovery Protocol (IPv6) into the MAC address (a layer 2 concept) of the destination host.
16.	**What are the different features of MAC Protocols?** BTL 1 ▪ It should implement some rules that help to enforce discipline when multiple nodes contend for a shared channel. ▪ It should help maximize the utilization of the channel ▪ Channel allocation needs to be fair. ▪ It should be capable of supporting several types of traffic having different maximum and average bit rates.
17.	**What is meant by spread spectrum?** BTL 1 In telecommunication and radio communication, **spread-spectrum** techniques are methods by which a signal (e.g. an electrical, electromagnetic, or acoustic signal) generated with

	a particular bandwidth is deliberately **spread** in the frequency domain, resulting in a signal with a wider bandwidth.
18.	**List out the types of spread spectrum?** BTL 1 Frequency Hopping Spread Spectrum (FHSS), Direct-sequence spread spectrum (DSSS) , Time Hopping spread spectrum (THSS) and Chirp spread spectrum (CSS)
19.	**What is Frequency Hopping Spread Spectrum (FHSS)?** BTL 1 ***Frequency Hopping Spread Spectrum (FHSS)*** is a method of transmitting radio signals by rapidly switching a carrier among many frequency channels, using a pseudorandom sequence known to both transmitter and receiver. It is used as a multiple access method in the ***frequency-hopping code division multiple access (FH-CDMA)*** scheme.
20.	**Give the advantages of spread spectrum over a fixed-frequency transmission?** BTL 1 ▪ Spread-spectrum signals are highly resistant to narrowband interference. The process of re-collecting a spread signal spreads out the interfering signal, causing it to recede into the background. ▪ Spread-spectrum signals are difficult to intercept. A spread-spectrum signal may simply appear as an increase in the background noise to a narrowband receiver. An eavesdropper may have difficulty intercepting a transmission in real time if the pseudorandom sequence is not known. ▪ Spread-spectrum transmissions can share a frequency band with many types of conventional transmissions with minimal interference. The spread-spectrum signals add minimal noise to the narrow-frequency communications, and vice versa. As a result, bandwidth can be used more efficiently.
21.	**What is direct sequence spread spectrum (DSSS)?** BTL 1 DSSS systems transmit the message bearing signals using a bandwidth that is in excess of the bandwidth that is actually needed by the message signal. This spreading of the transmitted signal over a large bandwidth makes the resulting wideband signal to appear as a noise signal which allows greater resistance to intentional and unintentional interference with the transmitted signal.
22.	**Give the features of DSSS?** BTL 1 DSSS phase-shifts a sine wave pseudo randomly with a continuous string of pseudo-noise (PN) code symbols called "chips", each of which has a much shorter duration than an information bit. That is, each information bit is modulated by a sequence of much faster chips.

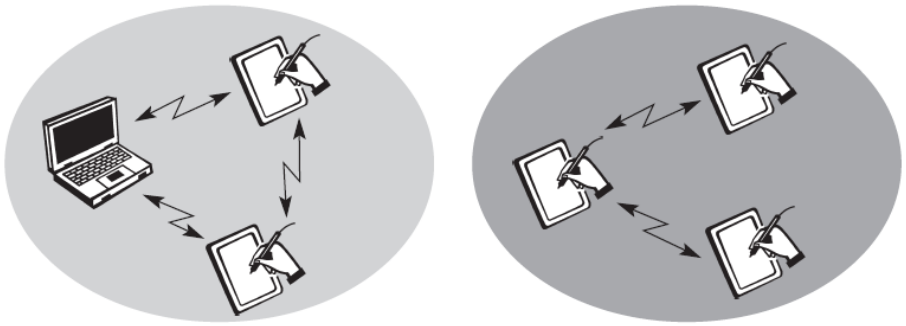
	Therefore, the chip rate is much higher than the information signal bit rate. DSSS uses a signal structure in which the sequence of chips produced by the transmitter is already known by the receiver. The receiver can then use the same *PN sequence* to counteract the effect of the PN sequence on the received signal in order to reconstruct the information signal.
23.	**What is Time-Hopping spread spectrum (THSS)**? BTL 1 ***Time-hopping (TH)*** is a communications signal technique which can be used to achieve anti-jamming (AJ) or low probability of intercept (LPI). It can also refer to pulse-position modulation, which in its simplest form employs 2^k discrete pulses (referring to the unique positions of the pulse within the transmission window) to transmit k bit(s) per pulse. To achieve LPI, the transmission time is changed randomly by varying the period and duty cycle of the pulse (carrier) using a pseudo-random sequence. The transmitted signal will then have intermittent start and stop times. Although often used to form hybrid spread-spectrum (SS) systems.
24.	**What is chirp spread spectrum (CSS)?** BTL 1 In digital communications, ***chirp spread spectrum*** (CSS) is a spread spectrum technique that uses wideband linear frequency modulated chirp pulses to encode information. A chirp is a sinusoidal signal whose frequency increases or decreases over time (often with a polynomial expression for the relationship between time and frequency). In the picture is an example of an up chirp—as you can see, the frequency increases linearly over time.
25.	**List and explain the inter-frame spacing.** BTL 1 ▪ SIFS (Shortest inter-frame spacing) - It has the highest priority because it has the shortest waiting time for medium access. And it is defined for Short control messages. ▪ PIFS (PCF inter frame spacing)-It has medium priority because it has a waiting time between DIFS and SIFS. It is used for a time bounded service. ▪ DIFS (DCF inter frame spacing)-This parameter denotes the longest waiting time and has the lowest priority for medium access.
26.	**State the significance of Radio transmission over infrared. (April 2017)** BTL 1 **Radio transmission** **infrared** (i) Coverage range Upto 50m for LOS Upto 10m (ii) Data rate 100kbps 500bps-1kbps (iii) Power consumption 5-20 mW during ON state 20-150 mW during ON state

27.	**OFDM uses a set of orthogonal sub-carriers for transmission of data. OFDM is used in WLANs. Consider an OFDM system that uses 52 sub-carriers out of which 48 are pilot sub-carriers. System bandwidth is 20MHz and OFDM symbol duration including cyclic prefix is 4µs. If code rate is 3/4 and 64 QAM is used, find the data rate. (April 2017)** BTL 1 Data rate = $\frac{\text{No of bits/symbol for the carriers}}{OFDM\ symbol\ duration}$ For 64-QAM with ¾ rate, No of bits / subcarrier = $6*\frac{3}{4}$ =4.5 Total No. of bits for 48 sub carriers = 4.5 bits per symbol / subcarrier * 48 subcarriers = 216 bits/symbol **Data rate = 216/4µs = 54Mbps**.
	PART - B
1.	**Brief explain about the advantages of WLAN Techniques. (13M)** BTL 1 • Flexibility (1M) • Planning (1M) • Design (2M) • Robustness (1M) • Cost (1M) • Quality of Service (1M) • Restrictions (1M) • Safety and Security (2M) • Global Operation (1M) • Low Power (1M) • Transparency of Application (1M)
2.	**Compare Infra-red vs radio transmission techniques. (13M)** BTL 1 Infra-red – Introduction (2M) Main Advantages (2M) Disadvantages (2M) Radio Transmission – Introduction (3M) Advantages (2M) Disadvantages (2M)
3.	**Explain about Infrastructure and ad-hoc networks in detail. (13M)** BTL 1

Example of three infrastructure-based wireless networks



Ad-hoc wireless networks

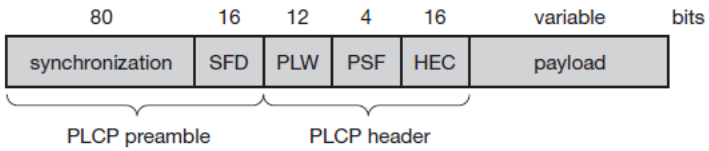


Example of two ad-hoc wireless networks

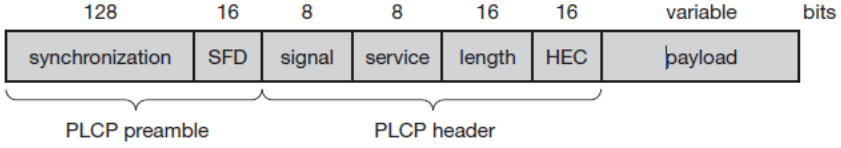
4. **Explain the technique about Frequency hopping spread spectrum. (13M)** BTL 1

Frequency hopping spread spectrum (FHSS) is a spread spectrum technique which allows for the coexistence of multiple networks in the same area by separating different networks using different hopping sequences.

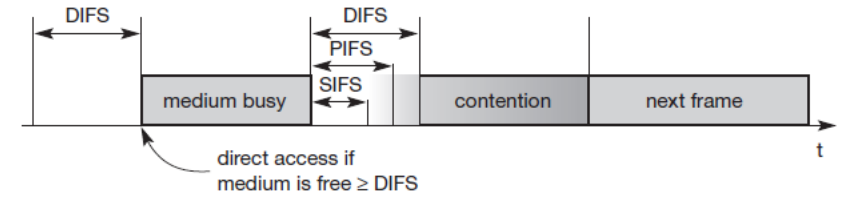
Figure 7.7 Format of an IEEE 802.11 PHY frame using FHSS



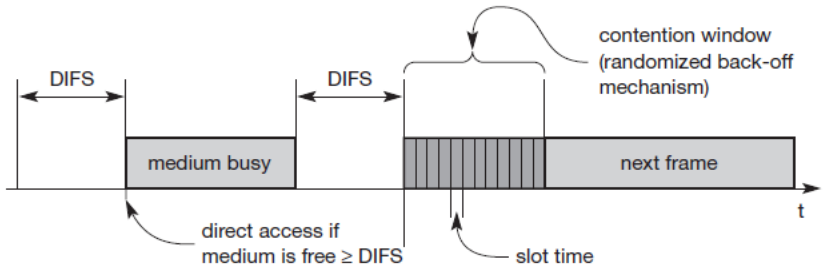
5. **How the Direct sequence spread spectrum is utilized in WLAN techniques. (13M)** BTL 1



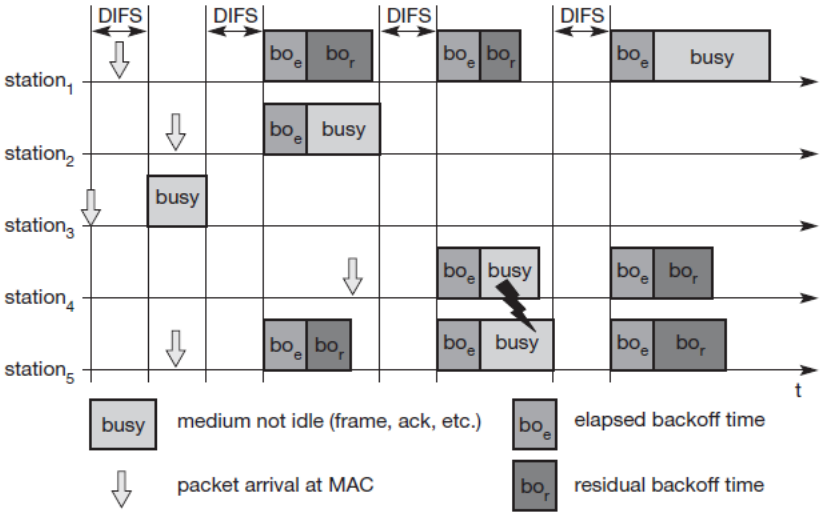
Format of an IEEE 802.11 PHY frame using DSSS



Medium access and inter-frame spacing



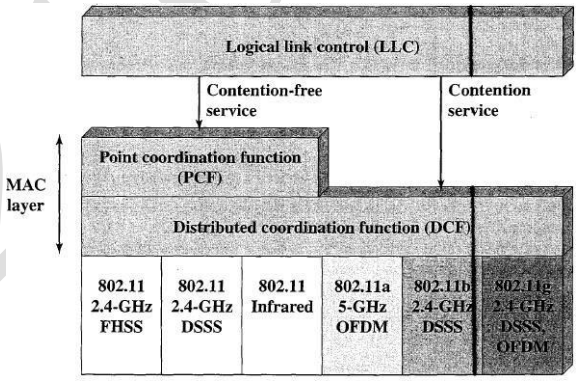
Contention window and waiting time



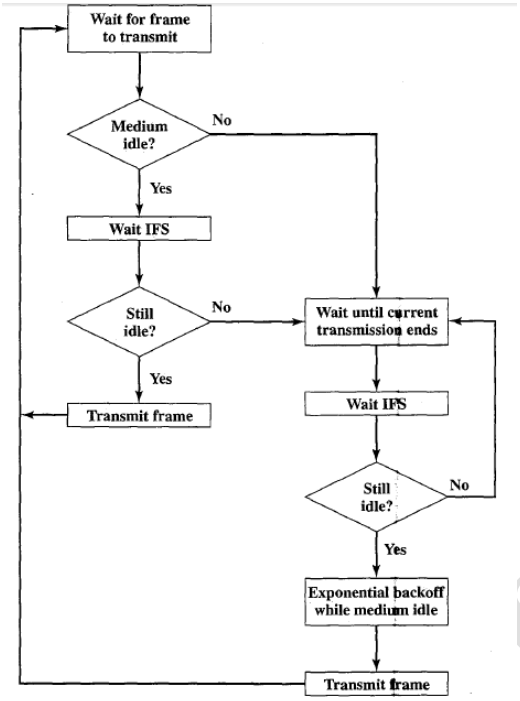
Basic DFWMAC–DCF with several competing senders

6. **Explain MAC of IEEE 802.11. (13M)** BTL 1

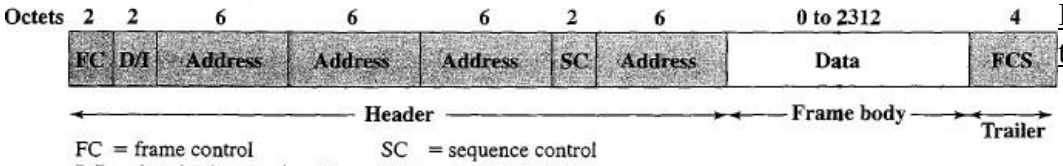
Medium Access Control



Coordination Function:



MAC Frame

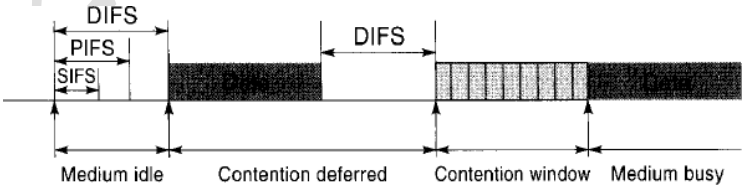


(a) MAC frame

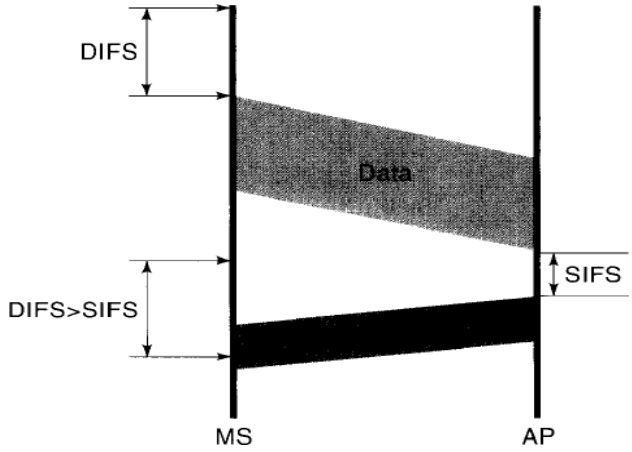
(b) Frame control field

MAC frame types.

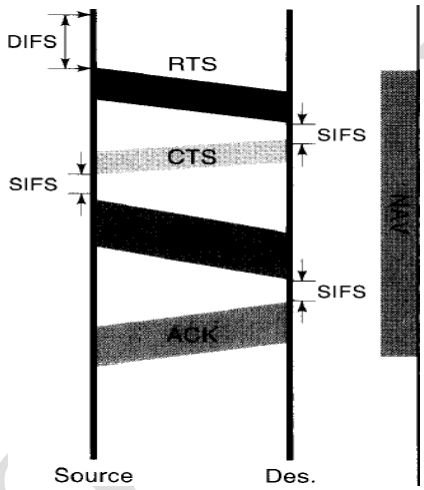
7. **Explain MAC Sub layer in detail. (13M)** BTL 1



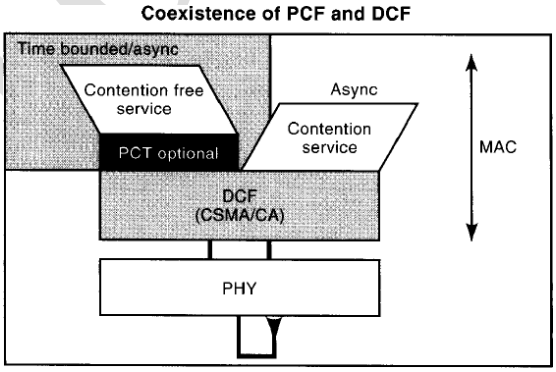
Primary operation of the CSMA/CA in the IEEE 802.11



Implementation of the CSMA/CA with ACK in an infrastructure network



Implementation of RTS/CTS mechanism in the IEEE802.11



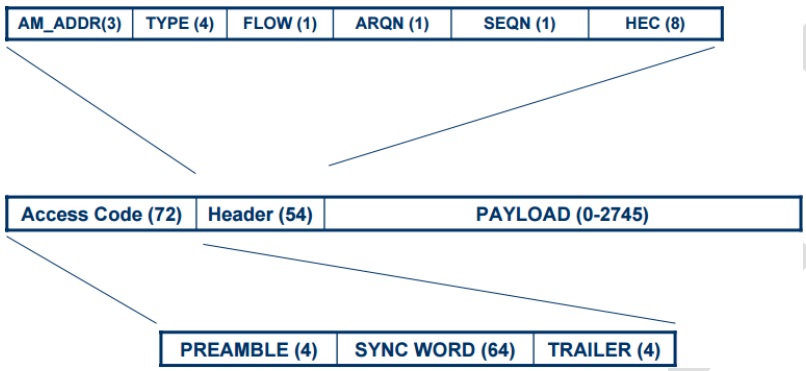
Implementation PCF on Top of the DCF in the IEEE 802.11

8. **Explain the Physical and MAC layer of Bluetooth with neat sketch. (13M)** BTL 1

(OR)

Explain physical and MAC layer of Wi max. (13M) BTL 1

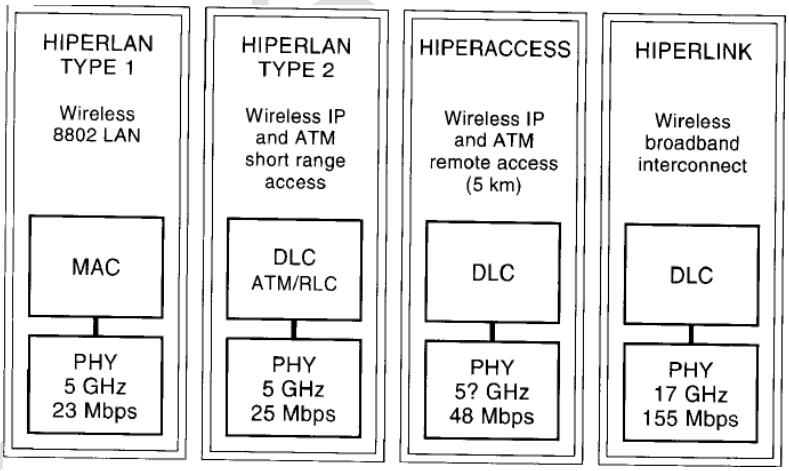
- *Physical layer of Bluetooth*
- *Regulatory requirements*
- *Transmitter Characteristics*
- *Receiver Characteristics*
- *MAC layer of Bluetooth*
- *Frame Format*



Frame Format of the Bluetooth packet

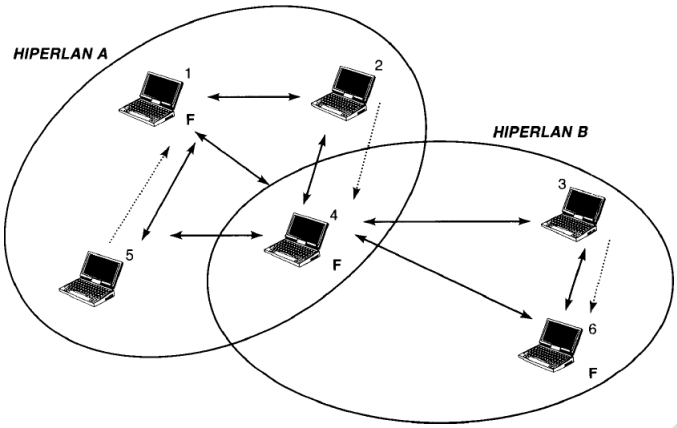
Header Field:

9. **Explain Hiper LAN in detail. (13M)** BTL 1



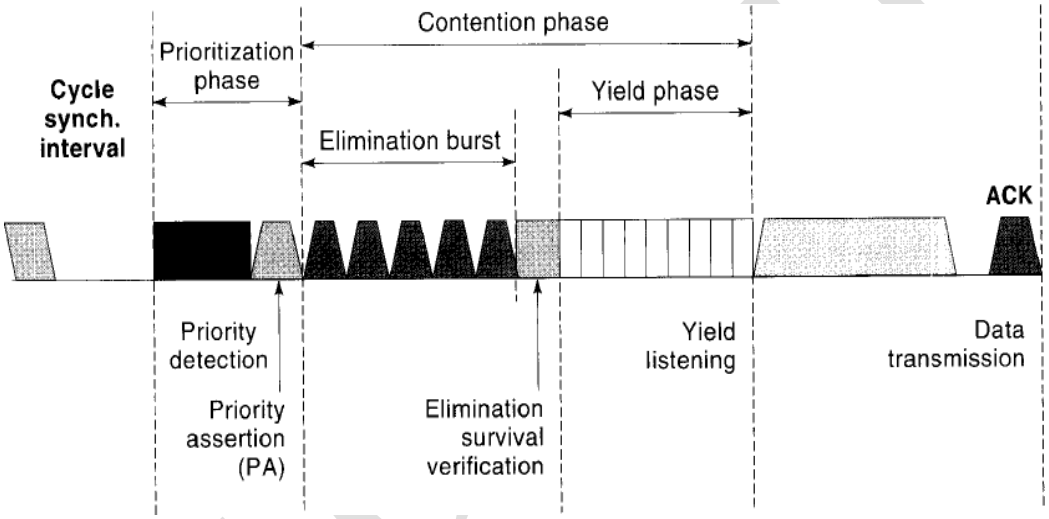
Division of the HIPERLAN activities

HIPERLAN-1 Requirements and Architecture



Ad hoc network architecture in the HIPERLAN-1

HIPERLAN-1 PHY and MAC Layers



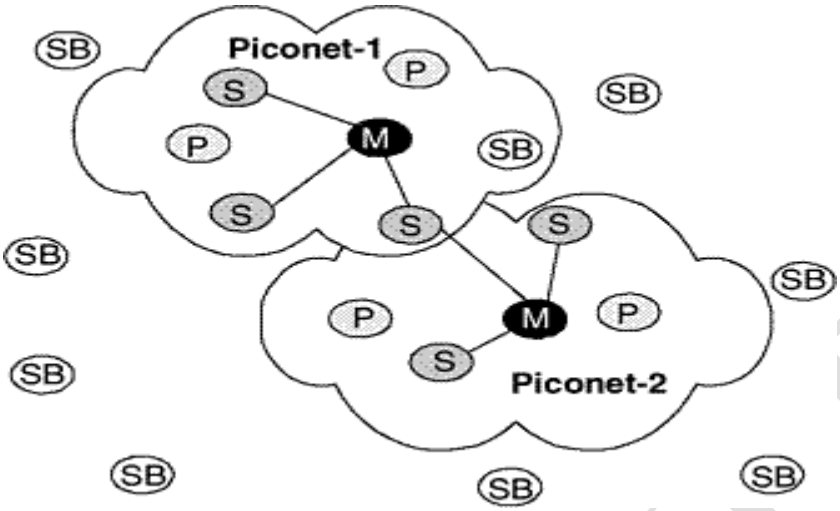
Channel Access cycle in the HIPERLAN-1

10. **Explain the architecture of Bluetooth. (13M)** BTL 1

Features (2M)

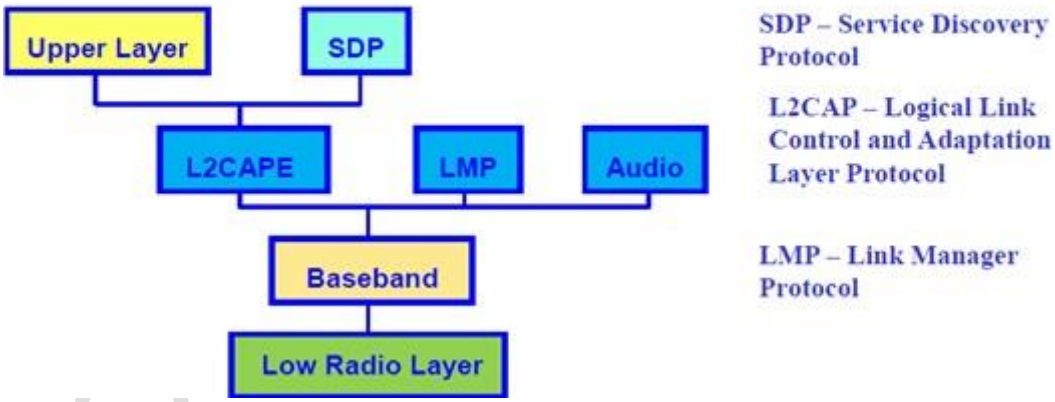
Bluetooth Architecture: (6M)

Bluetooth Scattered Adhoc Topology



M – Master, S – Slave, S – Stand By, P – Parked/Hold

Bluetooth Protocol Stack (5M)



PART – C

1. **Explain the mechanisms for minimum transmission bandwidth. (15M)** BTL 1

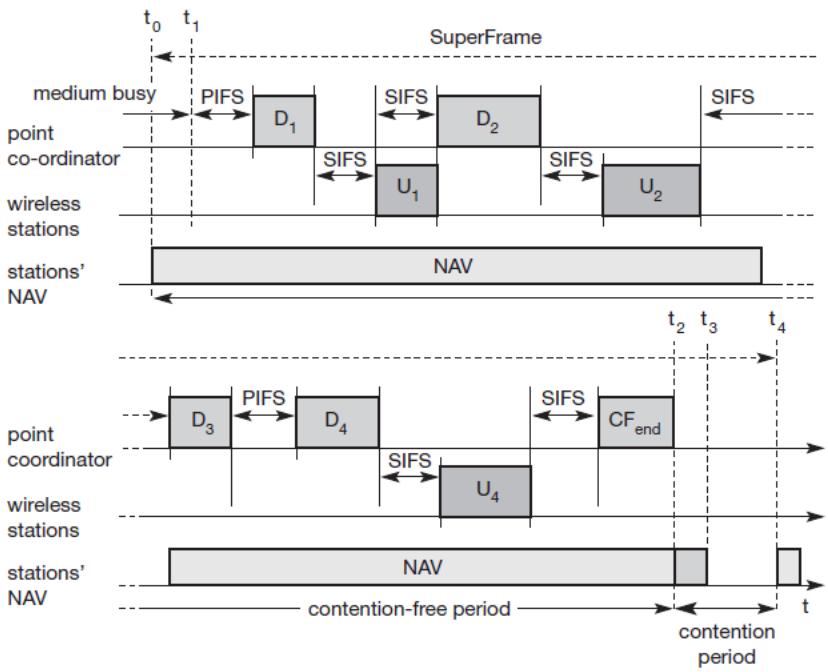


Figure 7.15 Contention-free access using polling mechanisms (PCF)

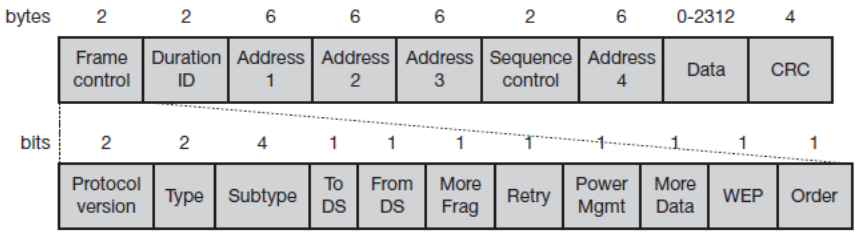


Figure 7.16 IEEE 802.11 MAC packet structure

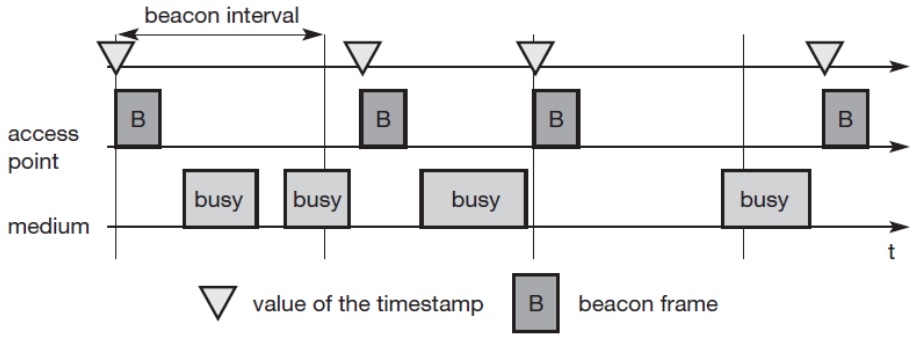
to DS	from DS	Address 1	Address 2	Address 3	Address 4
0	0	DA	SA	BSSID	–
0	1	DA	BSSID	SA	–
1	0	BSSID	SA	DA	–
1	1	RA	TA	DA	SA

Table 7.1 Interpretation of the MAC addresses in an 802.11 MAC frame

2. **Brief about MAC management techniques used in IEEE 802.11. (15M)** BTL 1

MAC management plays a central role in an IEEE 802.11 station as it more or less controls all functions related to system integration, i.e., integration of a wireless station into a BSS, formation of an ESS, synchronization of stations etc.

Figure 7.18
Beacon transmission in a busy 802.11 infrastructure network



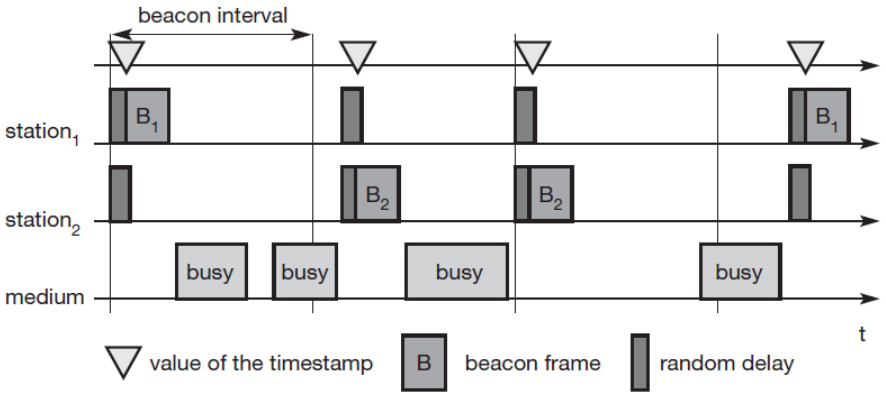
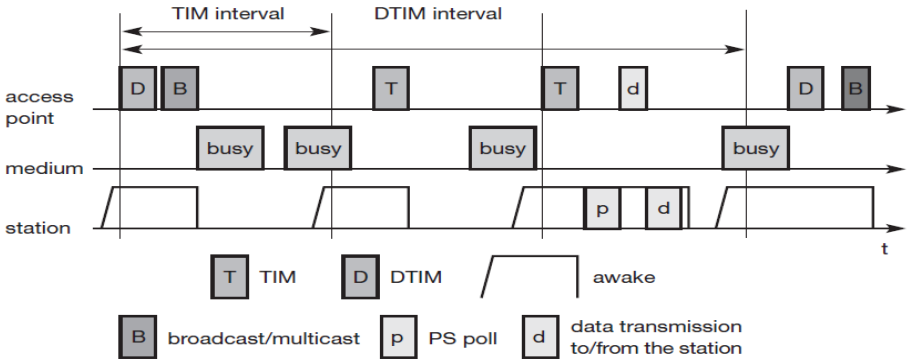


Figure 7.19
Beacon transmission in a busy 802.11 ad-hoc network

Power management

Figure 7.20
Power management in IEEE 802.11 infrastructure networks



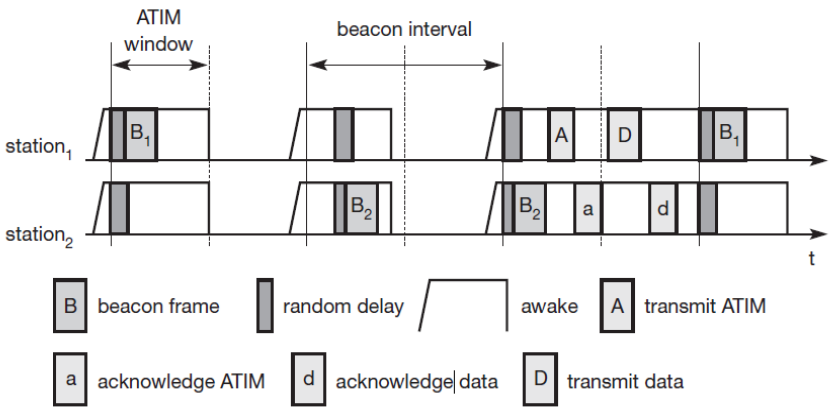


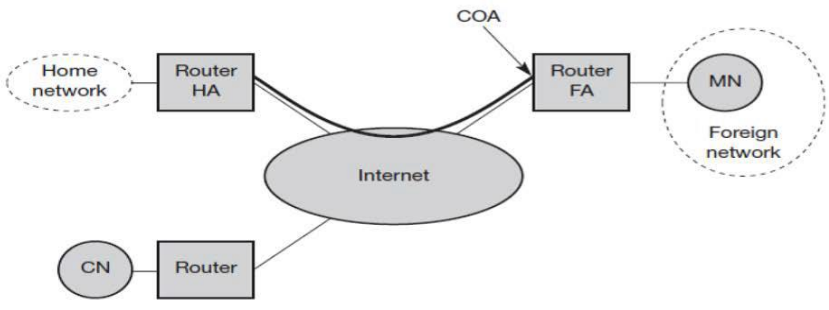
Figure 7.21
Power management in IEEE 802.11 ad-hoc networks

3.	**Explain the clear concept about roaming. (15M)** BTL 1 The steps for roaming between access points are: • A station decides that the current link quality to its access point AP1 is too Poor – Scanning • Passive Scanning & Active Scanning • The station then selects the best access point - sends an **association request** • new access point AP2 answers with an **association response**

UNIT II - MOBILE NETWORK LAYER	
Introduction - Mobile IP: IP packet delivery, Agent discovery, tunneling and encapsulation, IPV6- Network layer in the internet- Mobile IP session initiation protocol - mobile ad-hoc network: Routing, Destination Sequence distance vector, Dynamic source routing	
PART - A	
1.	**What is meant by mobile IP?** BTL 1 Mobile IP communication protocol refers to the forwarding of Internet traffic with a fixed IP address even outside the home network. It allows users having wireless or mobile devices to use the Internet remotely.
2.	**List out the features of Mobile IP?** BTL 1 ▪ Transparency: Mobile end system should continue to keep its IP address ▪ Compatibility: It should be compatible with existing internet protocol ▪ Scalability: It should be scalable to support billions of moving host worldwide. ▪ Security: provide users with secure communication over the internet
3.	**Mention 3- types of address assignment policies used in DHCP.** BTL 1 **Manual configuration** – manager can configure a specific address for a specific computer. **Dynamic configuration** – server loans an address to a computer for a limited time. **Automatic configuration** – DHCP server assigns permanent address when a computer first attaches to the network.
4.	**What are the different terminologies of mobile IP?** BTL 1 ▪ Home Network ▪ Home address ▪ Foreign agent ▪ Foreign Network ▪ Mobile IP
5.	**What is agent advertisement?** BTL 1 Foreign and the home agents advertise their presence through periodic agent advertisement messages. An agent advertisement message, lists one or more care of address and a flag indicating whether it is a home agent or a foreign agent.
6.	**What are the key mechanisms in mobile IP?** BTL 1 ▪ Discovering the care of address ▪ Registering the care of address ▪ Tunneling to the care of address.

7.	**Mention the different entities in a mobile IP.** BTL 1 Mobile Node, Correspondent Node, Home Network, Foreign Network, Foreign Agent, Home Agent, Care-Of address, Foreign agent COA and Co-located COA.
8.	**What is encapsulation and de-capsulation? (April 2017)** BTL 1 Encapsulation is the mechanism of taking a packet consisting of packet header and data putting it into the data part of a new packet. The reverse operation, taking a packet out of the data part of another packet, is called de-capsulation.
9.	**Define an outer header and outer header.** BTL 1 The HA takes the original packet with the MN as destination, puts it into the data part of a new packet and sets the new IP header in such a way that the packet is routed to the COA. The new header is called the outer header. There is an inner header which can be identical to the original header as this case for IP-in-IP encapsulation, or the inner header can be computed during encapsulation.
10.	**What is meant by generic routing encapsulation?** BTL 1 Generic routing encapsulation allows the encapsulation of packets of one protocol suite into the payload portion of a packet of another protocol suite.
11.	**What are the general problems of mobile IP regarding security and support of quality of service?** BTL 1 Mobility poses many security problems. A minimum requirement is the authentication of all messages related to the management of mobile IP. It must be sure for the IP layer if it forwards a packet to a mobile host that this host really is the receiver of the packet. The IP layer can only guarantee that the IP addresses of the receiver is correct. There are no ways of preventing faked IP address or other attacks.
12.	**Define Tunnel.** BTL 1 Tunnel establishes a virtual pipe for data packets between a tunnel entry and a tunnel endpoint. Packets entering a tunnel are forwarded inside the tunnel and leave the tunnel unchanged. Sending a packet through a tunnel is achieved by using encapsulation.
13.	**What is a Care of address in Mobile–IP? (April 2017)** BTL 1 Care-of address (COA): The COA defines the current location of the MN from an IP point of view. All IP packets sent to the MN are delivered to the COA, not directly to the IP address of the MN. Packet delivery toward the MN is done using a tunnel. To be more precise, the COA marks the tunnel endpoint, i.e., the address where packets exit the tunnel.

14.	**What are the types of care of address?** BTL 1 It is the address that is used to identify the present location of a foreign agent ▪ Foreign agent care of address ▪ Co-located care of address
15.	**What is the different operation of mobile IP?** BTL 1 ▪ The remote client sends a datagram to the MN using its home address it reaches the home agent as usual. ▪ The home agent encapsulates the datagram in a new packet and sends it to the foreign agent.
16.	**Define Home agent.** BTL 1 It is located in home network and it provides several services for the Mobile Network (MN). Home agent maintains a location registry. The location registry keeps track of the node locations using the current care of address of the mobile network.
17.	**Define Ad hoc wireless network with example?** BTL 1 An ad-hoc network is a local area network (LAN) that is built spontaneously as devices connect. Instead of relying on a base station to coordinate the flow of messages to each node in the network, the individual network nodes forward packets to and from each other. In Latin, ad hoc literally means "for this," meaning "for this special purpose" and also, by extension, improvised or impromptu. In the Windows operating system, ad-hoc is a communication mode (setting) that allows computers to directly communicate with each other without a router.
18.	**What is the advantage of Infra-red technology?** BTL 1 The main advantages of infra-red technology are its simple and extremely cheap senders and receivers.
19.	**Give examples for mobile adhoc networks.** BTL 1 Another application example of a mobile ad-hoc network is Bluetooth, which is designed to support a personal area network by eliminating the need of wires between various devices, such as printers and personal digital assistants. A mobile ad-hoc network can also be used to provide crisis management services applications.
20.	**What is DHCP?** BTL 1 The dynamic host configuration protocol is mainly used to simplify the installation and maintenance of networked computers. If a new computer is connected to a network, DHCP can provide it with all the necessary information for full system integration into the network, e.g.,

	addresses of a DNS server and the default router, the subnet mask, the domain name, and an IP address.
21.	**Differentiate infrastructure and ad-hoc networks.** BTL 1 Infrastructure network- In this communication typically takes place only between the wireless nodes and the access point. Any two wireless network nodes can communicate with the use of AP. Ad-hoc networks- This type of network has no infrastructure and it does not have any Ap. Here any wireless nodes from two different wireless networks cannot communicate.
22.	**What is roaming?** BTL 1 If a user walks around with a wireless station, the station has to move from one access point to another to provide uninterrupted service. Moving between access points is called roaming.
	PART – B
1.	**Explain in detail about Mobile IP. (6M)** BTL 1 • Goals, assumptions and requirements (3M) • Quick 'solutions' (3M)
2.	**Explain the Requirements of Mobile IP. (6M)** BTL 1 • Compatibility (2M) • Transparency (2M) • Scalability & Efficiency (1M) • Security (1M)
3.	**How the Entities and terminology of mobile networks? (13M)** BTL 1 **Mobile node (MN):** (5M)  **Figure 8.1** Mobile IP example network **Correspondent node (CN):** (8M) • Home network • Foreign network

- Foreign agent (FA)
- Care-of address (COA)
- Foreign agent COA
- Co-located COA
- Home agent (HA)

4. **How the IP packet delivery is achieved in WLAN? (13M)** BTL 1

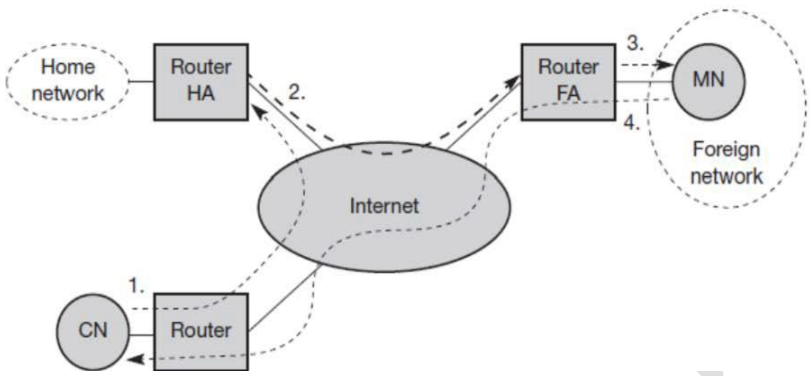


Figure 8.2
Packet delivery to and from the mobile node

- Agent discovery (3M)
- Agent advertisement (3M)

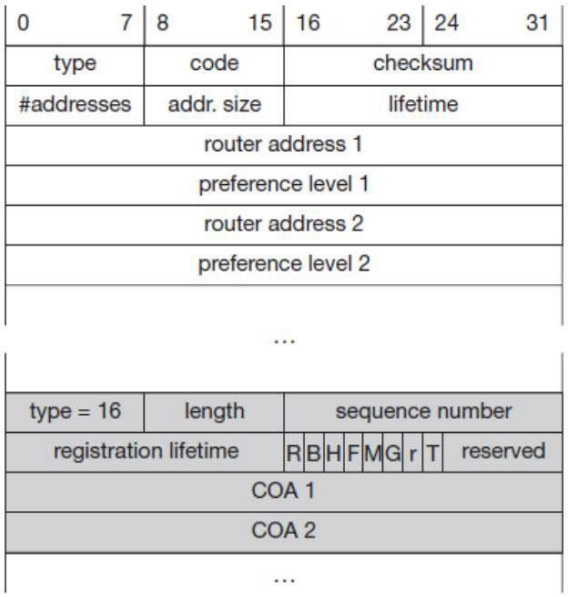


Figure 8.3
Agent advertisement packet (RFC 1256 + mobility extension)

- Agent solicitation (3M)
- Registration (4M)

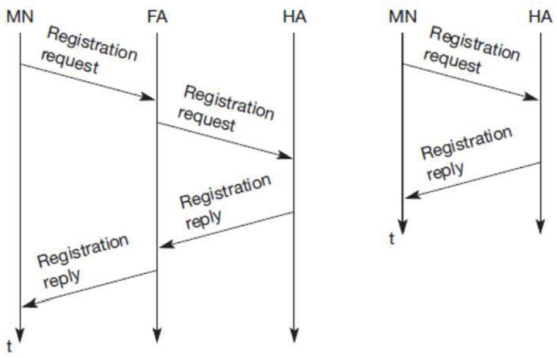


Figure 8.4 Registration of a mobile node via the FA or directly with the HA

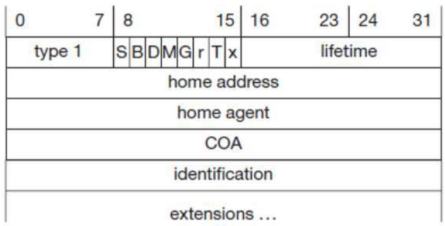
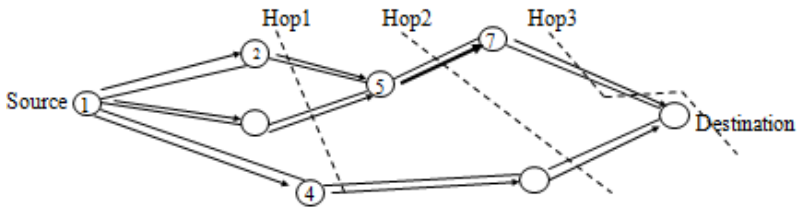


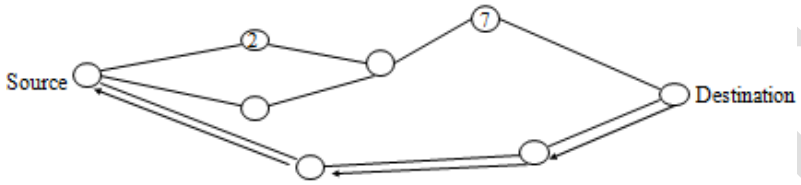
Figure 8.5
Registration request

5.	**Explain Table Driven Routing Protocol. (13M) (APR/MAY 2014)** BTL 1 **Explain DSDV protocol in brief. (13M)** BTL 1 Each node maintains routing information to all other nodes in the network (6M) When the topology changes, updates are propagated throughout the network. (7M) Examples are: • Destination Sequenced Distance Vector routing (DSDV) • Cluster-head Gateway Switch routing (CGSR) • Wireless Routing Protocol (WRP)	**(OR)**
6.	**Explain Source Initiated on-Demand Routing. (13M)** BTL 1 Some of the popular routing procedures are, (1M) • Ad hoc On-Demand Distance Vector (AODV). • Dynamic Source Routing (DSR) • Temporary Ordered Routing Algorithm (TORA) • Associativity Based • Routing (ABR) • Signal Stability Routing (SSR)	

Ad hoc On-Demand Distance Vector Routing (4M)

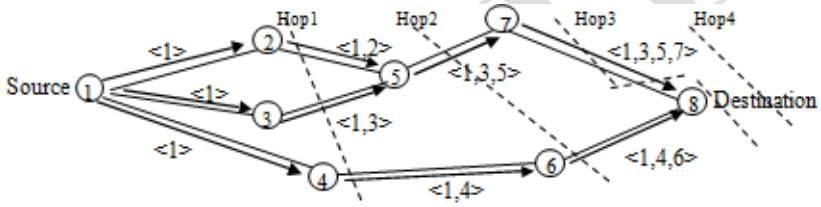


(a) Propagation of Route Request (RREQ) Packet

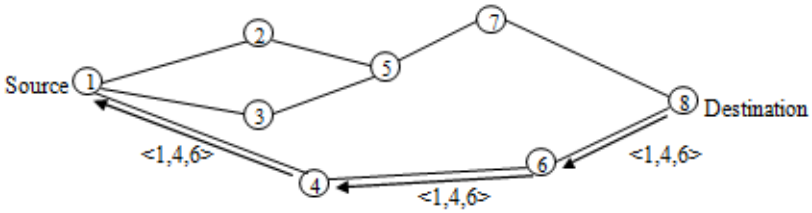


(b) Path Taken by the Route Reply (RREP) Packet

Dynamic Source Routing (4M)



(a) Building Record Route During Route Discovery



(b) Propagation of Route Reply with the Route Record

Temporarily Ordered Routing Algorithm (TORA) (4M)

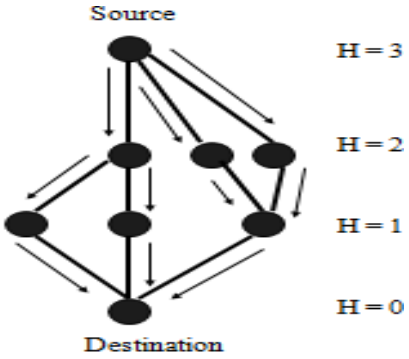


Illustration of Tora height metric

7.	**Explain a) Agent discovery, b) Registration, c) Tunneling and d) Encapsulation**

mechanisms in Mobile IP. (Or) Explain the Key Mechanisms in Mobile IP. (13M) BTL 2

Mobile IP is associated with three basic mechanisms: (2M)

i) Discovering the Care – of – Address (Agent Discovery)

ii) Registering the Care – of – Address (Registration)

iii) Tunneling the Care – of – Address (Tunneling and Encapsulation)

Agent Discovery (5M)

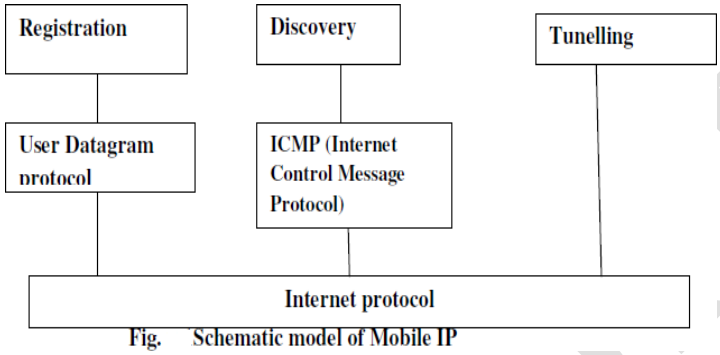


Fig. Schematic model of Mobile IP

Agent Advertisement

Agent Solicitation

Discovering the Care of address

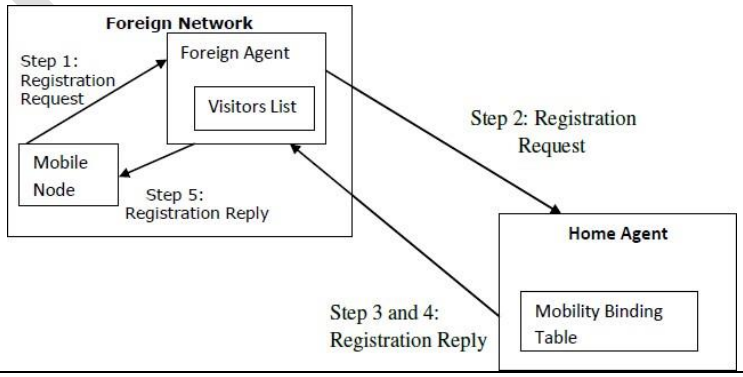
The process of agent advertisements

Registration Procedure in Mobile IP (6M)

Two Types of Registration

- one via a foreign agent that relays the registration to the mobile node's home agent,
- one directly with the mobile node's home agent (co-located care-of address).

Registering CoA



8. **Tunneling and encapsulation in Mobile IP. (13M)** BTL 4

Tunnel

Types of Care of Address (CoA) (2M)

- Foreign agent care-of address: the address of a foreign agent that MH registers with

- Co-located care-of address: an externally obtained local address that a MH gets.

Tunneling: (5M)

Two primary functions of tunneling:

- Encapsulation of data packet to reach the tunnel endpoint.
- Decapsulation when packet is delivered at the endpoint.

Steps involved in tunneling:

Types: IP-in-IP-encapsulation, minimal encapsulation or GRE

Encapsulation (6M)

i) IP-in-IP-encapsulation (mandatory, RFC 2003)

ii) Minimal encapsulation (optional)

iii) Generic Encapsulation

9. **Explain the goals, requirements and packet delivery for mobile IP. (13M)** BTL 1

(Or)

Sketch the schematic of a mobile IP network and explain the packet delivery between the mobile and corresponding node. (13M) BTL 3

(Or)

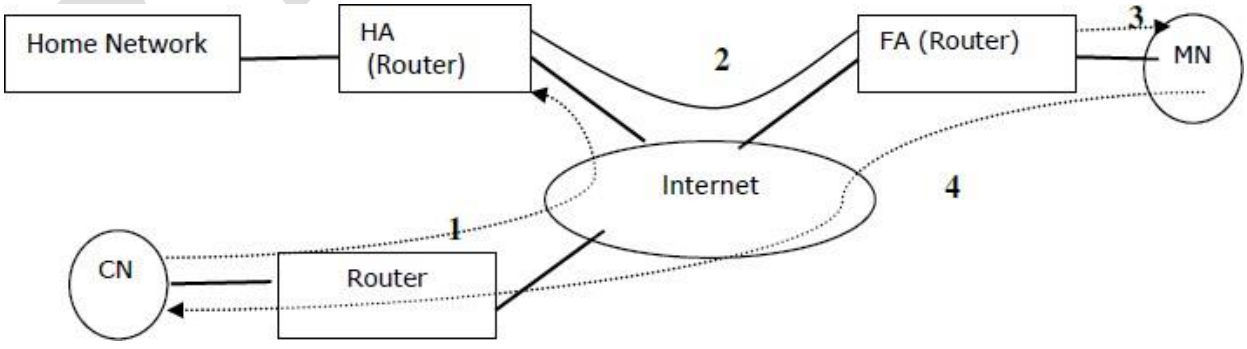
Explain how end to end packet delivery is done in mobile IP. (13M) BTL 1

Mobile IP (2M)

Goals of Mobile IP (2M)

Requirements of Mobile IP (2M)

Packet Delivery in Mobile IP (4M)



Route Optimization (3M)

- Enable direct notification of the corresponding host

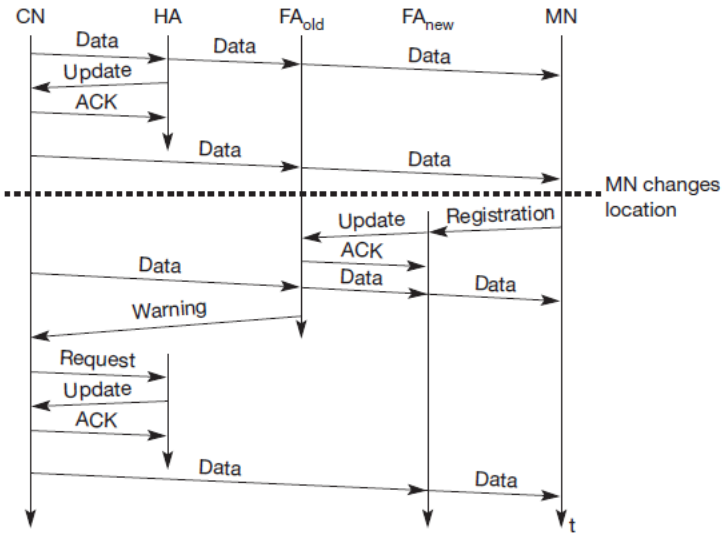
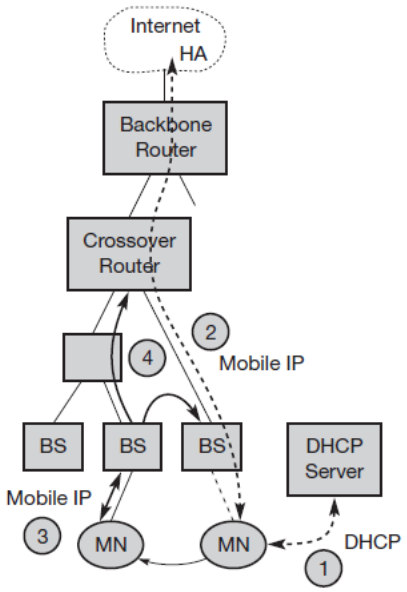
	• Direct tunnelling from the corresponding host to the mobile host • Binding cache maintained at the corresponding host
10.	**Explain in detail about IPV6 network layer in the internet. (13M)** BTL 1 • Simplified Header Format (2M) • Expanded Addressing Capability (2M) • Improved Support for Extensions and Options (3M) • Flow Labelling (3M) • Authentication and Privacy Capabilities. (3M)
	PART – C
1.	**Explain the Optimizations used the mobile IP Networks. (15M)** BTL 1 • Binding request (3M) • Binding update (3M) • Binding acknowledgement (4M) • Binding warning (5M)  **Figure 8.13** Change of the foreign agent with an optimized mobile IP
2.	**Explain the Reverse tunneling techniques used in WLAN. (15M)** BTL 1 • Firewalls (5M) • Multi-cast (5M) • TTL (5M)
3.	**Brief about Hawaii and its evolution techniques. (15M)** BTL 4 Introduction (9M)

Figure 8.15
Basic architecture of HAWAII

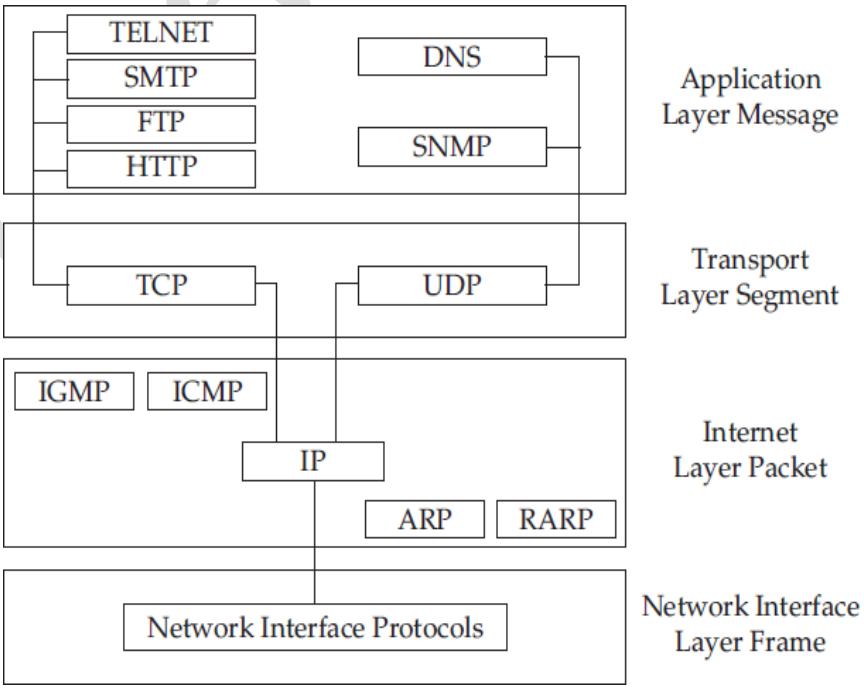


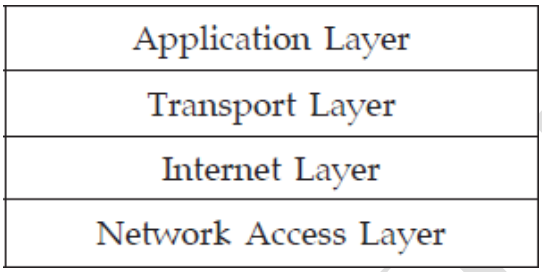
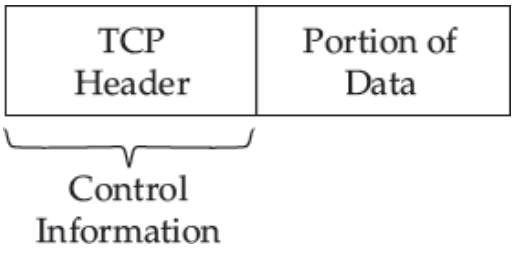
- *Advantages* (3M)
- *Disadvantages* (3M)

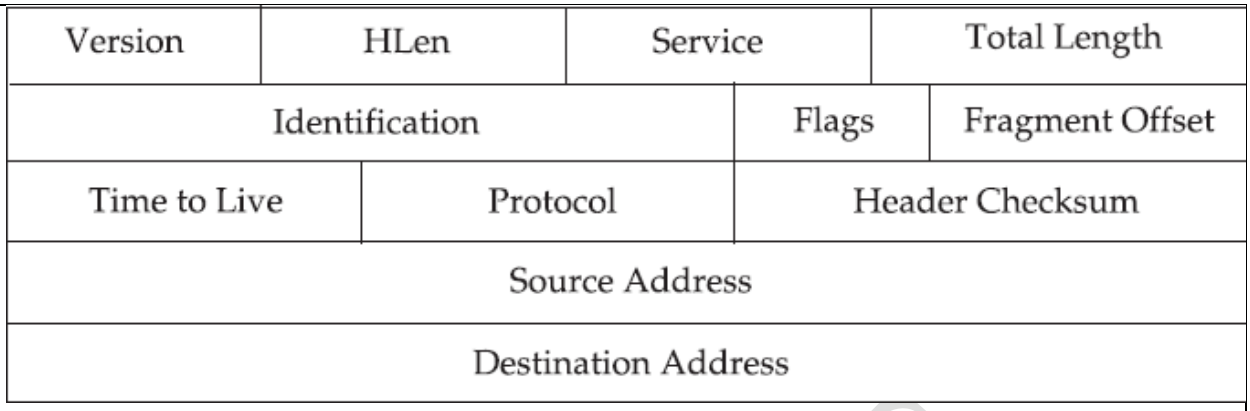
UNIT III - MOBILE TRANSPORT LAYER	
TCP enhancements for wireless protocols - Traditional TCP: Congestion control, fast retransmit/fast recovery, Implications of mobility - Classical TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, Transaction oriented TCP - TCP over 3G wireless networks.	
PART – A	
1.	**Define Routers.** BTL 1 Router is responsible for routing the packets that is receives to their destinations based on their IP addresses, possibly via other routers.
2.	**What are the different layers of TCP/IP?** BTL 1 Application layer, Transport layer, Internet layer, Network access layer
3.	**What are all the various flavors of TCP available?** BTL 1 ▪ Indirect TCP- I-TCP segments a TCP connection into a fixed part and a wireless part. ▪ Snooping TCP- Here the foreign agent buffers all packets with destination mobile host and additionally snoops the packet flow in both directions to recognize acknowledgements. ▪ Mobile TCP- M-TCP wants to improve overall throughput, to lower the delay, to maintain end to end semantics of TCP, and to provide a more efficient handover. ▪ Fast Transmit/Fast Recovery ▪ Transmission/Time-out freezing ▪ Selective retransmission ▪ Transaction-oriented TCP.
4.	**What is the goal of M-TCP**? BTL 1 The goal of M-TCP is to prevent the sender window from shrinking if bit errors or disconnection but not congestion cause current problems. ▪ To provide overall throughput ▪ To lower the delay ▪ To maintain end-to-end semantics of TCP ▪ To provide a more efficient handover.
5.	**What led to the development of Indirect TCP**? BTL 1 ▪ TCP performs poorly together with wireless links ▪ TCP within the fixed network cannot be changed.

	This led to the development of I-TCP which segments a TCP connection into a fixed part and a wireless part.
6.	**List the disadvantages of I-TCP (April 2017)** BTL 1 It does not maintain the semantics of TCP as the FH gets the acknowledgement before the packet is delivered at MH.I TCP does not maintain the end –end semantic of TCP and assumes that application layer would ensure reliability
7.	**List the disadvantages of I-TCP (April 2017)** BTL 1 It does not maintain the semantics of TCP as the FH gets the acknowledgement before the packet is delivered at MH.I TCP does not maintain the end –end semantic of TCP and assumes that application layer would ensure reliability
8.	**Define Agent solicitation.** BTL 1 Mobile node does not receive any COA, then the MN should send an agent solicitation message. But it is important to monitor that these agent solicitation message do not flood the network.
9.	**What is Snooping TCP?** BTL 1 In this approach, the foreign agent buffers all packets with destination mobile host and additionally 'snoops' the packet flow in both directions to recognize acknowledgements. The reason for buffering packets toward the mobile node is to enable the foreign agent to perform a local retransmission in case of packet loss on the wireless link.
10.	**What is M-TCP? Give the advantages of M-TCP. (April 2017)** BTL 1 M-TCP (mobile TCP) M-TCP splits the TCP connection into two parts as I-TCP does. An unmodified TCP is used on the standard host-supervisory host (SH) connection, while an optimized TCP is used on the SH-MH connection. The supervisory host is responsible for exchanging data between both parts similar to the proxy in ITCP. The advantages of M-TCP are the following: It maintains the TCP end-to-end semantics. If the MH is disconnected, it avoids useless retransmissions, slow starts or breaking connections by simply shrinking the sender's window to 0. Since it does not buffer data in the SH as I-TCP does, it is not necessary to forward buffers to a new SH.
11.	**What is I-TCP?** BTL 1 I-TCP segments a TCP connection into a fixed part and a wireless part. The example is mobile host connected via a wireless link and an access point to the 'wired' internet where the correspondent host resides. The correspondent node could also use wireless access.

	Standard TCP is used between the fixed computer and the access point. No computer in the internet recognizes any changes to TCP. Instead of the mobile host, the access point now terminates the standard TCP connection, acting as a proxy.
12.	**Differentiate types of Care of address.** BTL 1 The COA could be located at the FA, i.e., the COA is an IP address of the FA. The FA is the tunnel end-point and forwards packets to the MN. Many MN using the FA can share this COA as common COA. The COA is co-located if the MN temporarily acquired an additional IP address which acts as COA. This address is now topologically correct, and the tunnel endpoint is at the MN. Co-located addresses can be acquired using services such as DHCP. One problem associated with this approach is the need for additional addresses if MNs request a COA.
13.	**What is selective re-transmission?** BTL 1 A very useful extension of TCP is the use of selective retransmission. If a single packet is lost, the sender can now determine precisely which packet is needed and can retransmit it. Using selective retransmission is also beneficial in all other networks.
14.	**What is meant by a binding cache?** BTL 1 One way to optimize the route is to inform the CN of the current location by caching it in a binding cache which is a part of the local routing table for the CN.
15.	**What is the basic purpose of DHCP?** BTL 1 Dynamic Host configuration Protocol is set of rules used by communication devices, to request and obtain an IP address from a server which has a list of address available for assignment.
16.	**How does I-TCP isolate problems on the wireless link?** BTL 1 ▪ I-TCP does not need any changes in the TCP protocol. ▪ Transmission errors on the wireless link cannot propagate into the fixed network. ▪ Mechanisms are needed to improve TCP performance as in the case of I-TCP only the mobile host and foreign agents need changes. Hence we can test new schemes without destabilizing the system. ▪ As there is strict partition, two different protocols can be used between the FA/MH and other end.
17.	**What is time out freezing?** BTL 1

	It is used in situations where the mobile node (MN) faces long durations of disconnection. During the timeout period the MN may get some data sequences. After timeout, the TCP transmission freezes.
18.	**What are the possible locations for care of address?** BTL 1 The care-of address is a slightly tricky concept. There are two different types, which correspond to two distinctly different methods of forwarding datagrams from the home agent router. Foreign agent COA: The COA could be located at the FA, i.e., the COA is an IP address of the FA. The FA is the tunnel end-point and forwards packets to the MN. Co-located COA: The COA is co-located if the MN temporarily acquired an additional IP address which acts as COA. This address is now topologically correct, and the tunnel endpoint is at the MN. Co-located addresses can be acquired using services such as DHCP.
19.	**What is triangular routing?** BTL 1 The inefficient behaviour of a non-optimized mobile IP is called triangular routing. The triangle is made up of three segments, CN to HA, HA to COA\MN, and MN back to CN.
	PART – B
1.	**Describe the TCP / IP Protocol Suite and Architecture of TCP/IP. (10)** BTL 1 **TCP / IP Protocol Suite.** BTL 1 *Transmission Control Protocol (TCP) and Internet Protocol (IP).* (7M)  *TCP/IP Protocol Stack*

	Application layer protocols (6M) Transport Layer IP Layer Network Access Layer Packet transfer in TCP/IP Architecture of TCP / IP  Application layer Transport layer Internet layer Network access layer Data link Layer Physical Layer
2.	**Explain the structure of TCP segment and IP Datagram. (13M)** BTL 1 The TCP header includes several items of information including the following: (6M) i) Destination Port ii) Checksum iii) Sequence number  *Structure of TCP segment* *IP Datagram* (7M)

	 *Structure of IP Datagram*
3.	**Discuss in detail about classical TCP improvements (or) TCP Enhancements. (13M)** BTL 3 **(or)** **Explain in detail Snooping TCP and its advantages and disadvantages. (13M)** BTL 1 **What is Transaction oriented TCP? Explain. (13M)** BTL 1 *Classical TCP improvements* (13M) Two reasons that led to the development of indirect TCP are (I-TCP) One is that TCP performs poorly together with wireless links; The other is that TCP within the fixed network cannot be changed.
	PART – C
1.	**Discuss about TCP over 2.5/3G wireless networks. (15M)** BTL 3 • Data rates • Latency • Jitter • Packet loss • Large windows • Limited transmit • Large MTU • Selective Acknowledgement (SACK) • Explicit Congestion Notification (ECN) • Timestamp • No header compression

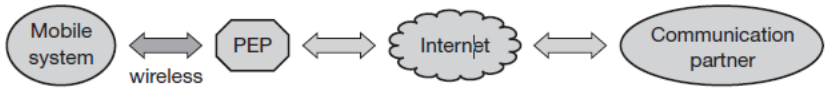
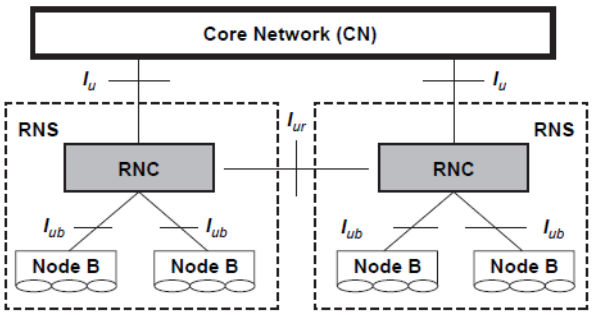
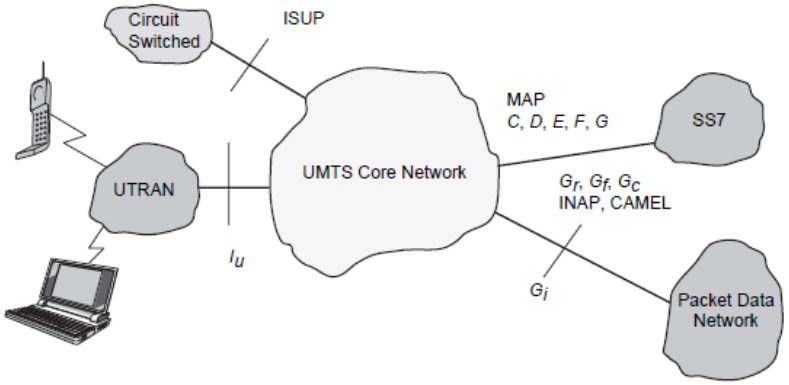


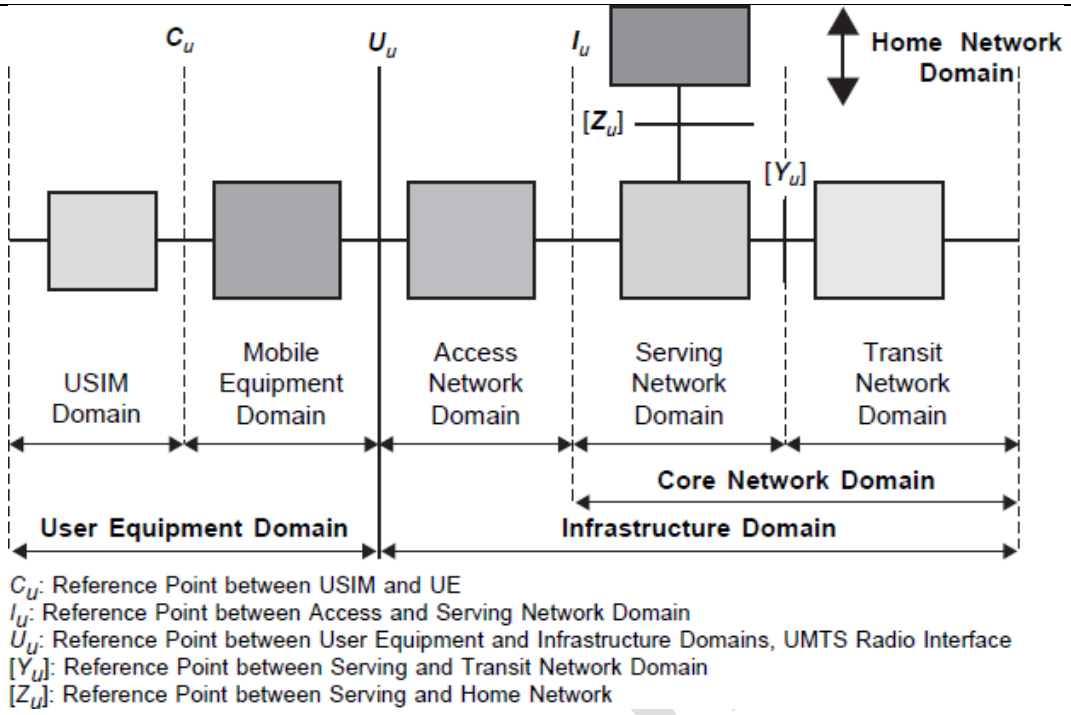
Figure 9.5 Performance enhancing proxy

UNIT IV - WIRELESS WIDE AREA NETWORK	
Overview of UTMS Terrestrial Radio access network-UMTS Core Network Architecture: 3G-MSC, 3G-SGSN, 3G-GGSN, SMS-GMSC/SMS-IWMSC, Firewall, DNS/DHCP-High speed Downlink packet access (HSDPA)- LTE network architecture and protocol.	
PART - A	
1.	**List the sub-systems of UMTS Terrestrial Radio Access Network (UTRAN).** BTL 1 The UTRAN consists of a set of radio network subsystems (RNSs). The RNS has two main logical elements: Node B and an RNC.
2.	**State the responsibilities of an RNC.** BTL 1 An RNC is responsible for the use and allocation of all the radio resources of the RNS to which it belongs. The RNC also handles the user voice and packet data traffic, performing the actions on the user data streams that are necessary to access the radio bearers
3.	**State the responsibilities of Node B.** BTL 1 A Node B is responsible for radio transmission and reception in one or more cells to/from the user equipment (UE).
4.	**Draw the UTRAN logical architecture.** BTL 1  RNC: Radio Network Controller RNS: Radio Network Subsystem
5.	**What is the need for I_u interface?** BTL 1 The UMTS I_u interface is the open logical interface that interconnects one UTRAN to the UMTS core network (UCN). On the UTRAN side the I_u interface is terminated at the RNC, and at the UCN side it is terminated at U-MSC.
6.	**State the three different protocol planes of I_u interface.** BTL 1

	The I_u interface consists of three different protocol planes — the radio network control plane (RNCP), the transport network control plane (TNCP), and the user plane (UP).
7.	**List the functions of RNCP.** BTL 1 It carries information for the general control of UTRAN radio network operations. It carries information for control of UTRAN in the context of each specific call. It carries user call control (CC) and mobility management (MM) signaling messages.
8.	**What is the need for I_{ur} interface?** BTL 1 The connection between two RNCs (serving RNC (SRNC) and drift RNC (DRNC)) is the I_{ur} interface. It is used in soft handoff scenarios when different macro diversity streams of one communication are supported by Node Bs that belong to different RNCs. Communication between one RNC and one Node B of two different RNCs are realized through the I_{ur} interface.
9.	**What are the functions carried out by I_{ur} interface?** BTL 1 Basic inter-RNC mobility support, Dedicated channel traffic support, Common channel traffic support and Global resource management support.
10.	**What is the need for I_{ub} interface?** BTL 1 The connection between the RNC and Node B is the I_{ub} interface. There is one I_{ub} interface for each Node B. The I_{ub} interface is used for all of the communications between Node B and the RNC of the same RNS.
11.	**State the functionality of U_u interface.** BTL 1 The UMTS U_u interface is the radio interface between a Node B and one of its UE. The U_u is the interface through which UE accesses the fixed part of the system.
12.	**State the functions of 3G-MSC.** BTL 1 The 3G-MSC is the main CN element to provide CS services. The 3G-MSC also provides the necessary control and corresponding signalling interfaces including SS7, MAP, ISUP (ISDN user part), etc. The 3G MSC provides the interconnection to external networks like PSTN and ISDN.
13.	**Draw UMTS core network architecture.** BTL 1

	
14.	**Write about 3G-SGSN.** BTL 1 The 3G-SGSN is the main CN element for PS services. The 3G-SGSN provides the necessary control functionality both toward the UE and the 3G-GGSN. It also provides the appropriate signalling and data interfaces including connection to an IP-based network toward the 3G-GGSN, SS7 toward the HLR/EIR/AUC and TCP/IP or SS7 toward the UTRAN.
15.	**List the functions of 3G-GGSN.** BTL 1 The GGSN provides interworking with the external PS network. It is connected with SGSN via an IP-based network. The GGSN may optionally support an SS7 interface with the HLR to handle mobile terminated packet sessions.
16.	**What are the tasks carried out by SMS-GMSC?** BTL 1 Reception of short message packet data unit (PDU), Interrogation of HLR for routing information and Forwarding of the short message PDU to the MSC or SGSN using the routing information.
17.	**Why do we need Firewall in a network?** BTL 1 This entity is used to protect the service providers' backbone data networks from attack from external packet data networks. The security of the backbone data network can be ensured by applying packet filtering mechanisms based on access control lists or any other methods deemed suitable.
18.	**Write about DNS.** BTL 1 The DNS server is used, as in any IP network, to translate host names into IP addresses, i.e., logical names are handled instead of raw IP addresses. Also, the DNS server is used to translate the access point name (APN) into the GGSN IP address. It may optionally be used to allow the UE to use logical names instead of physical IP addresses.
19.	**List out the need for DHCP.** BTL 1

	A dynamic host configuration protocol server is used to manage the allocation of IP configuration information by automatically assigning IP addresses to systems configured to use DHCP.
20.	**State the salient features of HSDPA.** BTL 1 HSDPA is based on the same set of technologies as high data rate (HDR) to improve spectral efficiency for data services — such as shared downlink packet data channel and high peak data rates (8–10 Mbps) — using high-order modulation and adaptive modulation and coding, hybrid ARQ (HARQ) retransmission schemes, fast scheduling and shorter frame sizes. HSDPA also shortens the round-trip time between the network and terminals and reduces variance in downlink transmission delay.
21.	**What is the role of firewall used in UMTS network? (April 2017)** BTL 1 All traffic coming in and going out of the private network is handled by the firewall. The firewall ensures that only authenticated traffic is allowed to pass through it.
	PART – B
1.	**Discuss in detail about Universal Mobile Telecommunication systems. (13M)** BTL 3 • Introduction to UMTS (2M) • The UMTS networks are different from the 2G networks in the following respects: (11M) • Higher speech quality: • Higher data rate: • Virtual home environment (VHE): • Features of UMTS • UMTS System Architecture

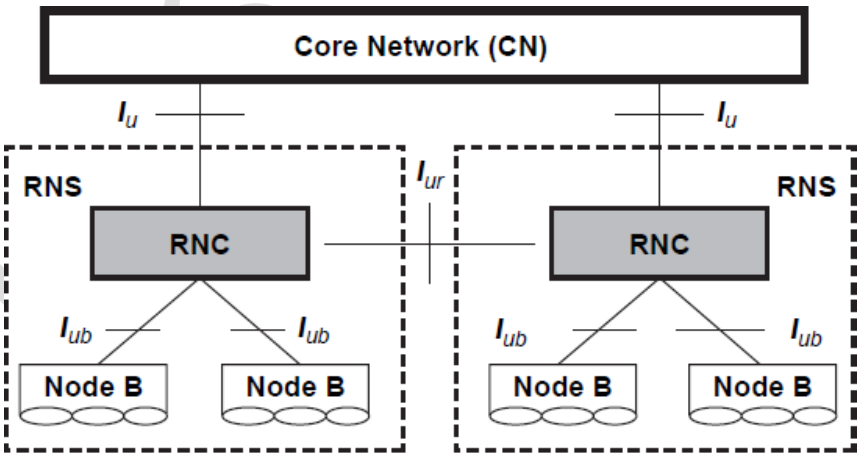


UMTS Domain and Reference points

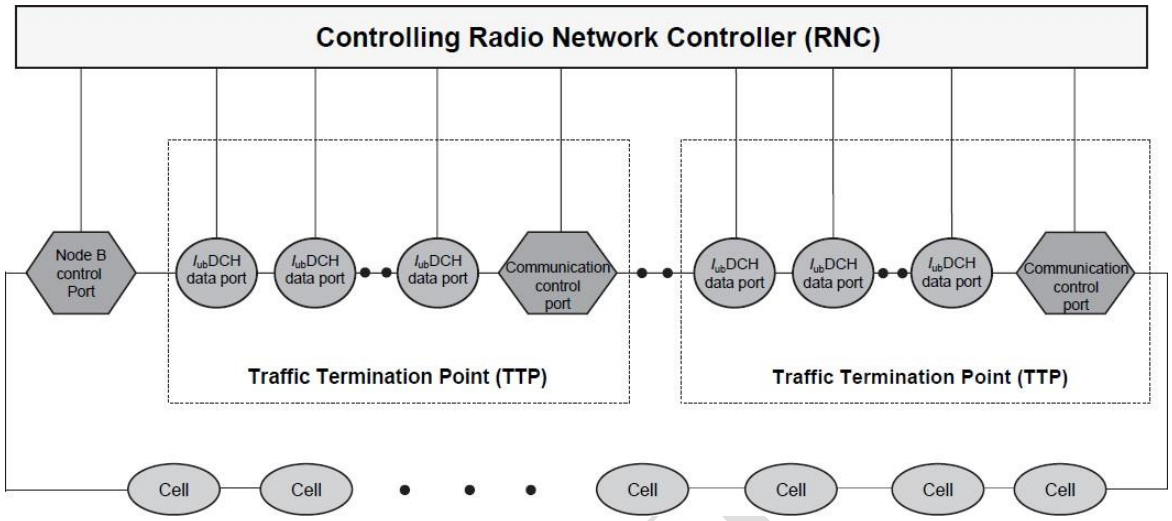
Radio Network Subsystem (RNS)

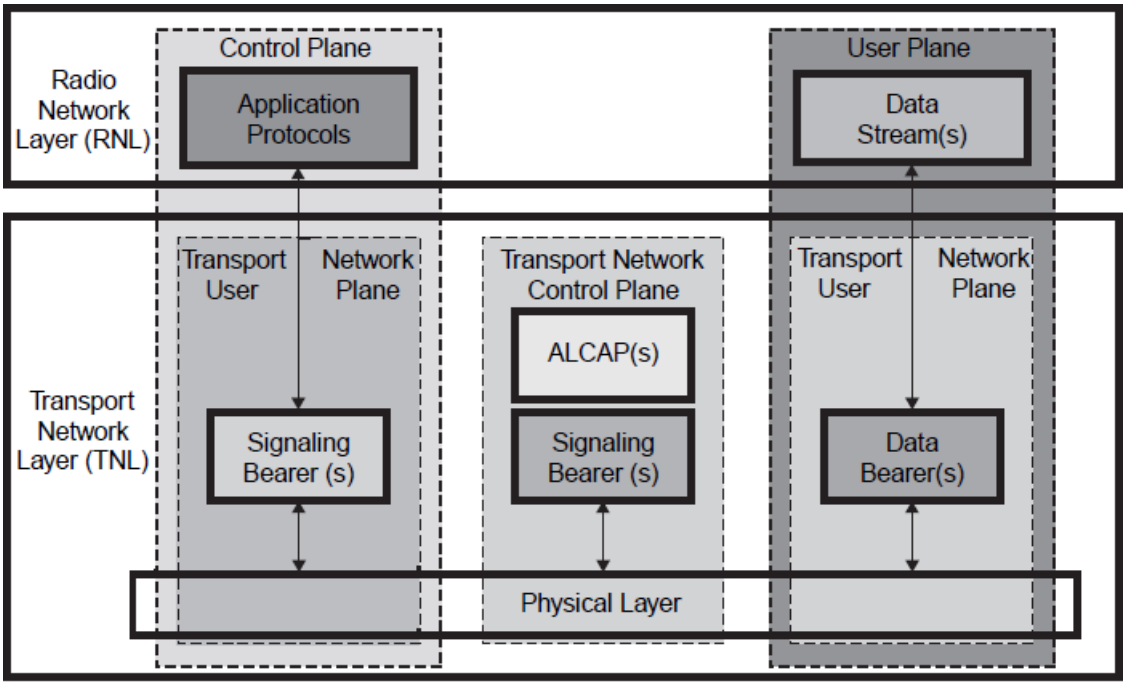
2. **Discuss the responsibilities of the RNC, Node B in the UMTS network. (13M)** BTL 3

Responsibilities of the RNC, Node B in the UMTS network (7M)



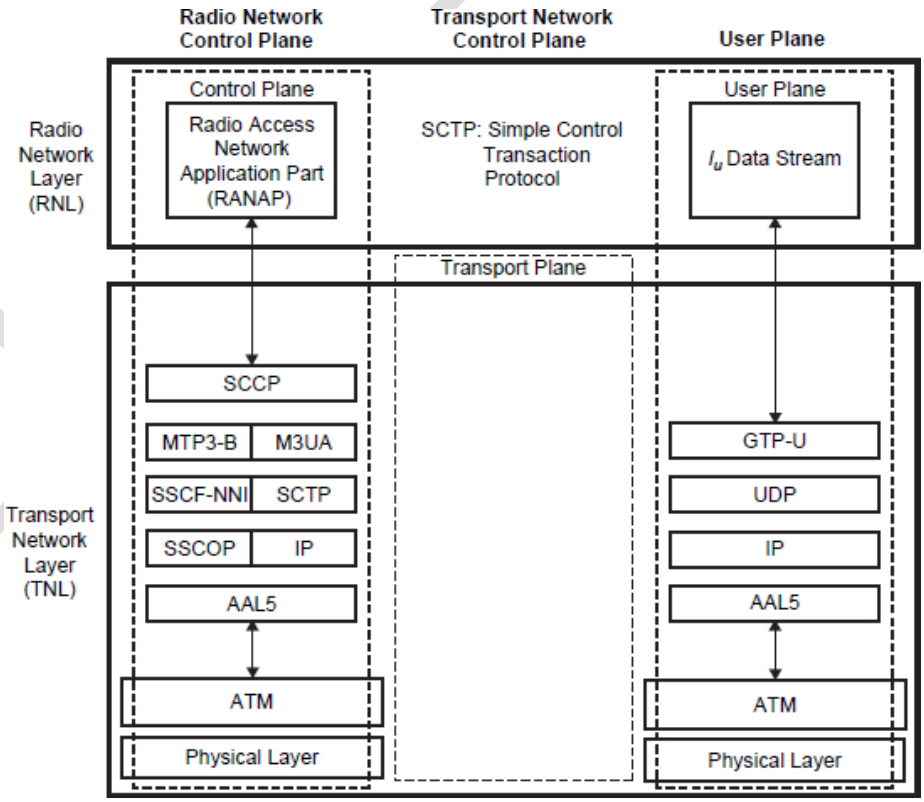
RNC: Radio Network Controller
RNS: Radio Network Subsystem

	UTRAN Logical Architecture  *Node B Logical Architecture* (6M)
3.	**Discuss the role of the access link control application part (ALCAP) in the UMTS. (13M)** BTL 3 The transport network control plane carries all control signaling within the transport layer. It does not include radio network layer information. It contains access link control application part (ALCAP) required to set up the transport bearers (data bearers) for the user plane. It also includes the signaling bearer needed for the ALCAP.
4.	**Discuss Iu interfaces in the UMTS.** BTL 3 ***lu Interface***

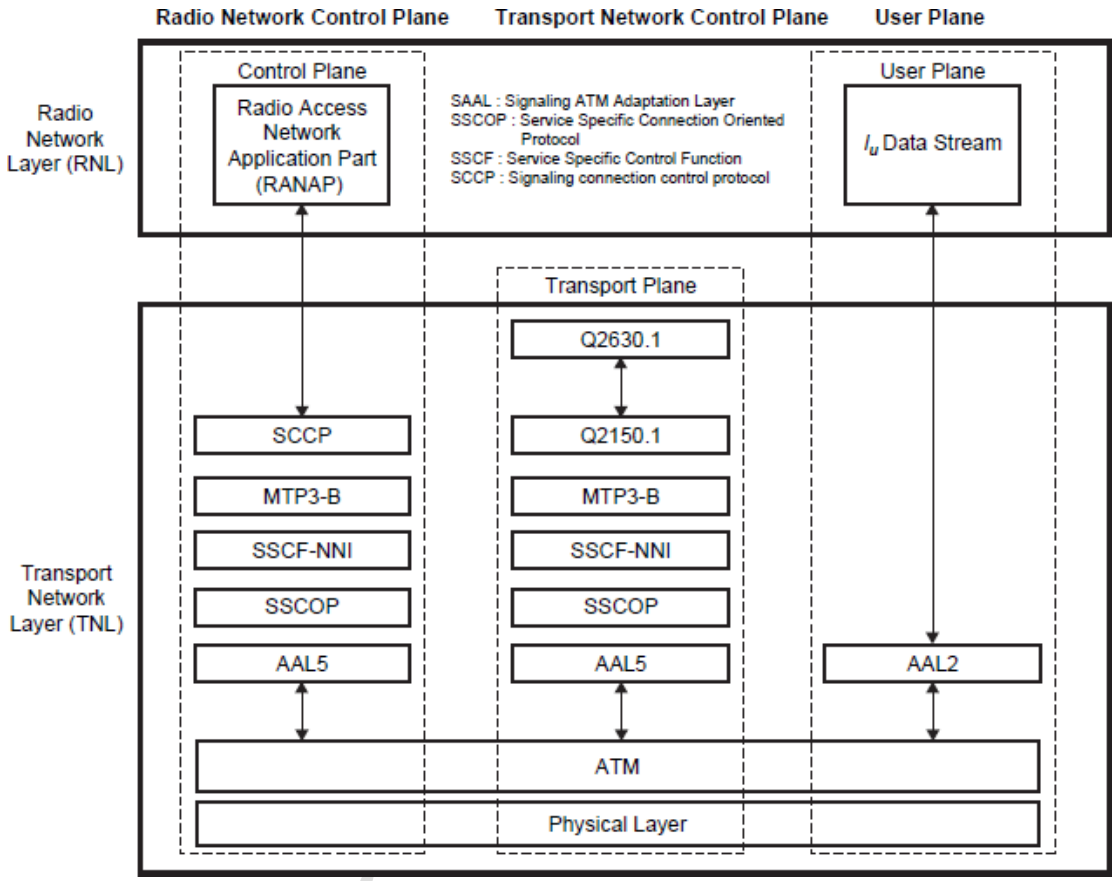


ALCAP: Access Link Control Application Part

General Protocol Model for UTRAN interfaces



PS Protocol architecture on lu interfaces



CS Protocol architecture on lu interfaces

5. **Discuss Iur interfaces in the UMTS. (13M)** BTL 3

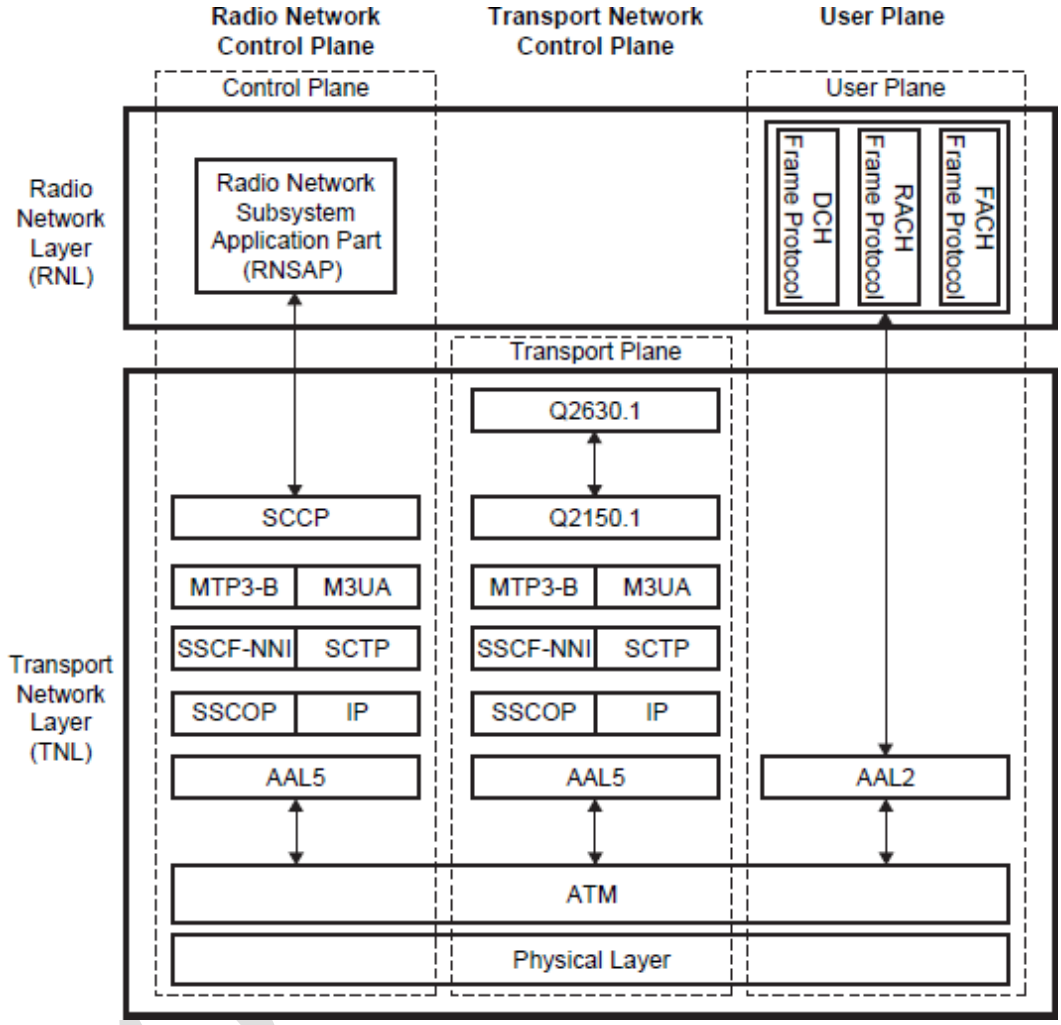
The Iur interface is used to carry:

The protocols used on this interface are:

- Radio access network application part (RANAP)
- DCH frame protocol (DCHFP)
- RACH frame protocol (RACHFP)
- FACH frame protocol (FACHFP)
- Access link control application part (ALCAP)
- Q.aal2
- Message transfer part 3-B (MTP3-B)

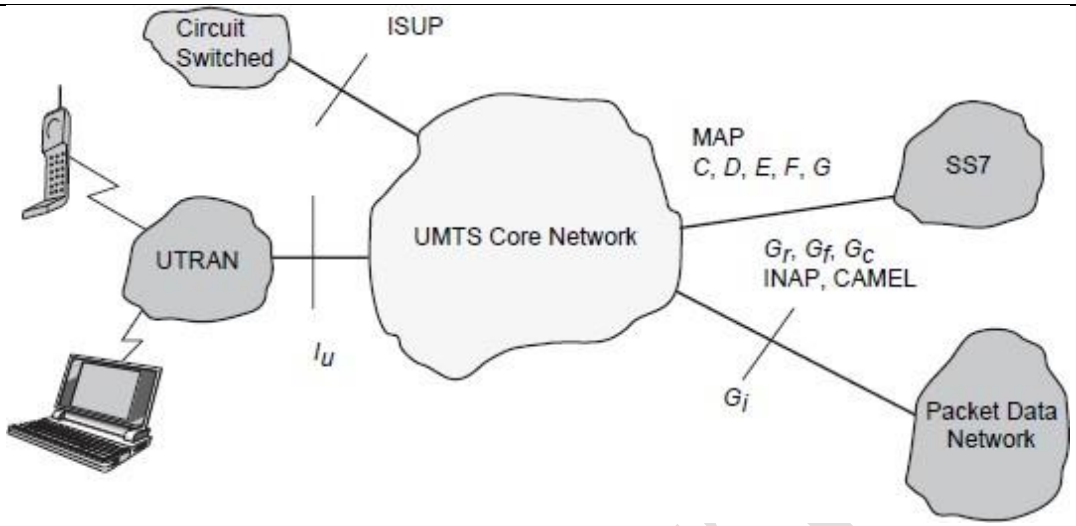
1. Basic inter-RNC mobility support
2. Dedicated channel traffic support
3. Common channel traffic support
4. Global resource management support

6.	**Discuss Iub interfaces in the UMTS. (13M)** BTL 3

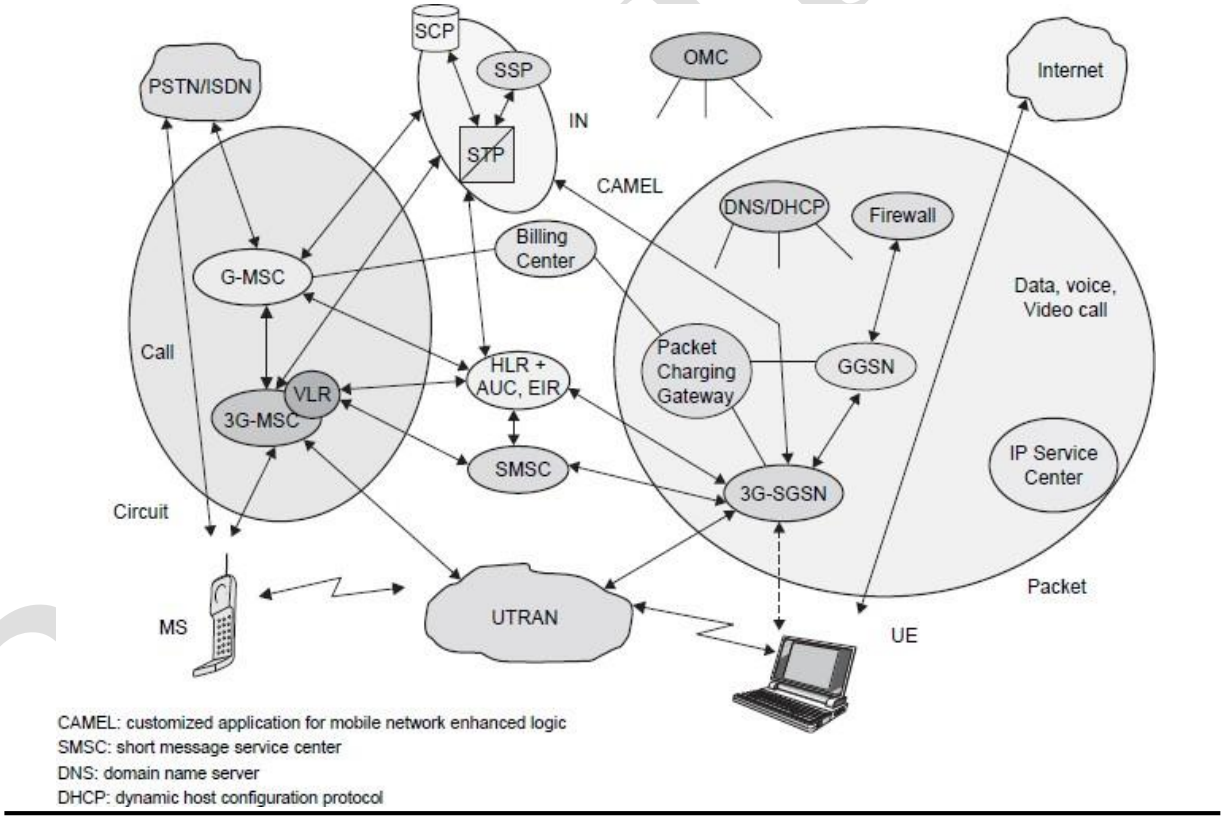


Protocol structure of Iur interface

7.	**Explain in detail about UMTS Core Network Architecture. (13M)** BTL 1 UMTS Core Network Architecture



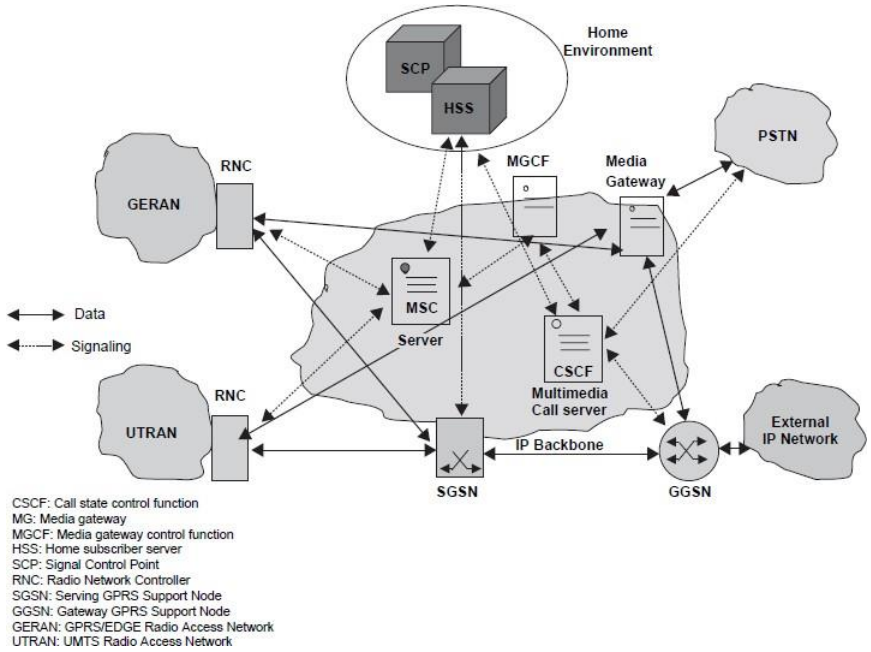
UMTS Core Network Architecture



Logical architecture of the UMTS Core Network

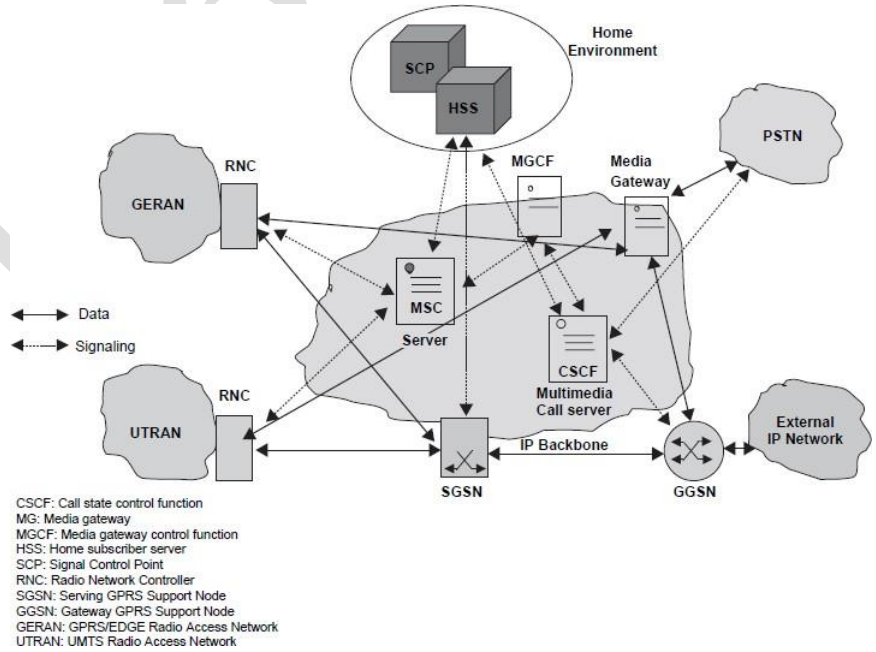
- 3G-MSC
- 3G-SGSN
- 3G-GGSN
- SMS-GMSC/SMS-IWMSC

	PART – C
1.	**Discuss in detail about High-Speed Downlink Packet Access (HSDPA) (15M)** BTL 3

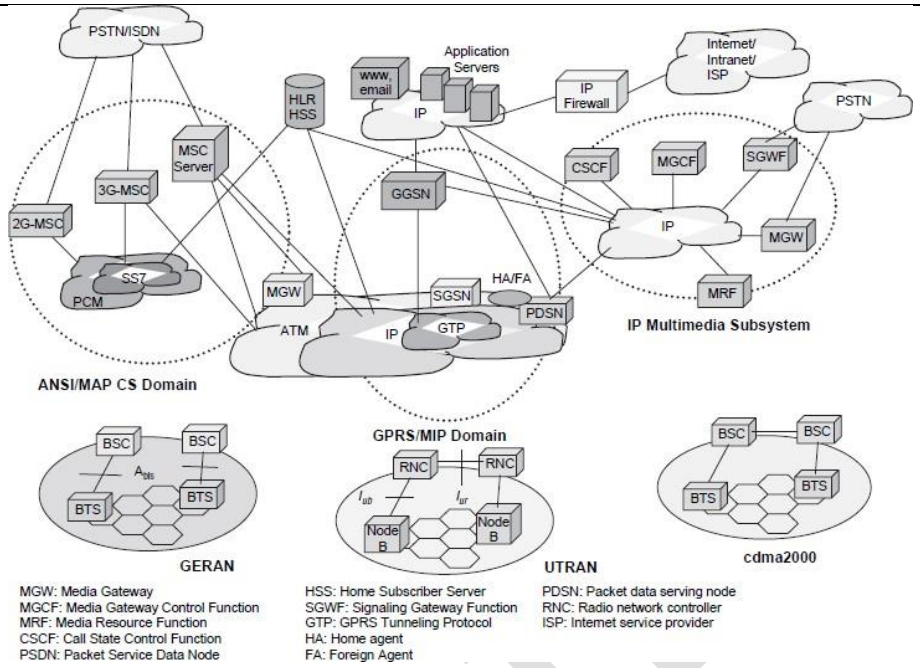


Simplified all-IP UMTS Architecture

2.	**Explain the HSDPA objective and its operation in detail. (15M)** BTL 1



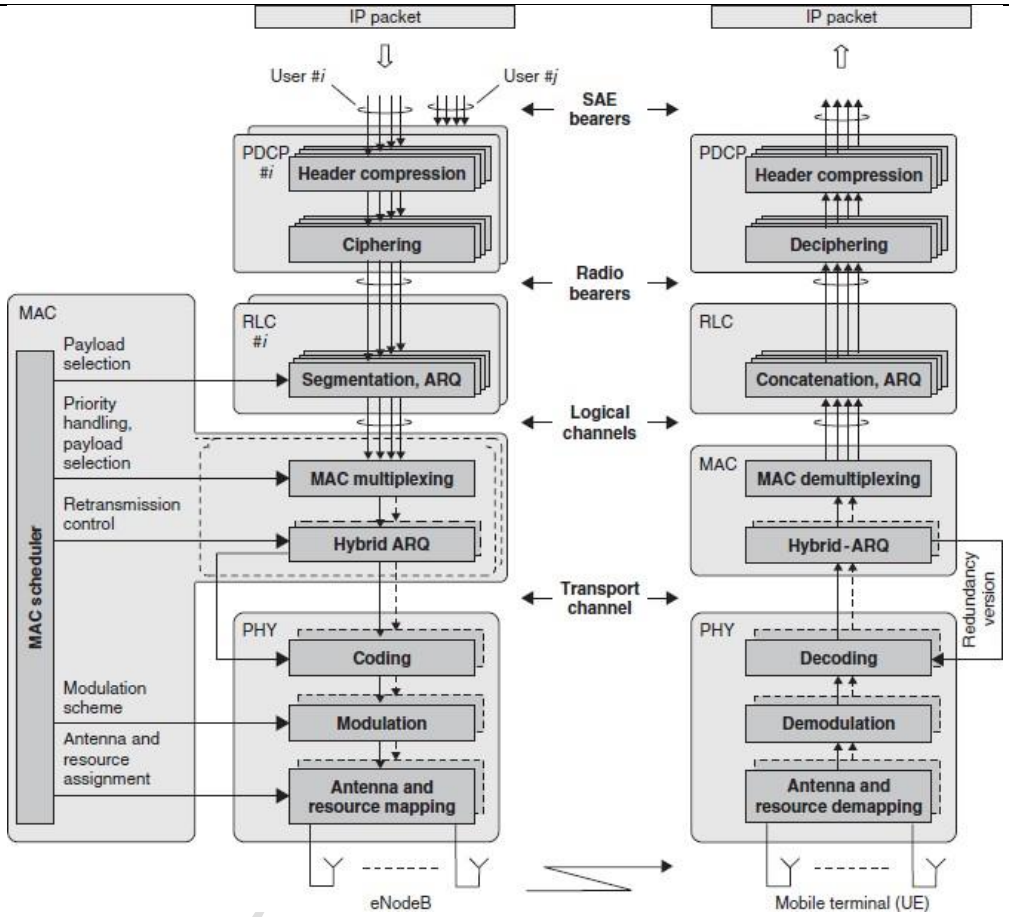
Simplified all-IP UMTS Architecture



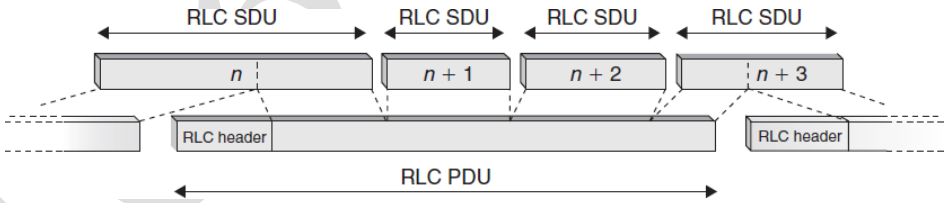
All-IP core network architecture for UMTS

HSDPA Data Rates

3.	**Explain in detail about LTE network architecture and protocol. (15M)** BTL 2 *LTE protocol architecture (Downlink)* (8M)



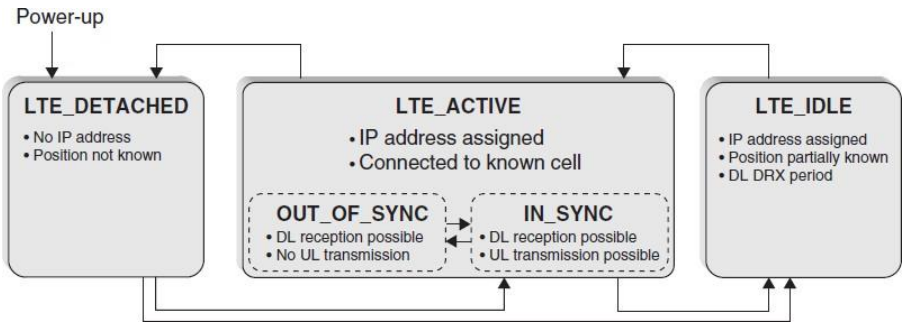
LTE protocol architecture (Downlink)



RLC segmentation and concatenation

MAC: medium access control

Logical channels and transport channels (5M)



LTE States

UNIT V 4G NETWORKS

Introduction – 4G vision – 4G features and challenges - Applications of 4G – 4G Technologies: Multicarrier Modulation, Smart antenna techniques, OFDM-MIMO systems, Adaptive Modulation and coding with time slot scheduler, Cognitive Radio.

PART – A

1. **Differentiate between 3G and 4G networks?** BTL 1

3G	4G
Bandwidth used is 5-20 MHz	Bandwidth used is more than 100MHz
Access technologies used are WCDMA and CDMA 2000	OFDM and MC-CDMA technologies are used

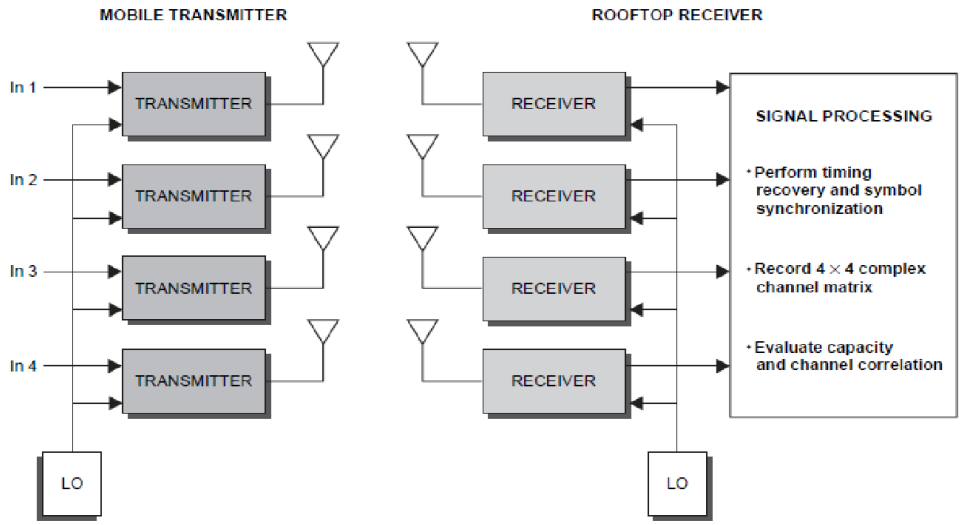
2. **What is the data rate offered by 4G systems?** BTL 1

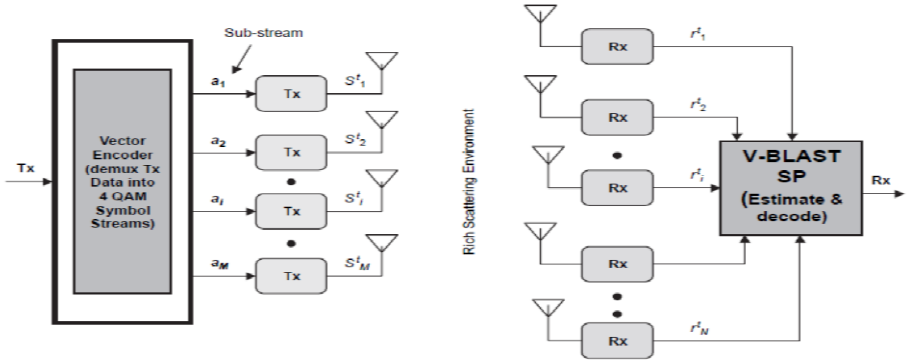
   4G networks operate with higher data rates of 20-100 Mbps in mobile mode.

3. **List the key features of 4G networks from the user point of view. (April 2017)** BTL 1

   - High usability: anytime, anywhere, and with any technology

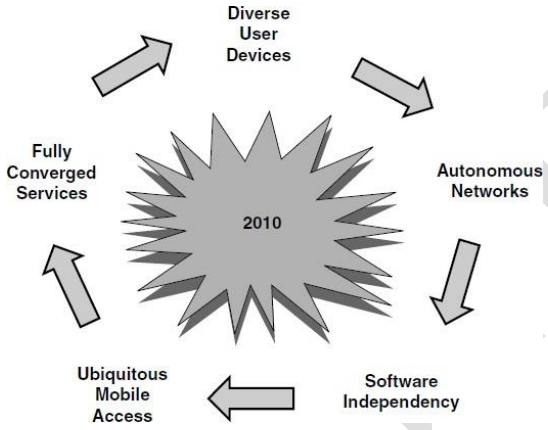
	▪ Support for multimedia services at low transmission cost ▪ Personalization ▪ Integrated services
4.	**Mention the challenges faced by 4G networks (April 2017)** BTL 1 ▪ Limitations in device size ▪ Cost and power consumption, ▪ Backward compatibilities to systems
5.	**What are the applications of 4G technology?** BTL 1 ▪ Virtual navigation ▪ Tele-medicine ▪ Tele-geo-processing applications
6.	**What is multi carrier modulation? Mention its advantages. (April 2017)** BTL 1 MCM is a baseband process that uses parallel equal bandwidth subchannels to transmit information and is normally implemented with fast Fourier transform (FFT) techniques. MCM's advantages are better performance in the inter-symbol-interference environment, and avoidance of single-frequency interferers.
7.	**What are the types of multi carrier modulation?** BTL 1 The types of multi carrier modulation are multicarrier code division multiple access (MC-CDMA) and orthogonal frequency division multiplexing (OFDM) using time division multiple access (TDMA).
8.	**Explain the concept of Multiple Input Multiple Output (MIMO)?** BTL 1 Smart antenna techniques, such as multiple-input multiple-output (MIMO) systems, can extend the capabilities of the 3G and 4G systems to provide customers with increased data throughput for mobile high-speed data applications. MIMO systems use multiple antennas at both the transmitter and receiver to increase the capacity of the wireless channel.
9.	**Give the capacity equation for Single Input Single output (SISO) system.** BTL 1 The channel bandwidth is B, the transmitter power is P_t, the signal at the receiver has an average signal-to-noise ratio of SNR_0, then the Shannon limit on channel capacity C is $C = B \log_2(1+SNR_0)$
10.	**Explain briefly the concept of MIMO-OFDM systems in detail.** BTL 1 OFDM and MIMO techniques can be combined to achieve high spectral efficiency and increased throughput. The OFDM-MIMO system transmits independent OFDM modulated data

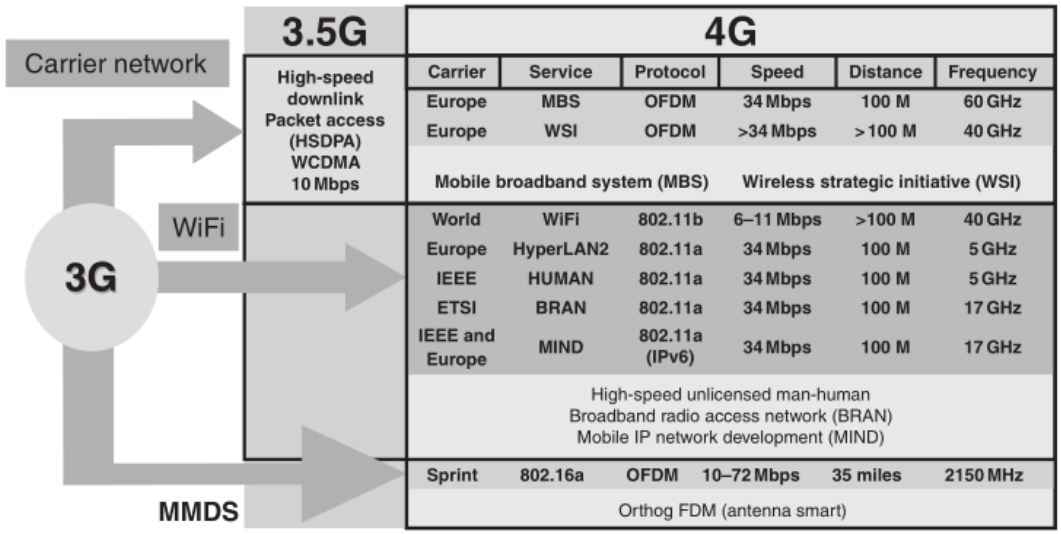
	from multiple antennas simultaneously. At the receiver, after OFDM demodulation, MIMO decodes each sub channel to extract data from all transmit antennas on all the sub channels.
11.	**How efficient packet data transmission can be achieved in 4G networks?** BTL 1 Efficient packet data transmission can be achieved by using a suitable automatic repeat request (ARQ) scheme combined with an adaptive modulation and coding system, and a time-slot scheduler that uses channel predictions.
12.	**Explain briefly the concept of Bell Lab Layered Space Time (BLAST) architecture.** BTL 1 BLAST is a space division multiplexing (SDM)-based MIMO system. It provides the best trade-off between system performance (spectral efficiency and capacity) and system implementation complexity. The spectral efficiency of BLAST ranges from 20 to 40 bps/Hz. It uses a zero-forcing (ZF) nonlinear detection algorithm based on a spatial nulling process combined with symbol cancellation to improve system performance. The BLAST exploits multipath by using scattering characteristics of the propagation environment to enhance transmission accuracy.
13.	**Sketch the block diagram of MIMO system.** BTL 3 
14.	**What is Software Defined Radio (SDR)?** BTL 1 A software-defined radio (SDR) system is a radio communication system which uses significant amounts of signal processing in a general-purpose computer, or a reconfigurable piece of digital electronics.
15.	**List out the features of 4G networks?** BTL 3 ▪ Fully converged services ▪ Software independency ▪ Diverse user devices ▪ Autonomous networks

16.	**Sketch the architecture of BLAST system.** BTL 1 
17.	**Mention the hardware components of Software Defined Radio?** BTL 1 The hardware of a software-defined radio typically consists of a super heterodyne RF front end which converts RF signals from and to analog RF signals, and analog to digital converters and digital to analog converters which are used to convert digitized intermediate frequency (IF) signals from and to analog form respectively.
18.	**List out the various advantages of SDR technology.** BTL 1 ▪ Software-defined radios can be quickly and easily upgraded with enhanced features. In fact, the upgrade could be delivered over-the-air. ▪ Software-defined radios can talk and listen to multiple channels at the same time.
19.	**What is Cognitive Radio? Mention any one application.** BTL 1 The CR can be viewed as an enabling technology that will benefit several types of users by introducing new communications and networking models for the whole wireless world, creating better business opportunities for the incumbent operators and new technical dimensions for smaller operators, and helping shape an overall more efficient approach regarding spectrum requirements and usage in the next generation wireless networks. **Application:** Spectrum Sensing
20.	**Explain services provided by 4G?** BTL 1 4G systems will provide not only telecommunications services, but also data and multimedia services. To support multimedia services, high-data-rate services with system reliability will be provided. Personalized service will be provided by 4G networks. It is expected that when 4G services are launched, users in widely different locations, occupations, and economic classes will use the services.
	PART – B
1.	**Explain in detail, the 4G vision, features and challenges of 4G with applications. (13M)** BTL 2

Some key features (primarily from users' points of view) of 4G mobile networks are as follows: (4M)

- High usability: anytime, anywhere, and with any technology
- Support for multimedia services at low transmission cost
- Personalization
- Integrated services





Reference: Presentation notes taken from presentation by Carl Burnett, for Spring Standards and Protocols Class, June 2002

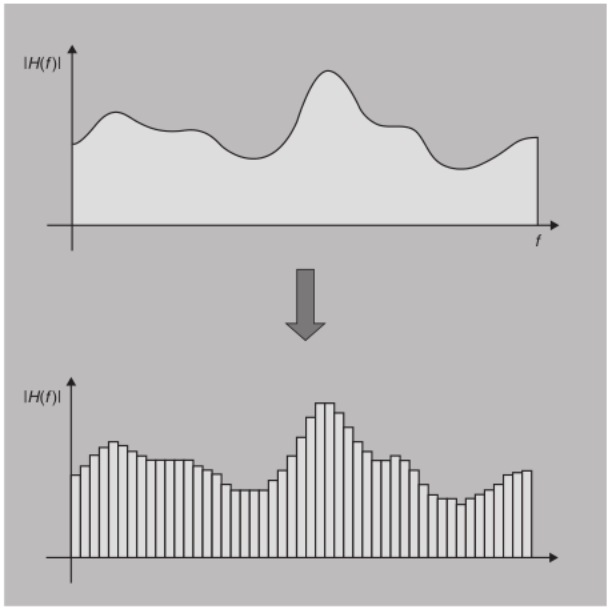
4G key challenges and their proposed solutions (5M)

Applications of 4G (4M)

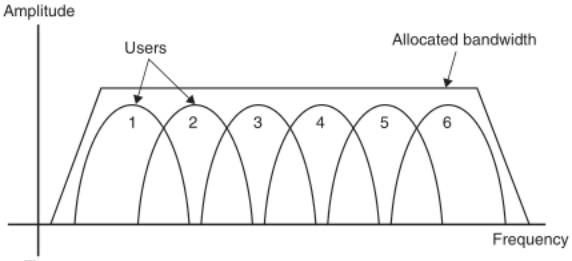
2. **Explain the various technologies used in 4G. (13M)** BTL 1

Multicarrier Modulation (13M)

$$D(dB) = 10 \log N$$



A broadband channel divided into many parallel narrowband channels



Overlapping subchannels

3. **Write short notes on (13M)** BTL 1

(i) SISO (ii)SIMO (iii) MISO (iv) MIMO

Single-input, single-output: (3M)

$$C = B \log_2 (1 - SNR0)$$

Single-input, multiple-output: (3M)

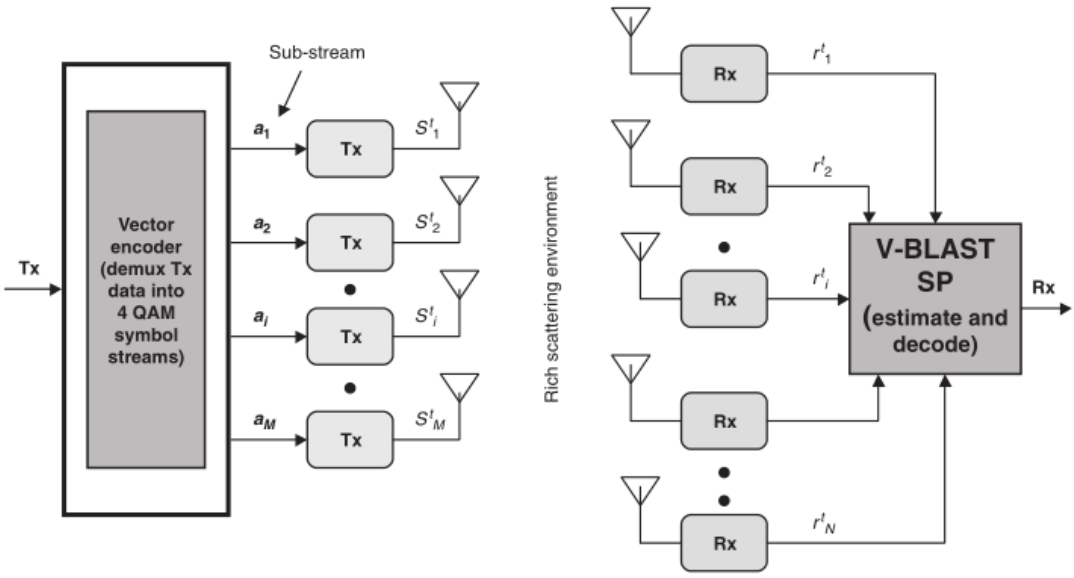
$$\text{SNR} \approx \frac{N^2 \times (\text{signal power})}{N \times (\text{noise})} = N \times \text{SNR}_0$$

$$C \approx B \log_2 (1 + N \times \text{SNR}_o)$$

Multiple-Input, Single-Output(MIMO) (3M)

$$\text{SNR} \approx \frac{M^2 \times [(\text{signal power})/M]}{\text{noise}} = M \times \text{SNR}_0$$

Multiple-Input, Multiple-Output(MIMO) (4M)

	$$C \approx B \log_2 (1 + N \times M \times SNR_o)$$ $$C_{single} \approx B \log_2 (1 + (N/M) \times SNR_o)$$ $$C \approx MB \log_2 (1 + (N/M) \times SNR_o)$$
4.	**Explain Adaptive Modulation and Coding with Time-Slot Scheduler. (13M)** BTL 1 • In general, TCP/IP is designed for a highly reliable transmission medium in wired networks where packet losses are seldom and are interpreted as congestion in the network. • Efficient packet data transmission using TCP in 4G. • Use a suitable automatic repeat request (ARQ) scheme combined with an adaptive modulation and coding system, and a time-slot scheduler that uses channel predictions. • The time-slot scheduler shares the spectrum efficiently between users while satisfying the quality-of-service (QoS) requirements.
5.	**Explain in detail about Bell Labs Layered Space Time (BLAST) System. (13M)** BTL 1 BLAST is a space-division multiplexing (SDM)-based MIMO system. It provides the best trade-off between system performance (spectral efficiency and capacity) and system implementation complexity. (3M)  *Architecture of the BLAST system* • Transmitter (5M)

	• Receiver (5M) • Model • Signal Processing Algorithm • Implementation
	PART – C
1.	**Explain Software Defined Radio in detail. (15M)** BTL 1 A software-defined radio (SDR) system is a radio communication system which uses software for the modulation and demodulation of radio signals. An SDR performs significant amounts of signal processing in a general-purpose computer, or a reconfigurable piece of digital electronics. *SDR Characteristics* (13M)
2.	**Write short notes on Cognitive Radio. (15M)** BTL 2 • With the CR paradigm, spectrum can be efficiently shared in a more flexible fashion by a number of operators/users/systems. (13M) • The CR can be regarded as an extension of SDR. • Most of the research work currently is focusing on spectrum-sensing cognitive radio particularly on the utilization of TV bands for communication. • It is possible to implement CR features — The ability to detect and avoid (protect) incumbent users — While using relatively conventional radio transmitter/receiver architectures and techniques. The goal of CR: relieve radio spectrum overcrowding (2M)

GE6075 Professional Ethics in Engineering L T P C
3 0 0 3

Objectives:

- To enable the students to create an awareness on engineering ethics and human values, to instill moral and social values and loyalty and to appreciate the rights of others.

Unit I Human Values 10

morals, values and ethics – integrity – work ethic – service learning – civic virtue – respect for others – living peacefully – caring – sharing – honesty – courage – valuing time – cooperation – commitment – empathy – self-confidence – character – spirituality – introduction to yoga and meditation for professional excellence and stress management.

Unit II Engineering Ethics 9

senses of 'engineering ethics' – variety of moral issues – types of inquiry – moral dilemmas – moral autonomy – Kohlberg's theory – gilligan's theory – consensus and controversy – models of professional roles – theories about right action – self-interest – customs and religion –uses of ethical theories.

Unit III Engineering as social experimentation 9

Engineering as experimentation – engineers as responsible experimenters – codes of ethics – a balanced outlook on law.

Unit IV Safety, responsibilities and rights 9

Safety and risk – assessment of safety and risk – risk benefit analysis and reducing risk – respect for authority – collective bargaining – confidentiality – conflicts of interest – occupational crime – professional rights – employee rights – intellectual property rights (IPR) – discrimination.

Unit V Global issues 8

Multinational corporations – environmental ethics – computer ethics – weapons development engineers as managers – consulting engineers – engineers as expert witnesses and advisors – moral leadership –code of conduct – corporate social responsibility.

Total: 45 Periods

Outcomes:

Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

Text Books:

1. Mike W. Martin and Roland Schinzinger, "Ethics In Engineering", Tata Mcgraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall Of India, New Delhi, 2004.

References:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard And Michael J. Rabins, "Engineering Ethics – Concepts And Cases", Cengage Learning, 2009.
3. John R Boatright, "Ethics And The Conduct Of Business", Pearson Education, New Delhi, 2003
4. Edmund G Seebauer And Robert L Barry, "Fundamentals Of Ethics For Scientists And Engineers", Oxford University Press, Oxford, 2001.
5. Laura P. Hartman And Joe Desjardins, "Business Ethics: Decision Making For Personal Integrity And Social Responsibility" Mc Grawhill Education, India Pvt. Ltd.,New Delhi, 2013.
6. World Community Service Centre, ' Value Education', Vethathiri Publications, Erode, 2011

SUB CODE: GE6075 SUB NAME: PROFESSIONAL ETHICS IN ENGINEERING

SUBJECT HANDLER: S.Mary Cynthia YEAR /SEM: IV/08

	UNIT –I HUMAN VALUES
	Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.
Q.NO	**PART * A**
1	**What are human values?**BTL2 Values decide the standard of behavior. Some universally accepted values are freedom justice and equality. Other principles of values are love, care, honesty, integrity, self-respect.
2	**Define ethics. What are ethical values?(MAY-JUNE 2016) (NOV-DEC 2015)** BTL2 the philosophical study of the moral value of human conduct and of the rules and principles that ought to govern it. Trustworthiness, respect, responsibility, fairness, caring is ethical values
3	**Distinguish values from ethics and culture. (MAY-JUNE 2016)** BTL4 Values are mainly related to individuals and since they are related to justice, they remain the same for everyone. E.g. Truth, honesty, empathy, self respect. Values do not change from individual to individual. Ethics is common to a group of individuals; the group may be religious or professional. Ethics is mostly based on some code or law and judgment of any action is based on code of conduct or law. Ethics change from individual to individual Culture commonly refers to conduct of a group. e.g system of worship, marriage. It may differ from society to society, nation to nation or religion to religion.
4	**What is integrity? (NOV-DEC2018)** BTL2 Integrity is the unity of character based on moral values. Consistency in attitudes, emotions and conduct in relations to morally justified actions and values are also the part of integrity of individual. It implies honesty, trustworthiness.

5	**What is courage as a value?** BTL2 Courage implies self-respect and governs confrontations with danger and risk. It is not excessive rashes or cowardice, but it is the middle ground. Taking calculated risks and boldness in facing crises are the hallmarks of courage as a human value. It defines the mental makeup of an individual in taking bold decisions even under adverse situations.
6	**Define work ethics.**BTL2 By one's work one cannot harm others. Any worker cannot escape accountability. Worker has the moral responsibility to see that no other person's right, private or freedom is impaired or transgressed.
7	**What is service learning? (APR-MAY 2017)** BTL2 Service learning tells that one has moral responsibility to increase the desirable effects and to decrease the harmful effects. Any service should increase the desirable result.
8	**Mention some civic virtues.** BTL1 Good citizen demand civic virtue. It is the principle of not harming the surroundings .it also includes living peacefully, respect for others, protecting the environment and being normally and ethically good.
9	**Write short notes on caring and sharing.** BTL3 Caring is the essence of moral life. Caring involves feelings, relationship, contends with other persons and protecting others and causing least damage to others. Sharing means sharing of feelings, ideas thoughts, resources and profits. Sharing is always mutually beneficial. Sharing morally acceptable feelings, resources and materials is a value.
10	**Write notes on honesty.** BTL3 Any human being should imbibe honesty-honesty in acts, honesty in speech and honesty in beliefs. Honesty is the fundamental virtue in human relationship even though in may be difficult to follow some times.
11	**Give short notes on co-operation.** BTL1 Co-operation means extending help to others, for a good cause. Co-operation may be through an idea, a suggestion, an assistance or physical work which extends to others for common benefit.
12	**Define empathy.** BTL2 Empathy means putting self in a position of someone else and thinking as the later and reasoning suitable action.
13	**Write a note on Integrity.** BTL2 Integrity is the bridge between responsibility in private and professional life.
14	**What do you mean by Compromise?** BTL2 In a negative sense it means to undetermined integrity by violating one's fundamental moral principles. In a positive sense, however, it means to settle differences by mutual concessions or to reconcile conflicts through adjustments in attitude and conduct.
15	**Give the two aspects of Honesty.(NOV-DEC 2016)** BTL1 Truthfulness – meeting responsibilities concerning truth-telling. Trustworthiness –Meeting responsibilities concerning trust.
16	**Differentiate Self-respect and Self-esteem.** BTL4 Self-respect: It is a moral concept; refers to the virtue properly valuing oneself. Self-esteem: It is a psychological concept; means having a positive attitude toward Oneself, even if the attitude is excessive or otherwise unwarranted.

17	**What are Human values? (NOV –DEC 2016)** BTL2 Values are the rules by which we make decisions about right and wrong, should and shouldn't, good and bad. "Emotional beliefs in principles regarded as particularly favorable or important for the individual." Types of Values: (a) Right conduct, (b) Peace (c) Truth, (d) Love, (e) Nonviolence.
18	**What are the factors that demonstrate a strong work ethic?** BTL2 1 Integrity, 2 Sense of Responsibility 3 Emphasis on Quality 4 Discipline 5 Sense of Teamwork.
19	**List the characteristics of a Good Work Ethic.** BTL1 Reliability, Dedication, Productivity, Cooperation, and Character
20	**State the term called civic virtue.** BTL1 Civic virtues are the moral duties and rights, as a citizen of the village or the country or an integral part of the society and environment. **Civic virtues are divided into four categories**: 1. Civic Knowledge 2. Self-Restraint 3. Self-Assertion 4. Self-Reliance
21	**Give short notes on Respect for others.** BTL1 Respect is a positive feeling of admiration or deference for a person. Respect can be a specific feeling of regard for the actual qualities of the one respected. It can also be conduct in accord with a specific ethic of respect. Treating people with respect makes your world a nicer place to live in, whether it's at home, at school, or out in your community. Don't insult people or make fun of them.
22	**Write a note on living peacefully.** BTL3 To live peacefully, one should start install peace within (self). Charity begins at home. Then one can spread peace to family, organization where one works, and then to the world, including the environment. Only who are at peace can spread peace. You cannot gift an article which you do not possess. The essence of oriental philosophy is that one should not fight for peace. It is oxymoron. War or peace can be won only by peace, and not by wars.
23	**Write short notes on various terms Self- Confidence, Character and Spirituality.** BTL3 **(May/June 16)(NOV-DEC2018) (NOV-DEC 2015)** **Self- Confidence**: Certainty in one's own capabilities, values, and goals. These people are usually positive thinking, flexible and willing to change. They respect others so much as they respect themselves. **Character**: To determine the ideals. **Spirituality:** Spirituality is a way of living that emphasizes the constant awareness and recognition of the spiritual dimension (mind and its development) of nature and people, with a dynamic balance between the material development and the spiritual development.
24	**Define moral values. (APR- MAY 2017) (APR- MAY 2015) (NOV-DEC 2015)**BTL2 Moral value is value that must be separated with other values. Every value will get quality if it has relation with other values. For example, Honesty is example of moral values; this value

<table>
<tr><td></td><td>has no meaning if it does not be applied with other values. Economic Value is relation of human and thing. Thing is needed because its usefulness. Economic Value relate with purpose value. Loyalty is moral value, but it must be applied with other, humanity value for general, for example, love of husband and wife.</td></tr>
<tr><td>25</td><td>Define spirituality. (NOV-DEC 2015)BTL2
, “Spirituality is often experienced as a source of inspiration or orientation in life. It can encompass belief in immaterial realities or experiences of the immanent or transcendent nature of the world.”</td></tr>
<tr><td>26</td><td>Difference between Mortality and Ethics. [Dec 2012] BTL4
<table>
<tr><td>Mortality</td><td>Ethics</td></tr>
<tr><td>Based on customs and tradition.</td><td>It is a critical reflection of moral</td></tr>
<tr><td>Concerned with wrong action when done</td><td>Concerned with right action when not</td></tr>
<tr><td>Top Priority is given because damage is</td><td>Less priority & less serious</td></tr>
<tr><td>Example: corruption and crime</td><td>Example: belief about manners</td></tr>
</table></td></tr>
<tr><td></td><td>PART * B</td></tr>
<tr><td>1</td><td>Explain some important human values. (13M) (April 2014) BTL2

Answer Page.no.0.1 to 0.2 - V.Jayakumar

Important human values :(9 M)
The five core human values are: (1) Right conduct, (2) Peace, (3) Truth, (4) Love, and (5) Nonviolence.
1. values related to right conduct are:
(a) Self-help skills: care of possessions, diet, hygiene, modesty, posture, self reliance, and tidy appearance
(b) Social skills: good behavior, good manners, good relationships, helpfulness, no wastage, and good environment.
(c) Ethical skills: code of conduct, courage, dependability, duty, efficiency, ingenuity, initiative, perseverance, punctuality, resourcefulness, respect for all, and responsibility.
2. Values related to peace are: attention, calmness, concentration, contentment, dignity, discipline, equality, equanimity, faithfulness, focus, gratitude, happiness, harmony, humility, inner silence.
3. Values related to truth are: accuracy, curiosity, discernment, fairness, fearlessness, honesty, integrity (unity of thought, word, and deed), intuition, justice.
4. Values related to love are: acceptance, affection, care, compassion, consideration, dedication, devotion, empathy, forbearance, forgiveness, friendship, generosity.
5. Values related to non-violence are:
(a) Psychological: benevolence, compassion, concern for others, consideration , forbearance, forgiveness, manners, happiness, loyalty, morality, and universal love
(b) Social: appreciation of other cultures, religions, brotherhood, care of environment, citizenship, equality, harmlessness,</td></tr>
</table>

	c) Perseverance persistence, determination, resolution, tenacity, dedication, commitment, constancy, steadfastness, stamina, endurance and indefatigability. d) Accuracy means freedom from mistake or error; conformity to truth or to a standard or model and exactness. e) Discernment means discrimination, perception, penetration, and insight. Discernment, powers to see not obvious to average mind. Stresses accuracy, especially in reading character, motives. **Evolution of Human Values: (4 M)** The human values evolve because of the following factors: 1. The impact norms of the society, fulfillment of the individual's needs or desires. 2. Developed or modified one's own awareness, choice, and judgment in fulfilling the needs. 3. By the teachings and practice of Preceptors (Gurus) or Saviors or religious leaders. 4. Fostered or modified by social leaders, rulers of kingdom, and by law (government).
2	**Write a detailed note on work ethics. Problems exist in the industrial/business scenario(13 M)** BTL3 **Answer Pg.no.0.1 to 0.2 - V.Jayakumar** **DEFINITION:(2 M)** Work ethics is defined as a set of attitudes concerned with the value of work, which forms the motivational orientation. The 'work ethics' is aimed at ensuring the economy productivity , safety , health and hygiene, privacy , security , cultural and social development (leisure, hobby, and happiness), welfare (social work), environment (anti-pollution activities), and offer opportunities for all, according to their abilities, but without discrimination. **ELEMENTS OF A STRONG WORK ETHIC: (6 M)** **1. Interpersonal skill:** It include the habits, attitude, manners, appearance and behaviors which affect how we get along with other people **2. Initiative:** Without initiative procrastination and missed opportunities can become problem. **3. Professionalism** Being professional involves everything, how you dress and present yourself in business world, way you treat others. **4. Accountability** Take personal responsibility, actions and out comes, every situation. Mistakes taken as learning experiences, ability to always better, must be upholder.

	5. Respectfulness Serving a customer, meeting with a client or collaborating with colleagues, do best respect everyone's opinions, especially under difficult circumstances. Value people's individual worth, their professional contributions. **6. Dedication** Don't stop until job done, and done right. Fully dedicated, to strive, to achieve, best results alongside putting extra hours,get things right. **7. Determination** Don't let obstacles stop, enthusiastically embrace challenges, job as an entrepreneur solve clients' problems. **8. Humility** Acknowledge everyone's contributions, and freely share credit accomplishments. Gratitude to colleagues who work hard, and appreciation to loyal clients. 9.**Dependability** Relates closely to when always on time and prepared for meetings. The ability to deliver work on time. **Many complex social problems exist in the industrial/business scenario, because: (5 M)** 1. Desire to be recognized as individuals and treated dignity, living human beings. 2. Work intrinsically valuable, enjoyable or meaningful in allowing personal expression and self-fulfillment. 3. Meaningful work , sense of personal identity and the self-esteem 4. Work, major instrumental good in life. 5. main source providing income needed to avoid economic dependence , 6. Pay, pace of work be in commensurate with the expertise required, acquired, utilized in persons. 7. Privacy of employee, including women, protected. 8. Security during job upon retirement, accepted, government jobs, public limited companies, corporate organizations. 9. Recognition non-work activities, leisure, paid holiday day, visit, dignitary, social service, developmental activities. 10. Hard work, productivity essential success industry. 11. Hard labor, undignified jobs, hazardous jobs, made less straining, dignified, safer. 12. Employee alienation, Absence of or inadequate 'recognition and reward system' and 'grievance redressal system', lack of transparency policy implementation, factions trade unions etc. 13. A different view of work ethics: Work is considered as a necessary evil. 14. Protestant Work Ethics, the financial success sign, favored by God. 15. Obtaining desired materials and services, achieving status and recognition others. 16. Exploitation and bargained pay should be discouraged. 17. Confidentiality of employer to be protected. 18. The quality of work life deserves to be improved. 19. Lead to ethical problems, affecting the work ethics.
3	**Explain integrity and honesty in ethics. (13 M) (NOV-DEC 2015) (NOV-DEC 2016)** BTL2 **Answer: Page No:190 - Mike W. Martin** **Answer Pg.no:0.9 to0.10 - V.Jayakumar** **Integrity: (6 M)**

	1. Integrity defined unity of thought, word, deed, open mindedness. 2. Capacity to communicate factual information, others make well-informed decisions. 3. Yields, person's 'peace of mind', hence add strength and consistency in character, decisions, and actions. 4. Paves way to one's success. 5. Enthuse people, not only execute job well, and achieve excellence in performance. 6. To own the responsibility, earn self-respect, recognition by doing job. 7. Moral integrity defined as a virtue **8.** Reflects consistency of one's attitudes, emotions, and conduct in relation to justified moral values**.** 9. I self-direction virtues **Honesty:(7 M)** Honesty is a virtue, and it is exhibited in two aspects namely, (1) **Truthfulness** i. Truthfulness faces the responsibilities upon telling truth. ii. One should keep one's word or promise. iii. By admitting one's mistake committed, it is easy to fix them. iv. Reliable engineering judgment, maintenance of truth, defending the truth, and communicating the truth, 'good' to others, (2) **Trustworthiness.** i) Trustworthiness, maintaining integrity and taking responsibility, personal performance. ii) right way to win, according to the laws or rules (legally and morally). iii. Build trust through reliability and authenticity. iv. Admit their own mistakes and confront unethical actions in others and take tough and principled stand, even if unpopular. v. Honesty is mirrored in many ways. Vi.People abides by law and lives by mutual trust. The common reflections are: (a) Beliefs (intellectual honesty). (b) Communication (writing and speech). (c) Decisions (ideas, discretion). (d) Actions (means, timing, place, and the goals). And (e) Intended and unintended results achieved.
4	**Explain the characteristics and importance of self confidence in ethics. (13M) (MAY-JUNE 2016)** BTL2 **Answer: Pg.no.0.29 - V.Jayakumar** **SELF-CONFIDENCE:** (3 M) 1. Certainty in one's own capabilities, values, and goals, self-confidence. 2. People usually positive thinking, flexible, willing to change. 3. Respect others so much as they respect themselves. 4. Self- confidence positive attitude, individual has some positive and realistic view, with respect to the situations, which one gets involved. 5. The people with self-confidence exhibit courage to get action and unshakable faith, abilities, whatever their positions. 6. Not influenced by threats, challenges and prepared to face the, natural or unexpected consequences. 7. The self- confidence person develops a sense of partnership, respect, and accountability,

	8. Helps organization, obtain maximum ideas, efforts, and guidelines from employees. **The people with self- confidence have the following characteristics: (4 M)** 1. A self-assured standing, 2. Willing to listen to learn from others and adopt (flexibility), 3. Frank to speak the truth, and 4. Respect others' efforts and give due credit. On the contrary, some leaders expose others when failure occurs, and own the credit when success comes. **The factors that shape self-confidence in a person are:(3 M)** 1. Heredity (attitudes of parents) and family environment (elders), 2. Friendship (influence of friends/colleagues), 3. Influence of superiors/role models, and 4. Training in the organization (e.g., training by Technical Evangelists at Infosys Technologies). **The following methodologies are effective in developing self-confidence in a person(3 M)** 1. Encouraging SWOT analysis. Evaluating their strength and weakness, anticipate and be prepared to face the results. 2. Training to evaluate risks and face them (self-acceptance). 3. Self-talk, conditioning mind for preparing self to act, without any doubt on his capabilities. 4. Make one accepts himself while striving for improvement. 5. Study, group discussion, on the history of leaders and innovators
5	**Discuss the importance time wasters. How can one manage time properly? (13 M)** BTL1 **Answer: Pg.no.0.24 to 0.25 - V.Jayakumar** **INTRODUCTION:(2 M)** Time is rare resource. Once spent, lost forever. Cannot be either stored or recovered. Time is the most perishable and most valuable resource too. Resource continuously spent, whether any decision or action is taken or not. History of great reformers and innovators, stressed, importance of time and valuing time. Time management: It is the rational way to ensure that our limited time is always used effectively. **Identifying time wasters: (3M)** Unscheduled and scheduled meetings Lack of adequate meetings Poor delegation Too much socializing Ineffective communication Lack of goal objectives Poorly organized supervision Poor use of telephone **Time management principle:(5M)** 1.clear objectives 2.prioritize tasks 3.stick to scheduled tasks

	4.Allow time to manage your time 5.The unexpected 6.Managing time wasters **An anecdote to highlight the 'value of time' is as follows:(3 M)** 1. To realize, value of one year, ask student who failed in the examinations; 2. To realize, value of one month, ask mother who delivered premature baby; 3. To realize, value of one week, ask editor of weekly; 4. To realize the value of one day, ask daily-wage laborer; 5. To realize, value of one hour, ask the lovers longing to meet; 6. To realize, value of one minute, ask person who missed train; 7. To realize value of one second, ask person who survived an accident; 8. To realize, value one Milli second, ask person who won the bronze medal in Olympics; 9. To realize value of one micro second, ask NASA team of scientists; 10. To realize value of one nano-second, ask a Hardware engineer!; If you have still not realized the value of time, wait; are you an Engineer?
6	**Discuss the concept of Caring, Sharing And Living Peacefully in detail. (13 M)** BTL2 **Answer: Page .no. 0.19 and 0.20 and 0.18 - V.Jayakumar** **Caring: (4 M)** 1. Caring, feeling for others. 2. A process which exhibits interest, support, the welfare of others with fairness, impartiality, justice all activities, employees, context of professional ethics. 3. Respect to feelings of others, respecting, preserving interests of others concerned. 4. Caring reflected in activities- friendship, membership in social clubs and professional societies, through various transactions in family, fraternity, community, country and in international councils. 5. In present day context, caring for environment, necessity for our survival. 6. Do not care environment, environment scare us. **SHARING: (4M)** 1. Primarily, caring influences 'sharing'. 2. Transfer of knowledge, experience, commodities, facilities with others. 3. Transfer genuine, legal, positive, voluntary, without expectation in return. 4. Proprietary information, not be shared with outsiders. 5. Process of sharing, experience, expertise, wisdom benefits reach more people faster. 6. Sharing voluntary, cannot be driven by force, 7. Motivated successfully through ethical principles. 8. sharing is 'charity' For humanity, 9. 'Sharing' a culture. 10. 'Happiness, wealth' multiplied 'crimes sufferings' reduced, by sharing. 11. Paves way for peace obviates militancy. 12. Philosophically, the sharing maximizes happiness for all human beings.

	13. Psychologies, fear, divide, and distrust between 'haves' 'have-nots' disappear. **LIVING PEACEFULLY:(5 M)** 1. To live peacefully, start install peace within. 2. Charity begins at home. 3. Then one can spread peace to family, organization where one works, and then to the world, including the environment. 4. Only who are at peace can spread peace. 5. You cannot gift an article which you do not possess. 6. Essence, oriental philosophy, one should not fight for peace. 7, It is oxymoron. War or peace, won by peace, and not by wars! One should adopt the following means to live peacefully, in the world: 1. Order in one's life 2. Pure thoughts in one's soul 3. Creativity in one's head. 4. Beauty in one's heart

	Explain commitment and empathy. (13 M) BTL2 **Answer: Pg.no.0.28 -V. Jayakumar** **Commitment:(5 M)** 1. Commitment means acceptance, responsibilities, duties, cooperation means help assistance. 2. By developing team commitment and cooperation in a work team assisting team to meet, goals and objectives. 3. Work teams that committed and cooperative more likely to achieve the goals the business has set. **Empathy: (8 M)** 1. Empathy capacity to understand feel another person, experiencing within other being's frame of reference, i.e., capacity, place oneself another's position. 2. Empathy seeing, eyes another, listening ears another feelings heart, another. 3. Many definitions, empathy encompass, broad range of emotional states. 4. Types of empathy cognitive empathy, emotional empathy, and somatic empathy. 5. Development human empathy, individual differences appear, ranging. no apparent empathic ability, empathy, harmful, self others 6. To well-balanced empathy, ability to distinguish between self other. **Daniel Goleman identified five key elements of empathy.** 1. Understanding Others. 2. Developing Others. 3. Having a Service Orientation. 4. Leveraging Diversity. 5. Political Awareness.
8	**Explain character and spirituality and their Importance in ethics.(13M)(MAY-JUNE 2016)** BTL2 **Answer: Pg .no.0.32 - V. Jayakumar** **INTRODUCTION: (4 M)** 1.Spirituality way of living emphasizes constant awareness recognition spiritual 2. Dimension, nature people, dynamic balance between material development, spiritual developments. 3. Great virtue of Indian philosophy for Indians. 4. Sometimes, spirituality includes faith, belief in supernatural power/ God,

	regarding worldly events. 5. Functions fertilizer for soil 'character' to blossom into values morals. **Spirituality in Workplace: (9 M)** Building spirituality in workplace: Spirituality promoted workplace by adhering to following activities: 1. Verbally respect individuals as humans recognize, values in all decisions actions. 2. Get to know people with whom you work know what important 3. Know goals, desires, and dreams too. 4. State your personal ethics your beliefs clearly. 5. Support causes outside business. 6. Encourage leaders to use value-based discretion, making decisions. 7. Demonstrate own self-knowledge spirituality in all actions. 8. Do unto others as you would have m do unto you.
9	**Briefly explain terms Values, Morals & Ethics. (13M)** BTL2 **Answer: Pg. no.0.4 - V. Jayakumar** **Morals: (4 M)** **Morals** principles on which one's judgments of right, wrong based. Morals refer to beliefs what not objectively right, but what considered right for situation What morally correct, not be objectively correct. Some moral principles : 1. Do not cheat 2. Be loyal 3. Be patient 4. Always tell truth 5. Be generous **Ethics: (6 M)** 1. Ethics principles of right conduct. . 2. main difference, morals more abstract, subjective, often personal or religion-based, 3. Ethics more practical conceived principles promoting fairness, social business interactions. Some ethical principles : 1. Truthfulness 2. Honesty 3. Loyalty 4. Respect 5. Fairness 6. Integrity **Values: (3 M)** **Values —**things have an intrinsic worth in usefulness or importance to possessor, or principles, standards, qualities considered worthwhile, desirable. 1. Tend to think of a value as something good, virtually all values morally relative neutral, really qualified by asking, –How it good? –Good to whom? 2. –good sometimes just a matter of opinion, taste, driven by culture, religion, habit, circumstance, environment, etc.

10	**What is integrity? Explain number of accounts viewed under integrity. What are the salient features of courage? (13 M)** BTL2 **Answer: Pg.no.0.10 - V.Jayakumar** **MEANING: (2M)** 1. Integrity elementary value for profession. 2. Important for all who exhibit strong moral ethical principles. 3. Deals exhibiting fairness honesty, all professional, personal relations. 4. Personal choice which uncompromising under any kind of circumstances. **Number of accounts viewed under integrity. (7M)** **1. Integrity as self-integration** • Establishes a formal relation to self people integrate different facets of ir personality to an intact whole. • Mainly a matter of keeping oneself totally intact uncorrupted. **2. Integrity as identity** • Commitment, one makes, oneself, people, relations, institutions, traditions culture etc. **3. Integrity as sting for something** • Self-integration identity sees integrity, matter of personal choice. • Person, high integrity, consistent endorsements, takes something within community. • Integrity considered, proper regard, role community process deliberation over valuable worth doing. **4. Integrity as purpose** • Places moral checks on kinds, commitments person of integrity must honor. • Integrity, morally correct despite, substantial moral disagreement, some issues with section of society. **5. Integrity as-Individual, Professional Institutional** • Integrity forms building block, ethical conduct competency. • Three different levels essential for an individual's professional survival. 1.Personal integrity Accountability for personal actions conducting personal relationships fairly honestly. 2.Professional integrity Professional duties obligations complete honesty in conformity, professional code of ethics. 3.Institutional integrity • Wider concept driven by mission--vision statements of an organization, established code of conduct procedures. • Ethical conduct throughout organization through personal example, management practices ethical training. **The salient features of courage:(4 M)** **a)**Moral courage b)Physical courage
	PART * C
1	**Distinguish values from ethics. (15M)** BTL4 **Answer: Pg.no.0.11 - V.Jayakumar** **Values: (2 M)**

- Values can be defined as those things that are important to or valued by someone.
- That someone can be an individual or, collectively, an organization.
- One place where values are important is in relation to vision.
- One of the imperatives for organizational vision is that it must be based on and consistent with the organization's core values.

Ethics: (3 M)

At its simplest, ethics is a system of moral principles. They affect how people make decisions and lead their lives.

Ethics is concerned with what is good for individuals and society and is also described as moral philosophy.

The term is derived from the Greek word *ethos* which can mean custom, habit, character or disposition.

Ethics covers the following dilemmas:

- How to live a good life
- Our rights and responsibilities
- The language of right and wrong
- Moral decisions - what is good and bad?

Explanation: (10 M)

Comparison Chart:

BASIC COMPARISON	ETHICS	VALUES
MEANING	Ethics refers to the guidelines for conduct, that address question about morality.	Value is defined as the principles ideals that helps them in making judgment of what is more importa
WHAT ARE THEY?	System of moral principles.	Stimuli for thinking.
CONSISTENCY	Uniform	Differs from person to person
TELLS	What is morally correct or incorrect, in the given situation?	What we want to do or achieve.
DETERMINES	Extent of rightness or wrongness of our options.	Level of importance.
WHAT IT DOES	Constrains	Motivates

2	**Briefly explain the importance of Yoga and meditation for successful life. (15M) (NOV-DEC 2015) (NOV-DEC 2016) (Nov/Dec2013)** BTL2

Answer: Refer notes

Yoga:(2M)

Yoga is a type of exercise in which you move your body into various positions in order to become more fit or flexible, to improve your breathing, and to relax your mind.

Yogic exercise recharge body with cosmic energy facilitates: (3M)

1. Attainment of perfect equilibrium harmony
2. Promotes self- healing.
3. Removes negative blocks from mind toxins from body
4. Enhances personal power
5. Increases self-awareness
6. Helps in attention, focus concentration, especially important for children
7. Reduces stress tension physical body ,activating nerve system

Importance of Yoga (4M)

1. Yoga for all-round fitness
2. Yoga for weight loss
3. Yoga for stress relief
4. Yoga for inner peace
5. Yoga to improve immunity
6. Yoga to live with greater awareness
7. Yoga for better relationships
8. Yoga to increase energy
9. Yoga for better flexibility & posture
10. Yoga to improve intuition

Meditation:(2M)

Meditation is a precise technique for resting the mind and attaining a state of consciousness that is totally different from the normal waking state. It is the means for fathoming all the levels of ourselves and finally experiencing the centre of consciousness within.

Importance of Meditation: **(4 M)**

- Focused attention
- Relaxed breathing
- Gives a sense of calm
- Gaining new perspective on stressful situation
- Increasing self awareness
- Reducing negative emotions

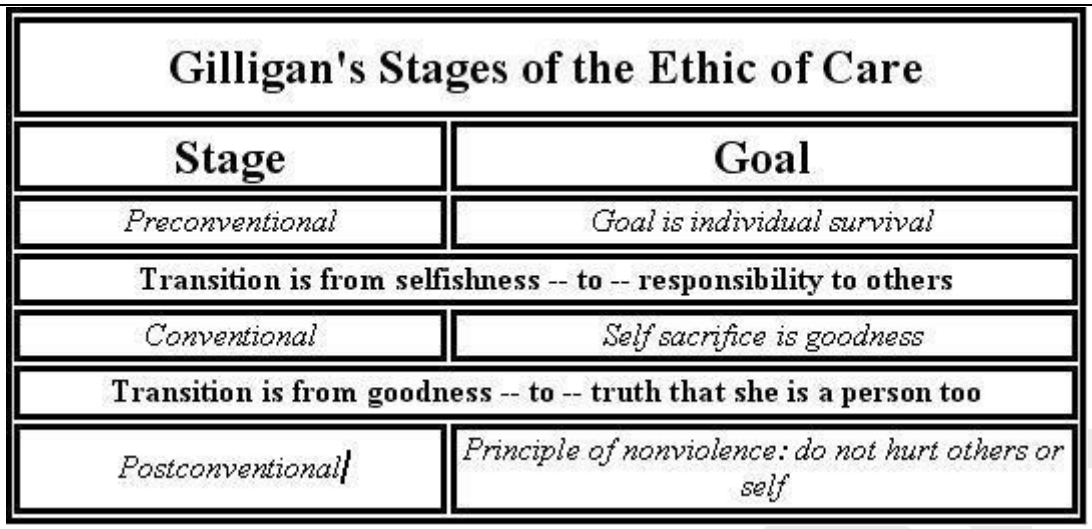
3	**Explain the need of stress management in detail. (15M) (April / May2017) (NOV-DEC 2015)** BTL2 **Answer: Refer Notes**. **INTRODUCTION: (3 M)** i. We all react differently to stress. ii. Based on available resources skills, you decide whether a situation stressful to you. iii. might become aggressive take your stress out on your loved ones or colleagues whilstors hold it in rare use escape techniques such as eating disorders or substance abuse, which ultimately more destructive. **Cause of stress:** a. constantly irritable or having sleep problems b. Snappy short fused c. Feeling anxious or depressed d. Excessively eating, drinking or smoking e. High, cholesterol, high blood pressure, eczema or skin problem f. Struggle with concentration, feeling unmotivated or insecure g. insecure feelings about money, your employment or your relationship **NEED FOR STRESS MANAGEMENT:(12 M)** **1. Set daily goals.** It important to set goals for before going to work next day. Setting specific daily goals for business, help stay focused, saving time money long run. **2. Delegate.** Delegate your business family responsibilities. If your job, delegate some of your responsibilities to qualified employees. **3. Prioritize your tasks.** Determine what needs done right away do those particular task order importance. That way, you won't be constantly worrying about completing se vital projects can relax after complete. **4. Communicate.** Don't waste your time assuming that certain people will do what y need to do. Talk to your co-workers your family so that everybody on same page. Can not only save you a lot of time but also will reduce your stress level. **5. Prepare for unexpected events.** Sometimes certain events may happen that might take everyone by surprise. Be flexible when unexpected events, deal immediately. **6. Don't procrastinate.** Do not put things off when you can do m today. An entrepreneur, important, staff, family members' complete tasks in a timely manner. **7.Reduce any potential conflicts.** When a potential problem starts to develop with workers or family members, try to find a solution immediately. Do not let potential conflicts drag on from one week to next. Use your problem-solving skills to prevent any arguments. **8.Get help if you need it.**

	Sometimes a person might need to speak to a counselor or take some educational classes in time management.

	UNIT II ENGINEERING ETHICS
	Senses of "Engineering Ethics" – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles – Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.
	PART * A
1	**Define moral Dilemma. (MAY/JUNE 2012)** BTL2 Dilemmas are certain kind of situations in which a difficult choice has to be made. Moral dilemmas can also be called moral problems. Moral Dilemmas have two or more folding's- moral obligations, duties, rights, goods, or ideals come disagreement with each other.
2	**What are the chief characteristics of a profession? (MAY/JUNE 2012)** BTL2 • It renders an essential social service. • It demands continuous in service training of its members • It involves a code of ethics. • It sets up its own professional organization. • It assures its members a professional career. • It has a truth and loyalty. • It has a transparency of work. • It gives instantaneous results.
3	**Write a note on significance of engineering ethics. (MAY/JUNE 2011)** BTL3 An engineer should have the ability and judgement to refine one's behaviours, decisions and actions in performing the duty to the family, organization and to the society. An engineer needs to be a free thinker. he needs to be an intellectual who has the proficiency in recognizing moral problems in engineering, comprehend and assess those views from different viewpoints
4	**What is engineering ethics? (MAY/JUNE 2011, MAY/JUNE 2014)** BTL2 Study of the moral issues and decisions confronting individuals and organizations engaged in engineering / profession. Study of related questions about the moral ideals, character, policies and relationships of people and corporations involved in technological activity. Moral standards /values and system of morals.
5	**What is meant by normative inquiry? (MAY/JUNE 2011)** BTL2 Engineering ethics involves normative inquiry in order to aim at identifying and justifying the morally desirable norms or standards that ought to guide individuals or groups. Normative questions include what ought to be? And what is good?
6	**What do you mean by ethical pluralism?(APRIL/MAY 2010)** BTL2 Ethical pluralism is the view that there may be alternative moral perspectives that are reasonable, but no one of which must be accepted completely by all rational and morally concerned persons.
7	**Differentiate Moral and Ethics. (MAY/JUNE 2010)** BTL4 **Moral:** • Refers only to personal behaviour. • Refers to any aspect of human action. • Social conventions about right or wrong conduct**.**

	Ethics: Involves defining, analyzing, evaluating and resolving moral problems and Developing moral criteria to guide human behaviour. Critical reflection on what one does and why one does it. Refers only to professional behaviour.
8	**Write any three uses of ethical theories. (NOV/DEC2010, MAY/JUNE 2014)** BTL3 Ethical theories are very useful in understanding and resolving moral dilemmas. In estimating the professional obligations and ideals. Determine to what extent, the obligations can be exercised in a given situation.
9	**What are the types of Theories about Morality/ Right action? (MAY/JUNE 2009) (NOV-DEC2018)** BTL2 Virtue ethics – Virtues and vices Utilitarianism – Most good for the most people Duty ethics – Duties to respect people Rights ethics – Human rights
10	**State Ethical Egoism. (MAY/JUNE 2009)** BTL1 It deals with self-interest. Each person is the best judge of their own self-interest and is responsible for maximizing their own interest. Egoism preaches selfishness but morality should encourage love, compassion etc.
11	**Differentiate Ethical Relativism and Ethical Egoism. (MAY/JUNE2008)** BTL4 Ethical egoism – the view that right action consist in producing one's own good. Ethical relativism – the view that right action is merely what the law and customs of one's society require**.**
12	**What is moral integrity? (MAY/JUNE2008)** BTL2 Moral integrity is the strength of character on the basis of moral concern and moral values. Integrity is the bridge that links the responsibilities between personal life and professional carrier.
13	**Differentiate profession and professionalism. (NOV/DEC 2008)** BTL4 Profession is a job through which someone makes living. Professionalism covers comprehensively all areas of practice of a particular profession. It requires skills and responsibilities involved in engineering profession.
14	**Give the importance of Lawrence Kohlberg's and Carol Gilligan's theory. (NOV/DEC2008)** BTL1 Kohlberg gives greater emphasis to recognizing rights and abstract universal rules. Gilligan Stresses the importance of maintaining personal relationships based on mutual caring.
15	**What is consensus and controversy?** BTL2 Consensus means agreement and controversy means disagreement. Both plays the vital roles while considering moral autonomy.
16	**What is the relationship between moral autonomy and authority?** BTL2 Moral' autonomy is exercised on the basis of moral concern for other people and recognition of good moral reasons. Authority provides the frame work in which learning can takes place in class room/work place.
17	**What are the concepts of pre-conventional & conventional level in Gilligan's theory?** Carol Gilligan recast the theory of Kohlberg as follows. BTL2 Pre conventional level: Desire to derive benefits for oneself. Right conduct is viewed in a selfish manner as solely what is good for oneself. Conventional level: Here the basic motive is willingness to sacrifice one's own interests and a strong desire to hurt other's interests. Mostly women are always willing to give up their personal interests in order to serve the needs of others.
18	**Define Ethics. Mention some universally accepted ethical standards. (NOV/DEC 13)** BTL2 "Ethics" as the "discipline dealing with what is good and bad and with moral duty and obligation," "a set of moral principles or value" or "a theory or system of moral values." Ethics assists individuals in deciding when an act is moral or immoral, right or wrong. Ethics can be grounded in natural law, religious tenets,

	parental and family influence, educational experiences, life experiences, and cultural and societal expectations. Ethical Standard such as Focus on ethics, Corporate culture, Managerial
19	**Define Professionalism. (APRIL/MAY 2015)** BTL2 Professionalism means behaving in an ethical manner while assuming and fulfilling your rightful responsibilities in every situation every time, without fail. To get a bit more granular, one can say that it means, in part, conducting your affairs in such a way as to engender trust and confidence in every aspect of your work.
20	**Define Moral Autonomy (NOV/DEC2014/2018)** BTL2 Moral autonomy, usually traced back to Kant, is the capacity to deliberate and to give oneself the moral law, rather than merely heeding the injunctions of others. Personal autonomy is the capacity to decide for one self and pursue a course of action in one's life, often regardless of any particular moral content.
	PART * B
1	**What are the stages of moral development according to Gilligan? Discuss it.(13M)(Nov/Dec2006) (Nov/Dec2007) (April/ May2011) (Nov/Dec2012) (Nov/Dec2013)** BTL2 **Answer Page.no:1.17 V.Jayakumar** **INTRODUCTION: (2 M)** • **Carol Gilligan Moral Development Theory Explained** Carol Gilligan moral development theory used, approach to reasoning. Women tended, score lower, scales of morality compared to men. Not agreeing, idea, women morally inferior to men Began, process of interviewing women, make difficult decisions in lives. Process develop a moral development theory, closely associated, women instead, men. **The Three Stages of Gilligan's Moral Development Theory: (6 M)** Gilligan produced, theory, three stages of moral development. • **The Pre-conventional Stage:** Goal of a woman, to survive. Focused on individuality Making sure basic needs been met. Priority to meet others needs. • **The Conventional Stage:** A woman recognizes, self-sacrifice, source "goodness" in life. Finds moral satisfaction, by helping other people Focusing on helping others to survive best way possible. • **The Post-conventional Stage:** "Ends no longer justify the means" to have needs met. A principle of non-violence, applies to every decision. Not wish to hurt or hurt others, looking alternative methods to meet needs. Diagram: (2 M)

	 **Gilligan suggests two transitions that occur during the stages. (2 M)** **The first transition:** • Occurs between the pre-conventional and conventional stages • Moves a woman's moral ethics from selfish to shares a responsibility to care others. **The second transition:** • Occurs between the conventional and post-conventional stages • Moves a woman being focused on "good" to being focused on "truth." • Looking, ways to survive for herself and for others • Begins, look, options fueled, need to stay true to certain moral constants.
2	**Explain the uses of ethical theories. (13M) (Nov/Dec2006)** BTL2 **Answer Page No.:60-66 Mike W. Martin** **The uses of ethical theories.: (13 M)** • Identifying moral considerations, reasons to constitute a dilemma. • Precise sense of information, relevant to solving moral development. • Provide guidance in solving moral problems. • moral ramifications of alternative courses action • Providing systematic framework of comparing alternatives. • Discussing moral issues with colleagues. • By providing frame works development of moral arguments • It strengthens ability to reach balanced and insightful judgments. • Justifying professional obligations and ideas. • 10. Relating ordinary and professional morality.
3	**Explain in detail: (13 M) (Nov/Dec2007)** BTL2 **1. Professional responsibility. Answer Page. no. 2.3 V. Jayakumar** **2. Self- respect. Answer: Page. no. 2.5 & 2.6 V. Jayakumar** **3. Utilitarianism. Answer Page No. 55 Mike W. Martin** **Professional responsibility** : **(6 M)** • The **duties** of attorneys to act in a professional manner • Obey the law, avoid conflicts of interest • Put the interests of clients ahead of their own interests. • Being morally responsible as a professional. **Most basic and comprehensive professional virtue.** **A wide variety of more specific virtues grouped as follows:** • **SELF DIRECTION VIRTUES:**

Fundamental virtues in exercising moral autonomy and responsibility.
e.g. self understanding, humility and good moral judgment

- **PUBLIC SPIRITED VIRTUES:**

Focusing on good of clients and public affected by engineers‟ work

- **TEAMWORK VIRTUES:**

Enables professionals to work successfully with others.
E.g. collegiality, cooperativeness, the ability to communicate

- **PROFICIENCY VIRTUES:**

Mastery of one's craft that characterize good engineering practice
e.g. competence, diligence, creativity

- **MORAL INTEGRITY**

The unity of character on the basis of moral concern
Consistency among our attitudes in relation to justified moral values.

SELF-RESPECT (3 M)

- Valuing oneself in morally appropriate ways.
- Integral to finding meaning in one's life and work
- A pre-requisite for pursuing moral ideals and virtues.
- Self-respect is a moral concept of properly valuing oneself
- Self-esteem is a concept of positive attitude towards oneself.

Self-respect takes two forms.

- Recognition self-respect is properly valuing oneself
  One's inherent moral worth, every other human being has.
- Appraisal self-respect is properly valuing ourselves
  How well we meet moral standards, our personal ideals.

- **Utilitarianism: (4 M)**

Utilitarianism is a normative ethical theory

Places the locus of right and wrong solely on the outcomes

There are two main types of Utilitarianism. They are:

- **Act Utilitarianism**

Act Utilitarianism states that "A particular action is right if it is likely to produce the higher level of good for the most people in a given situation, compared to alternative choices that might be made."

- **Rule Utilitarianism**

The Rule Utilitarianism states that "Right actions are those required by rules that produce the higher level of good for the most people."

Formulation of Ethical Theories

- The concepts of the theory formulated must be coherent.
- The tenets of the theory should never contradict the other.
- The theory should never be defended upon false information.
- Guide in specific situations comprehending all aspects possible.

	• Compatible with individual's moral convictions in any situation.
4	**Explain Kohlber's theory in detail. (13 M) (MAY/JUNE2011) (NOV-DEC2018)** BTL2 **Answer Page. no. 1.15 V. Jayakumar** **Kohlberg's Stages of Moral Development (6 M)** **Level 1 - Pre-conventional morality (7 M)** • We don't have a personal code of morality. • Our moral code is shaped by the standards of adults • Stage 1. Obedience and Punishment Orientation. • The child/individual good in order to avoid being punished. • Stage 2. Individualism and Exchange. • Different individuals have different viewpoints. **Level 2 - Conventional morality** • To internalize the moral standards of valued adult role models. • Stage 3. Good Interpersonal Relationships. • The child, good in order to be seen as good person by others. • Stage 4. Maintaining the Social Order. • The child/individual becomes aware of wider rules of society. **Level 3 - Post-conventional morality** • Individual judgment is based on self-chosen principles. • Moral reasoning is based on individual rights and justice. • Stage 5. Social Contract and Individual Rights. • The child/individual aware of rules/laws, exist for the good of greatest number. • Stage 6. Universal Principles. • Develop own set of moral guidelines, may or may not fit law.
5	**Discuss the scopes of engineering ethics. (13 M)(April/ May2008) (April/ May2011)** BTL2 **Answer Page. no. 2 Mike W. Martin** **INTRODUCTION: (2 M)** • **Engineering Ethics** Moral issues, decisions confronting individuals and organizations engaged in **engineering**. **EXPLANATION: (11 M)** **Moral reasoning and ethical theories:** • By "morality," meant the standards of rightness and goodness • "Ethics" means those moral standards that appropriate to particular occupations **Engineers As Social Experimentation:** • In developing a product, an engineer learns through experimentation. • A trial and error method is the mostly used one to obtain results, **Engineers responsibility for safety:** • To maintain the safety of human beings. • To procure their rights of consent. • To warn them about the probable safety hazards. **Respect to employees and right to engineer:** • A safe and healthful workplace • To ask your employer to correct dangerous conditions. • To file a complaint about workplace hazards **GLOBAL ISSUES:** • Increases through trade, investment, transfer of technology, exchange of ideas, culture.

Engineers as Managers

- An Engineer is responsible in promoting ethics in an organization,
- Framing organizational policies, responsibilities and obligations.

6

Explain the different ethical theories right action, self-interest, duty ethics. (13M) (April / May2007) BTL2

Answer Page No. 60-72 Mike W. Martin

Duty ethics theory: (3 M)

- Consequences of performance of one's duties.
- Being honest, not cause suffering of other
- Being fair to others including the meek and week
- Being grateful, keeping Promises etc.

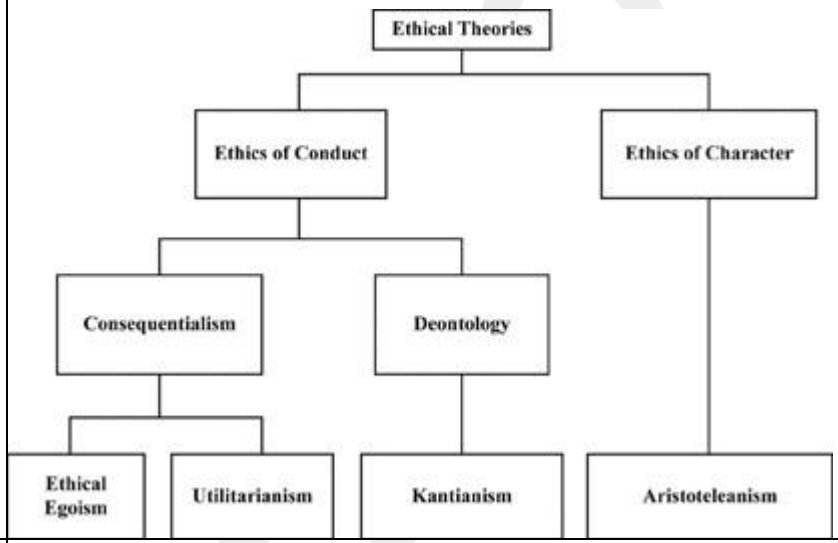
The RIGHTS EHICS:(4 M)

- The right to access the truth
- The right of privacy
- The right not to be injured
- The right to what is agreed

Self-Interest Ethics: (3 M)

- Right action consists in seeking self-fulfilment.
- Self to be realized, defined by caring relationships with individuals and society.
- Ethical egoism, right action consists in always promoting what is good for oneself.

DIAGRAM: (3 M)



7

Discuss the different models of professional roles.(13M)(May/June 2009) (NOV-DEC2018) BTL2

Answer Page. no. 1.23 V. Jayakumar

EXPLANATION: (13 M)

- **SAVIOR:**

Redeem society from poverty, inefficiency
Waste and the drudgery of manual labour.

- **GUARDIAN:**

Directions in which, pace at which, technology should develop.

- **BUREAUCRATIC SERVANT:**

Loyal organization person uses special skills to solve problems.

- **SOCIAL SERVANT:**

	Co-Operation with management, task of receiving society's directives, satisfying society's desires • **SOCIAL ENABLER AND CATALYST:** Vital role beyond mere compliance with orders. Management and society understand, own needs, to make informed decisions. • **GAME PLAYER:** Neither servants nor masters of anyone. Economic game rules that happen to be in effect at a given time.
8	**Explain the need of tolerance for different customs and ethical relativism in adverse society with suitable example. (13 M) (April /MAY 2014)** BTL2 **Answer Page No:2.16 V.Jayakumar** **Customs and Ethical Relativism: (6 M)** • There may be alternative moral attitudes that are reasonable. • Ethical pluralism allows in deciding how we should act. • Moral values are many, varied and flexible. • Reasonable persons always have reasonable disagreement on moral issues • Ethical relativism says actions morally right when they approved by law, custom • Ethical relativism tries to reduce moral values to laws. **Reasons for accepting ethical relativism: (7 M)** • The laws and customs seem to be definite, real and clear – cut. Help to reduce the endless disputes about right and wrong. Laws seem to be an objective way to approach values. • It believes values are subjective at cultural level. The moral standards varied from one culture to another. Morality encourages virtue of tolerance of difference among societies. • The moral renationalise or moral contextualise. Making simple and absolute rules are impossible in this way. Customs, laws considered as morally important factors for making judgments.
9	**Explain the vital role of consensus and controversy while considering moral autonomy in Engineering ethics. (13 M) (Nov/Dec2012)** BTL2 **Answer Pg. no. 1.18 V. Jayakumar** **CONSENSUS AND CONTROVERSY** **Models of professional roles: (6 M)** • **SAVIOR:** Redeem society from poverty, inefficiency Waste and the drudgery of manual labour. • **GUARDIAN:** Directions in which, pace at which, technology should develop. • **BUREAUCRATIC SERVANT:** Loyal organization person uses special skills to solve problems. • **SOCIAL SERVANT:** Co-Operation with management, task of receiving society's directives, satisfying society's desires • **SOCIAL ENABLER AND CATALYST:** Vital role beyond mere compliance with orders. Management and society understand, own needs, to make informed decisions. • **GAME PLAYER:** Neither servants nor masters of anyone. Economic game rules that happen to be in effect at a given time.

	Consensus and Controversy (4 M) • Literally, consensus means _agreement', controversy means _disagreement'. • Individual exercise moral autonomy, to attain same results as other people obtain • This kind of controversies i.e., disagreements are inevitable. • Exercising moral autonomy is not as precise, clear-cut as arithmetic • The moral disagreements are natural and common. • Promoting tolerance in practical applications of moral autonomy by engineers. **Relationship between autonomy and authority (3 M)** • Moral autonomy and respect for authority compatible with each other. • Exercising moral autonomy based on moral concern for other people • Exercising moral autonomy recognition of good moral reasons. • Also moral autonomy emphasizes the capabilities and responsibilities of people. • Authority provides framework, through which learning attitudes are encouraged. • Conflicts will arise between individuals need for autonomy, consensus about authority. • This situation can be rescued by having open and frank
10	**State Meaning of moral dilemma. Describe the types and few steps in confronting Moral Dilemma in the life (13 M) (April/ May2007)** BTL2 **Answer Pg. no. 32 Mike W. Martin** **Definition: (2 M)** A moral dilemma is defined as any situation in which the person making the decision experiences a conflict between the moral rightness of a decision and the quality of the results it produces. Many times, these dilemmas involve a morally wrong decision that produces a desirable result, or vice versa. **The following three categories of complex and gloomy moral situations: (8 M)** • **Vagueness** The condition where the doubt lies in whether the action refers to good or bad. • **Conflicting reasons** Fixing the priorities depends upon the knowledge and the moral values one has. The reason why the particular choice makes sense. • **Disagreement** When two or more solutions and none among them is mandatory The final solution selected should be best most probable conditions. • **Steps in Facing Moral Dilemmas (3 M)** Whenever a person is faced with a moral dilemma, the issue is to be solved with a stepwise approach as this will generate a better output. **The step of identification involves the following −** • The issue has to be thoroughly understood. • The duties, responsibilities of persons involved to be clearly known. • The moral factors related to the issue are to be understood. • The conflicting responsibilities
	PART * C
1	**Discuss the moral problems faced by an Indian common man. (15 M) (April / May2008)** BTL2 **Answer Page. no: 5 Mike W. Martin 3rd Edition Refer notes** **Morality: (3 M)** Morality is the human attempt to define what is right and wrong about our actions and thoughts, and what is good and bad about our being that we are. *"Moral issue is a working definition of an issue of moral concern is presented as any issue with the potential to help or harm anyone, including oneself."*

Types of Moral Issues (5 M)

There are mainly two types of Moral issues. They are –

- **Micro-ethics**

Problems that occur on a daily basis in field of engineering, its practice by engineers.

- **Macro-ethics**

This approach deals with social problems which are unknown.

Problems may unexpectedly face the heat at both regional, national levels.

Examples: (3 M)

1. Animal Welfare - Is it okay to eat meat or dairy?

Moral problems faced by an Indian common man: (4 M)

- Discrimination based on caste, creed and colour.
- Reservation in education and employment field enjoyed by "backward class" for 3 generations and still continue to use.
- To meet basic amenities-food, clothing and shelter.
- Garbage collection and disposal
- Traffic congestion in urban areas
- Farmers not getting support prices for crops
- Corruption

2

Name and explain the various types of Ethical inquiries available. Analyze in detail the *Self –Interest and Ethical Egoism* (15M)BTL4

Answer Page. no. 72 Mike W. Martin(*Self –Interest and Ethical Egoism)*

Answer refer notes.

Types of Inquiries (8 M)

Normative inquiries
Conceptual inquiries
Factual or descriptive inquiries

- **Normative Inquiries**

The description that describes what one ought to do under a specific circumstance.

- **Conceptual Inquiries**

The description of meaning of concepts, principles and issues related to engineering ethics.

- **Factual and Descriptive Inquiries**

The descriptive inquiry help to provide the facts for understanding
Finding solutions to the value based issues.

Self-interest: (4 M)

It refers to the goodness of oneself in the long run.

- The ethical theories recognize the importance of self-respect.
- Utilitarian considers one's own good as well as the good of others.
- Duty ethicists stress duties to us and for won well-being.
- Ethicists of rights emphasize our rights to pursue our own good.
- Virtue ethicists accent the importance of self – respect.

	• Pursuit of self – interest must be balanced • Kept under control by moral responsibilities to other people. **Ethical Egoism (3 M)** • It tries to reduce morality to the pursuit of self - interest. • The main duty of us is to maximize our own good. • Make a differentiation between narrower and wider forms of self-interest • Ethical Egoists try to protect their positions by arguing • Pursue their self – interest in a very cautious manner to value, interest rationally on facts. • Not a persuasive or probable theory to state what is morality • It is only a convinced rejection of morality.
3.	**Explain the theory of human right ethics and its classification. (15 M) (Nov/Dec 15)** BTL2 **Answer Page. no. 55 to 66 Mike W. Martin** **THEORIES ABOUT RIGHT ACTION:** These theories are essential for cause of right action and morality. They are: • **"Golden mean"** ethics **(3 M)** The best solution is achieved through reason and logic A compromise or "golden mean" between extremes of excess, deficiency. **Problem:** Variability from one person to another in their powers of reasoning The difficulty in applying the theory to ethical problems**.** • **"Rights –** based" ethics **(4 M)** Every person is free and equal Has the right to life, health, liberty and possessions **Problem:** One person's right may be in conflict with another's rights. • **"Duty –** based" ethics **(4 M)** Each person has a duty to follow a course of action **Problem:** Universal application of a rule can be harmful. • **"Utilitarian"** ethics **(4 M)** The best choice, which produces maximum benefit for greatest number of people **Problem:** Qualification of the benefits can be difficult.

	UNIT –III **ENGINEERING AS SOCIAL EXPERIMENTATION**
	Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook
1	**Write some of the pros and cons of industrial standardization. (MAY/JUNE 2012) (NOV-DEC2018)**BTL2 **Advantages of Standards:** • Reducing costs • Increasing productivity • Reducing unnecessary variety • Ensuring inter changeability • Minimizing waste • Ensuring safety • Quality assurance **Disadvantages of standards:** • The implementation of standard removes the creative element of the program • Standards force people to change their methods • Standards reduce productivity by forcing unnecessary actions • Standards do not prevent bugs.
2	**List out the limitations of ethical code. (MAY/JUNE 2011)(NOV/DEC 2014)** BTL1 • Some issues cannot be handled in the context of a code. • There are some difficulties with enforcing the code, or at least the public may believe that enforcement committees are not tough enough on their peers. • There is often no way to bring the interests of the client, patient, or research participant systematically into the code-construction process. • There are parallel forums in which the issues in the code may be addressed, with the results sometimes at odds with the findings of the code (for example, in the courts).
3	**Define ethical accountability. (MAY/JUNE 2011)** BTL2 The inherent tendency of accepting moral responsibility for the actions of an individual and also the spontaneous willingness to subject him to the moral scrutiny in an open-minded manner is called ethical accountability.
4	**Name the aerospace ace experts and scientists who were associated with the Launching of challenger. (MAY/JUNE 2010)** BTL2

	Allan McDonald of Morton-Thiokol at Cape Kenned y, Arnold Thomson and Roger Bois jolywho were the seal experts at Morton-Thiokol a n d engineering managers, Bob Lund and Joe Kil minster were the experts associated with the launching of challenger space program.
5	**Name some of the important code of ethics published by engineering societies. (MAY/JUNE 2010)** BTL2 National society of professional Engineers. Board of Ethical review. NSPE opinion of the Board of ethical review. American Association of Engineering societies (AAES). Institute of Electrical and Electronics Engineers (IEEE).
6	**What are the problems with the law in engineering?(NOV/DEC 2010)** BTL2 The numerous legal considerations that must be taken into account by engineers, considerations that are typically outside of the traditional knowledge base and experience of an engineer. Patents and the process of obtaining one; maintenance of licensing and certification; and having a firm understanding of codes and standards are just some of the many issues facing engineers in their career path.
7	**How engineering could be regarded as preventive technology? (MAY/JUNE 2009)** BTL2 As per the familiar proverb that "prevention is better than cure", the ultimate process of solving the scientific-based problems is not by curing alone, but effectively by the preventive measures. Such type of defensive measures to prevent scientific ills is called preventive technology.
8	**What are the general features of morally responsible engineers?(MAY/JUNE 2009)** BTL2 • Conscientiousness. • Comprehensive perspective. • Autonomy. • Accountability.
9	**Write some of the specific role of informed consent in engineering experimentatio**n. (BTL2) Informed consent is the vital concept to interact engineers with public society. It reflects the respects for the fundamental rights of minority people involved in the experimental procedures.

	It enables both the public and clients to be aware of the practical risks and benefits of that experimentation.
10	**Write the differentiation between engineering and standard experiments.** (BTL2) Engineering experimentation involves human subjects as control groups, Unlike in the standard experimentation .The process of obtaining the informed consent from the human-engineering experimentation. Unlike in the scientific experiments, new knowledge is not gained in engineering experiment.
11	**Differentiate scientific experiments and engineering projects** (BTL4) Scientific experiments are conducted to gain new knowledge, while ―engineering projects are experiments that are not necessarily designed to produce very much knowledge.
12	**How Titanic tragedy be brought under engineering as social experimentation?** (BTL2) Failure in the far-sighted approach of not providing enough number of lifeboat sand non-availability of proper safe exits handled to the sinking of titanic ship that caused the death toll of 1522 persons on b o a r d . These in designing a r e the reasons for bringing titanic tragedy under engineering as social experimentation
13	**Write down some of the uncertainties occur in the model designs.(APR-MAY2017)** (BTL3) Model used for the design calculations. Exact characteristics of the materials purchased. Constancies of materials used for processing and fabrication. Nature of the pressure, the finished product will encounter.
14	**Give short notes on engineering as experimentation. (MAY/JUNE2014) (APR/MAY 2015)(NOV/DEC 2014)** (BTL1) Experimentation (Preliminary tests or Simulations) plays a vital role in the design of a product or process.In all stages of converting a new engineering concept into a design likes, first rough cut design,Usage of different types of materials and processes, detailed design, Further stages of work design.
15	**State the importance of Ethics codes. (MAY/JUNE2014)** (BTL1) Engineers shall uphold and advance the integrity, honour, and dignity of the engineering Profession by: •Using their knowledge and skill for the enhancement of the human race; •Being honest and impartial and serving with fidelity the public, their employers, and clients. •Striving to increase the competence and prestige of the engineering profession.

	•Supporting the professional and technical societies of their discipline
16	**List the conditions required to define a valid Consent.** (BTL1) It must be voluntary and informed, and the person consenting must have the capacity to make the decision. Capacity – the person must be capable of giving consent, which means they understand the information given to them and they can use it to make an informed decision.
17	**Give some universally accepted ethical principles.** (BTL2) • Honesty • Commitment • Empathy • respect for the dignity • Competent Caring for the Well-Being of Persons and Peoples • Integrity • Professional And Scientific Responsibilities To Society
18	**List out the advantages of industrial standards. (APR/MAY 2015)** (BTL1) • Increased marketability • Reduced operational expenses • Better management control • Increased customer satisfaction • Improved internal communication
19	**what do you understand by balanced outlook on Law?** (BTL2) A balanced outlook on laws stresses the necessity of laws and regulations and their limitations in directing engineering practice. In order to live, work and play together in harmony as a society, there must be a balance between individual needs and desires against collective needs and desires. Only ethical conduct can provide such a balance. This ethical conduct can be applied only with the help of laws. Laws are important as the people are not fully responsible and because of the competitive nature of the free enterprise system which does not encourage moral initiative.
20	**Define Whistle Blowing.** (BTL2) This is an act by an employee informing the public or higher management of unethical or illegal behavior by an employee or supervisor. Engineers shall not attempt to injure, maliciously or falsely, directly or indirectly, the professional reputation, prospects, practice, or employment of other engineers.
21	**List the advantages of code of ethics.(NOV-DEC2018) BTL1** • Guide employees in situations where the ethical course of action is not immediately obvious.

	• A code can help create a climate of integrity and excellence. • Help the company communicate its expectations to the staff to suppliers, vendors and customers. • Minimize subjective and inconsistent management standards. • Help a company remain in compliance with complex government regulations. • Build public trust and enhance business reputations. • Offer protection in preempting or defending against lawsuits. • Enhance morale, employee pride, loyalty and the recruiting of outstanding employees. • Help promote constructive social change by raising awareness of the community's needs and encouraging employees and other stakeholders to help. • Promote market efficiency – especially in areas where laws are weak or inefficient – by rewarding the best and most ethical producers of goods and services.
21	**How does the law facilitate the ethics in engineering?(APR-MAY 2017)** BTL2 Engineering ethics is the field of system of moral principles that apply to the practice of engineering. The field examines and sets the obligations by engineers to society, to their clients, and to the profession. As a scholarly discipline, it is closely related to subjects such as the philosophy of science, the philosophy of engineering, and the ethics of technology.
	PART * B
1	**i. Assess how Engineering societies can promote ethics.** **ii. Evaluate the General responsibilities of moral engineers.(13M)** (BTL5) **Answer refer notes.** **Engineering societies and promoting ethics.(4 M)** • Hold paramount safety, health, welfare of public. • Perform services in areas of their competence. • Issue public statements in an objective, truthful manner. • Act for each employer, client as faithful agents, trustees. • Avoid deceptive acts. • Conduct them honorably, responsibly, ethically, lawfully • To enhance the honor, reputation, usefulness of profession. • **The responsibilities of moral engineer.(7 M)** Loyalty to corporations, respect for authority, collegiality. Teamwork is a few important virtues in the field of Engineering. • **Loyalty**

	Loyalty is the faithful adherence to an organization, employer. **Loyalty to an employer can be either of the two types:** • **Agency-loyalty:** Acting to fulfill one's contractual duties to an employer. • **Attitude-loyalty :** A lot to do with attitudes, emotions A sense of personal identity as it does with actions. • **Collegiality** A work environment where responsibility, authority shared among colleagues. **Main factors that help in maintain harmony among members at a workplace are(2 M)** Respect Commitment Connectedness
2	**Explain a Balanced Outlook on Law. (13 M) (NOV/DEC2010)** (BTL2) **Answer Page 100- Mike W. Martin** **Explanation – (6 M)** • It stresses the necessity of laws and regulations • Limitations can understand with an overview of laws in engineering profession. • Individual needs, collective needs of the society stimulate harmony in society. • The ethical conduct can be applied with the help of laws. • Laws are important as people are not completely responsible. • The competitive nature of free enterprise system, does not encourage moral initiative. **Let us look at a few examples from the past that represent the importance of law.(7 M)** Babylon's Building Code Bhopal disaster
3	**Express in detail about engineers as responsible Experimenters. (13 M) (APR-MAY2017)** (BTL2) **Answer Page. 95 Mike W. Martin** **General responsibility of engineering as society(4 M)** • Engineers primarily considered as technical enablers, facilitators, rather than sole experimenters. • Responsibility is shared with management, the public and others. • The engineers should display virtue of being morally responsible person. **General features of moral responsible engineers(9 M)**

	• Conscientiousness • Relevant information • Moral Autonomy • Accountability **Conscientiousness:** Commitment to live according to certain values. **Relevant information:** Engineers properly gauge all information related to meeting one's moral obligations. **Moral autonomy:** The ability to think critically and independently about moral issues Apply moral thinking to situations, arise during professional engineering practice. **Accountability:** 'Accountability 'means being responsible, liable, answerable or obligated. Willingness to present morally convincing reason for ones action, conduct.
4	**Illustrate the codes of ethics set by professional societies. (13 M)** (BTL2) **Answer refer notes.** **Codes of ethics set by professional societies (13 M)** • Guided in all their relations by the highest standards of honesty and integrity. • Engineers shall at all times strive to serve the public interest. • Engineers shall avoid all conduct or practice that deceives the public. • Not disclose, without consent, confidential information concerning business affairs. • Engineers shall not influence in their professional duties by conflicting interests. • Engineers shall not attempt to injure, maliciously or falsely, directly or indirectly. • Guilty of unethical, illegal practice shall present information to proper authority for action. • Credit for engineering work to those to whom credit is due, recognize proprietary interests of others.
5	**Examine the roles played by the codes of ethics. (13 M) (MAY/JUNE2011,NOV/DEC 2013)(NOV/DEC2014)** (BTL1) **Answer Page no. 44 Mike W. Martin** **Code of ethics Meaning:(2 M)**

	To provide basic framework for ethical judgment for a professional. **Roles of Code of Ethics: (13 M)** **The code of ethics propagated by professional societies play a vital role. They are,** • Inspiration • Guidance • Support for responsible conduct • Deterring and disciplining unethical professional conduct • Educational and promotion of mutual understanding • Contributing to positive public image of profession • Protecting the status quo suppressing dissent within the profession • Promoting business interest through restraint of trade.
6	**How engineering project differ from standard experimentation? (13 M)(NOV/DEC 2013)** (BTL2) **Answer page no: 91 Mike W. Martin** **The scientific experiments in the laboratory and the engineering experiments in the field exhibit several contrasts as listed below: (13 M)** **Experimental control:** • Members for study selected into two Groups namely A, B at random. • Group A are given special treatment. • The group B Given no treatment, called 'controlled group'. • Placed in the same Environment as other group A. • Engineering, through random sampling, survey made among users • To assess results on product. **Humane touch:** • Engineering experiments involve human souls, their needs, views,& expectations, • Creative use as in case of social experimentation. • This view not agreed by many of engineers. • Quality engineers, managers fully realized this humane aspect. **Informed consent:**

	• Engineering experimentation viewed as Societal Experiment • Since subject, the beneficiary is human beings. • Medical practice- moral, legal rights Have recognized while planning experiments
7	**i. Explain limitations of code of ethics.** **ii. Briefly discuss the importance of code of ethics. (13M) (APR-MAY2017)** (BTL4) **Answer: (Refer notes)** **Definition of code of ethics (2 M)** The definition of a code of ethics is "a collection of principles and practices that a business believes in and aims to live by." It should be a document that goes along with the company mission and vision statement. Anyone who interacts with the company or works for the company should understand the code. Much of this is part of employee policy and guidelines, but it also carries over to dealing with vendors and partners. ***Limitations of Codes:*** **(3 M)** • Codes are restricted to general and vague wordings. • Engineering codes often have internal conflicts. • They cannot be treated as final moral authority for professional conduct. • Only a few practicing engineers are members of Professional Societies • Members of Professional Societies not aware of existence of codes oftheir societies never go through it. • Codes can be reproduced in a very rapid manner. • Codes said to be coercive i.e., implemented by threat, force. **The importance of code of ethics.(8 M)** • Step one: Get your priorities straight • Step two: Where to get your input • Step three: Common major pitfalls • Step four: Where to get help • Step five: Assigning someone to be in charge
8	**Discuss ethics in research (13M) (NOV/DEC2013/2018)** (BTL2) **Answers refer notes.** **INTRODUCTION: (3 M)** People think of ethics, think of rules for distinguishing between right, wrong, such as Golden Rule. **EXPLANATION: (10 M)**

	The following is a rough and general summary of some ethical principles: • Honesty • Integrity • Carefulness • Openness • Respect for Intellectual Property • Confidentiality • Responsible Publication • Responsible Mentoring • Respect for colleagues • Social Responsibility • Non-Discrimination • Competence • Legality • Animal Care • Human Subjects Protection
9	**Illustrate in detail about engineering as experimentation. (13M)** (BTL3) **Answer Page no 89 to 94 Mike W. Martin.** **Engineers as Experimenters: (4 M)** • Process of developing a product, an engineer generally learns through experimentation. a trial and error method is mostly used one to obtain results • Hence, primarily any experiment carried out with partial ignorance. • Outcomes of the experiments may not be as expected. • An engineer should always be ready for unexpected output. **Consider following points which are related to moral aspects of human behaviour(9 M)** • To maintain safety of human beings. • To procure their rights of consent. • To keep them aware regarding experimental nature of project. • To warn them about probable safety hazards. • Monitor results of experiment continuously.

	• Having autonomy in conducting experiments. • Accepting accountability for results of tproject. • Exhibiting their technical competence, characteristics of professionalism.
10	**How the ethical codes provide discipline among the engineers? (13M) (MAY/JUNE2014), (APR/MAY2015) (NOV/DEC 2014)** (BTL2) **Answer refer notes.** **EXPLANATION: (13 M)** • Engineers hold paramount safety, health, welfare of public • To comply with principles of sustainable development in performance of professional duties. • Engineers perform services only in areas of their competence. • Engineers issue public statements only in an objective, truthful manner. • Engineers act in professional matters for each employer • Avoid conflicts of interest. • Engineers build their professional reputation on the merit of their services • Not compete unfairly with others. • Engineers act in such a manner as to uphold and enhance the honor, integrity. • Act with zero tolerance for bribery, fraud, and corruption.
	PART * C
1	**Express in detail about the types and importance of industrial standards. (15M) (APRIL/MAY 2015)** (BTL2) **Answer refer notes.** **Types of standards:(11 M)** **Optimum standards:** • Facilitate the creation of political as well as business related advantages. **Formal standards:** • Strategic initiatives with broad applicability, with roles for ANSI, standards developers, industry, government. **Private standards:** • Developed by an organization or a trade association. **Testing standards:** • They provide a method to test products or materials.

	Performance standards: • Performance requirements usually measured using a specified test procedure, standard. **Dimensional standards:** • They establish a number of key dimensions that must be met. • This allows product inter changeability. **Quality standards:** • They describe certain characteristics that must be met • Insuring the buyer that some minimum level of quality is met. **Importance of standards (4 M)** • Administration, legislative bodies also benefited by Industry standard. • Standardization facilitates a healthy competition, designing of new concepts. • It ascertains the rank of an industry in the economic set up of a country. • Optimum standards facilitate creation of political, business related advantages. • Setting industry standard, to provide a platform for giving shape to new creations.
2	**Discuss the various ethical issues involved in Bhopal disaster. (15M) (May/June2009)** (BTL2) **Answer refer notes.** **EXPLANATION:(15 M)** • In case of Bhopal tragedy all of them were neglected. • The poor quality of the facility • Lack of many instruments was the reason for the leak. • Two out of three main safety systems unable to cope with situations. • The flare tower, water sprays for not functioning properly. • Public were never given any information about MIC, safety measures. • Location of plant close to settlement also one of ethical question to be raised. • "Perform services only in areas of their competence". • leak started after wash out of a pipe, had not sealed properly by a worker • Training did not meet standards and was ordered by novice supervisors.

3	**Compare and contrast engineering experiments with standard experiments. (15M) (Ma Y/June 2009) (NOV-DEC 2018)** (BTL4) **Answer Page No.89 to 94 Mike W. Martin Key points:** **Similarity to Standard Experiments(6 M)** • Carried out in partial uncertainties. • Outcomes of engineering projects, generally uncertain like other experiments • Requires thorough knowledge about products at pre-production, post-production stages. • Requires constant monitoring, alertness, • Vigil on part of the engineers at every stage of the project. **Differences between engineering experiments and other standard experiments. Experimental control (9 M)** **Experimental control:** • Members for study selected into two Groups namely A, B at random. • Group A are given special treatment. • The group B Given no treatment, called 'controlled group'. • Placed in the same Environment as other group A. • Engineering, through random sampling, survey made among users • To assess results on product. **Humane touch:** • Engineering experiments involve human souls, their needs, views,& expectations, • Creative use as in case of social experimentation. • This view not agreed by many of engineers. • Quality engineers, managers fully realized this humane aspect. **Informed consent:** • Engineering experimentation viewed as Societal Experiment • Since subject, the beneficiary is human beings. **Informed consent consists of two main elements:** • Knowledge: Human subjects should be given all information to make a reasonable decision. • Voluntariness: Human subjects, show their willingness to be a human model voluntarily. The person should not be forced, deceived, fraud, etc.

	UNIT-IV **SAFETY, RESPONSIBILITIES AND RIGHTS**
	Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.
	PART * A
1	**What is conflict Interest?(MAY/JUNE 2012) (NOV-DEC 2018)** BTL2 A situation that has the potential to undermine the impartiality of a person because of the possibility of a clash between the person's self-interest and professional interest or public interest. Types of Conflicts of interest: Actual conflict of interest Potential conflict of interest Apparent conflict of interest
2	**What are the reasons for Risk-Benefit Analysis?(NOV/DEC 2011, NOV/DEC 2013) (MAY/JUNE 2016)** BTL2 A risk-benefit analysis is a comparison between the risks of a situation and its benefits. The goal is to figure out whether the risk or benefit is most significant. It's used often in medicine, because every medical procedure has risks associated with it, and some procedures that could be beneficial actually turn out to statistically cause more harm than good. That's how medical researchers figure out whether certain procedures are worth doing and what types of people will benefit. • Risk-benefit analysis is concerned with the advisability of undertaking a project. • It helps in deciding which design has greater advantages. • It assists the engineers to identify a particular designs core higher with that of the another**.**
3	**Give few steps to reduce risks. (MAY/JUNE 2009)** BTL2 The factors are: • The engineer must have the right data. • Engineer should satisfy with the present design. • Engineer must test the safety of a product. • Engineer must measure and weight he risks with benefits for a product.
4	**Give the reasons for the Three Mile Island disaster? ((MAY/JUNE 2014)**BTL1

	In adequate training to the operators. Use of B&W reactors.
5	**List the two types of Risk.((MAY/JUNE 2012)** BTL1 • Personal Risk: An individual, who is given sufficient information, will be in a position to decide whether to take part in a risky activity or not . They are more ready to take on voluntary risks than in voluntary risks. • Public Risks: Risks and benefits to the public are more easily determined than to individuals, as larger number of people is taken in to account .Involuntary risks are found here.
6	**Define "risk".(May/June 2011)(NOV/DEC2014) (NOV-DEC 2016)**BTL2 A risk is the potential that something unwanted and harmful may occur. Risk = Probability X Consequences.
7	**What do you mean by voluntary risk? (May/June 2010, May/June 2010)** BTL2 If a person knowingly takes any risk, then he feels it safe. In contrast, if the same risk is forced to him, then he feels it unsafe. In simple terms the voluntary risks are considered as safe and the involuntary risks are considered as unsafe.
8	**What is safe risk and acceptability of risk? (IT Dec 2009,May 2010)** BTL2 Acceptability of risk: A risk is acceptable when those affected are generally no longer apprehensive about it. Apprehensiveness mainly depends on how the risk is perceived by the people. Safe Risk: If a person knowingly takes any risk then he feels it safe. In the same way voluntary risks are considered as safe risk
9	**List the methods that can be applied when testing is inappropriate. (May/June 2009)(NOV/DEC2014)** BTL1 • Scenario Analysis • Failure modes and effects analysis • Fault free analysis • Event free analysis
10	**What is the use of knowledge of risk acceptance to engineers?** BTL2 Though past experience and historical data give better information about safety of products designing there are still inadequate .The reasons are

	• The information is not freely shared among industries. • There also new applications of old technologies that provides available data, which are less useful. • So, in order to access the risk of a product, the engineers must share their knowledge and information with others in a free manner.
11	**What are the positive uncertainties in determining risks?** BTL2 • Purpose of designing • Application of the product • Materials and the skill used for producing the product
12	**What is the Risk Transfer?** BTL2 It refers to the legal assignment of the cost of certain potential losses from one party to another. The most common way of affecting such transfer is by insurance.
13	**What are the steps involved in design for safety? ((MAY/JUNE 2014)** BTL2 • Define the problem • Generate alternate solutions • Analyses each solution • Test the solution • Select the best solution • Implement the chosen solution**.**
14	**State the industrial definition on safety .(MAY/JUNE 2014)** BTL1 • A ship in harbour is safe, but that is not what ships are built for‖ – John A. Shedd • A thing is safe if its risks are judged to be acceptable,, - William W. Lawrence • We buy an ill-designed Iron box in a sale- Underestimating risk • We judge fluoride in water can kill lots of people - Overestimating risk • We hire a taxi, without thinking about its safety - Not estimating risk
15	**What is meant by Disaster? (MAY/JUNE 2014, NOV/DEC 2013)** BTL2 A DISASTER = A seriously disruptive event + A state of unpreparedness. E.g., Titanic collision with an iceberg, at night: Emergency Fewer lifeboats, inadequate training and warnings of icebergs unheeded ->Disaster
16	**What is informed consent? (MAY/JUNE 2011)(APR/MAY 2015)** BTL2 Informed consent is the process by which the treating health care provider discloses appropriate Information to a competent patient so that the patient may make a voluntary choice to accept or refuse treatment. It originates from the legal and ethical right the patient

	has to direct what happens to her body and from the ethical duty of the physician to involve the patient in her health care.
17	**What is the use of risk analysis?(APR/MAY 2015) (MAY/JUNE 2016) (APR/MAY 2017)**BTL2 Risk analysis is the process of defining and analyzing the dangers to individuals, businesses and government agencies posed by potential natural and human-caused adverse events.
18	**List the two types of authority given by Martin and Schinzinger. (May/June2011,NOV/DEC 2014),(APR/MAY2015)** BTL1 **Martin and Schinzinger define two types of authority** Institutional authority • Associated with administrative position Expert Authority • Accrues from specialized knowledge
19	**What are the elements of collegiality? (May/June 2010, NOV/DEC 2014)(Nov/Dec 2013) (MAY/JUNE 2014)** BTL2 • Respect • Commitment • Connectedness • Cooperation
20	**What do you mean by employee rights? And lists its categories. (Nov/Dec 2012)** BTL2 Employee rights are rights, moral or legal, that involve the status of being an employee. They include some professional rights that apply to the employer-employee relationship. Categories: • workplace safety • Civil rights • Family and medical leave • Workers compensation • Labor relations laws.
21	**What is the Basic Right of Professional Conscience? (MAY/JUNE 2011)** BTL2 The right to do what everyone agrees it is obligatory for the professional engineers to do the basic professional right is an entitlement giving one the moral authority to act without interference from others.
22	**What is Institutional authority? (NOV/DEC 2011)** BTL2 • Associated with administrative position.

	• Those with authority have the right to administer their duties and the freedom to actually achieve organizational goals by expending the resources available to them. This type of authority usually goes with the position: • Managers • Administrators • Project Engineers
23	**Define the term safety. How is it related to risk? (NOV-DEC 2018)** BTL2 Safety is a concept that includes all measures and practices taken to preserve the life, health, and bodily integrity of individuals. In the workplace, safety is measured through a series of metrics that track the rate of near misses, injuries, illnesses, and fatalities. In order to improve these metrics, employers and safety officials must also conduct investigations following any incident to ensure that all safety protocols and measures are being followed or to implement new ones if needed. **Safety relation with risk:** • Identifying a hazard • Collecting information and analyzing risk associated with it • Determining how to remove or reduce its effect by completely eliminating the process or equipment • Replacement with a better equipment or process • Using advanced technology or design and physically isolating processes or direct contact of user by the use of appropriate collective or personal protective equipment.
24	**Define term collective bargaining. (MAY/JUNE 2014)(NOV-DEC 2016) (APR/MAY 2017) (MAY/JUNE 2016)**BTL2 • There is a limit of one representative for each unit of employees • All representatives must promote the practice, and follow all procedures, of collective bargaining • Employers must bargain with the employees' representatives • Employees and their representatives have the right to discuss wage issues
25	**What do you mean by IPR? (APR/MAY 2017)** BTL2 Intellectual property rights are the rights given to persons over the creations of their minds. They usually give the creator an exclusive right over the use of his/her creation for a certain period of time.
26	**What is the difference between bribe and gifts? (Nov/Dec 2014)**BTL2 Gift: Something of value given without the expectation of return

	Bribe: Something of value given with the hope of a future influence or benefit
	PART * B
1	**What is risk benefit analysis? Explain the procedure in Risk Benefit Analysis. Discuss its roles in reducing risks. (13M) (Nov/Dec 2010, May/June2011) (NOV/DEC 2014) (APR/MAY 2017) (NOV-DEC 2016) (NOV/DEC 2018)** BTL2 **Answer: page: 128to 133T - Mike W. Martin** **Introduction: (2 M)** A risk-benefit analysis is a comparison between the risks of a situation and its benefits. The goal is to figure out whether the risk or benefit is most significant. • Uncertainties in design • Personal risk • Public risk and public acceptance **Various procedure in adopting risk benefit analysis: (8M)** • Identify the risks early on in your project. • Communicate about risks • Consider opportunities as well as threats when assessing risks. • Prioritize the risks • Fully understand the reason and impact of the risks. • Develop responses to the risks • Develop the preventative measure tasks for each risk. • Develop the contingency plan for each risk. • Record and register project risks. • Track risks and their associated tasks. **Role in reducing risks: (3 M)** • Application of inherent safety concept in design. • Use of redundancy principle in the instrument protection • Regular inspection • Training and operating personnel • Conducting regular safety audits • Development of well-designed emergency evacuation plan and regular rehearsal.
2	**Define the term risk and safety. Explain how an engineer assesses the risk? (13M) (NOV/DEC 2014) (Nov/Dec 2013) (NOV-DEC 2016)** BTL2 **Answer: Page: 121 - Mike W. Martin (2 M)**

	Define risk: "Potential for the realization of unwanted consequences from impending events." **Define safety:** "A thing is safe if its risks are judged to be acceptable." **(2 M)** **Definition** **(2 M)** A safety risk assessment is a systematic procedure for identifying and managing hazards. It encompasses thorough examination of the entire work environment, processes and equipment to determine any hazard to the health of the employees in the short or long term and implementing remedies. **Risk assessment:** **(3 M)** ▪ Risk assessments are recorded retained for significant hazards. ▪ Risk assessments are suitable, sufficient. ▪ Staffs are aware of, understand relevant risk assessments. ▪ Risk assessments are reviewed periodically **Risk assessment process:** **(4 M)** • Identify the hazards associated with a procedure • Consider who may be exposed and what is the maximum possible exposure • Include storage waste, disposal and cleaning, if appropriate. • List existing control measures. • Consider emergency procedures. • If further control measures required, list and set actions
3	**Describe the concept of Occupational crime with examples. (13M) (Nov/Dec 2013)(Apr/May 2015) (Nov/Dec 2015)** BTL2 **Answer: Page: 128 M - Mike W. Martin** **Block and Geis (Man, Crime and Society, 1970: 307) have classified occupational offenders into five groups on the basis of the nature of victim involved: (4 M)** • Persons acting as individuals against other individuals (e.g., fraudulent lawyers, doctors), • Those committing crimes against business concerns that employ them (embezzlers), • Those in policy-making positions who commit crimes for their organizations (anti-trust violators), • Agents of an organisation who victimize the general public (advertising fraud), and • Merchants victimizing their customers (short-weighing). • This method is simple. The victim could be employer, employee, public concern, government organisation, and so forth. **Types of occupation crime:** **(9 M)** • Price fixing • Endangering lives • Industrial espionage
4	**Write brief notes on** (i) **Whistle blowing (ii) Discrimination (13M) (APRIL/ MAY 2015)** BTL3

	Answer: Page: 172-173 - Mike W. Martin **Whistle blowing (6 M)** • A whistleblower is a person who exposes any kind of information • Exposes activity that is deemed illegal, unethical. • Exposes, which is not correct within an organization that is either private or public. Types of whistle blowing: • Internal Whistle Blowing • External Whistle Blowing • Open Whistle Blowing • Anonymous Whistle Blowing **Discrimination (7 M)** **Definition** It is referred to prejudice resulting from denial of an opportunity, unfair treatment in the job selection, promotion and transfer is called discrimination. **Types of Discrimination** • Direct discrimination • Indirect discrimination • Pregnancy and maternity discrimination • Absence from work because of gender reassignment • Discrimination connected to your disability • Duty to make reasonable adjustments for disabled people • Sexual harassment • Victimization
5	**Explain the types and advantages of Intellectual property rights. (13M) (Nov/Dec 2015) (APRIL/ MAY 2013,NOV/DEC 2013) (NOV/DEC 2014) (MAY/JUNE 2016) (APRIL/ MAY 2015)** BTL2 **Answer Refer Notes** **Intellectual property rights: (2 M)** Intellectual property rights are the rights given to persons over the creations of their minds. They usually give the creator an exclusive right over the use of his/her creation for a certain period of time. **Types of Intellectual Property Rights: (8 M)** Intellectual Property Rights can be further classified into the following categories −

	• Copyright • Patent • Trade mark • Trade Secrets, etc. **Advantages of Intellectual Property Rights (3 M)** • Provides exclusive rights to the creators or inventors. • Encourages individuals to distribute and share information and data instead of keeping it confidential. • Provides legal defence and offers the creators the incentive of their work. • Helps in social and financial development.
6	**Explain the concept of Confidentiality in detail. (13M) (NOV/DEC 2011)** BTL2 **Answer: Page: 146 to 148 -Mike W. Martin** **Introduction: (2 M)** • Any information that is desirable to keep secret. Usually has some exploitable value for business purposes **Types of information (8 M)** – Public (available to anyone) – Private (restricted/conditional availability) • Confidential • Privileged • Proprietary • Trade secrets (and ~patents) How companies might handle you changing jobs when confidentiality is at risk: **(3 M)** • Employee sign employment contracts that place constraints on future employment • Company give positive benefits to those leaving such as special pension considerations, the opportunity to do consulting etc. • Company works with employees to show the damage that can be done if information is passed on.
7	**Explain a detailed note about collective bargaining. (13M) (APRIL/ MAY 2010), (NOV/DEC 2013) (NOV/DEC 2014) (APRIL/ MAY 2015)** BTL2 **Answer: Page: -5.8 - V.Jayakumar** **collective bargaining: (3 M)** • There is a limit of one representative for each unit of employees

	• All representatives promote practice, and follow all procedures, of collective bargaining • Employers must bargain with the employees' representatives • Employees and their representatives have the right to discuss wage issues **Collective Bargaining Process** Preparation : **(10 M)** Choosing a negotiation team and representatives of both the union and employer. Discussion: Parties meet to set ground rules for collective bargaining negotiation process. Proposal: Representatives make opening statements, outlining options, possible solutions to issue at hand. Bargaining: Following proposals, parties discuss potential compromises, bargaining to create an agreement that is acceptable to both parties. A "draft" agreement, which is not legally binding, but a stepping stone to coming to a final collective bargaining agreement. Final Agreement: Once an agreement is made between the parties, it must be put in writing, signed by the parties, and put into effect.
8	**Discuss on Respect for authority and Conflict of interest. (13M) (MAY/JUNE 2014) (NOV/DEC 2014)** BTL2 **Answer: page: 150 to 151 - Mike W. Martin** **Respect for authority: (2 M)** • Authority is the "potential and resources" to accomplish tasks. • Power is the capability to do so • Authority gives the right to control decisions affecting the company's interests • Engineers must respect the authority of their employers **Martin and Schinzinger define two types of authority (5 M)** • Institutional authority Associated with administrative position • Expert Authority Accrues from specialized knowledge • Morally Justified Authority Institutions can try to direct engineers to do things that are not "morally justified"

	• Obliged to respect legitimate authority Does not give right to ignore legitimate directives Respecting authority comes second when: Lives are threatened Financial corruption is involved Grave economic loss may result **Conflict of interest: (2 M)** • "Professional conflicts of interest are situations where professionals have an interest which, if pursued, might keep them from meeting their obligations to their employers or clients."(M&S) • Three types of conflict of interest (Harris, Pritchard and Rabins, 2000) **(4 M)** • Actual • Potential • Apparent
9	**Explain the concept of Human rights and employee rights. And its role in organisation (13M) (MAY/JUNE 2014) (Nov/Dec 2013) (NOV/DEC 2014) (APRIL/ MAY 2015) (APR/MAY 2017)** BTL2 **Answers refer notes.** **Human rights: (3 M)** • Based on the principle of respect for the individual. • Each person morally, rationally treated who deserves to be treated with dignity. • Rights to which everyone is entitled—no matter who they are, where they live—simply because they are alive. **Employee rights. (2 M)** • An employee right can be any right, moral or legal, that involves status of being an employee. • They involve some professional rights also, such as the right to be paid according to the salary mentioned in one's contract. • Privacy and equal opportunity can be considered essential rights too. **Employee rights (4 M)** All employees have basic rights in the workplace -- including • The right to privacy • Fair compensation • Freedom from discrimination. • Equal Opportunity – Non-discrimination • Equal opportunity – Affirmative Action

	Rights of an Employee: (4 M) An employee is, at the very least, entitled to the following rights at his workplace − • No discrimination at work, especially on the basis of gender, nationality, religion, medical condition, and political affiliation. • Healthy work-life balance, which means no long hours at work. Employees can also report if their employer makes unnecessary delays in delegating work. • Protection of job for people with disabilities and medical conditions. • Complete protection against sexual harassment of any kind and immunity from being forced to exchange favors for benefits. • Freedom to discuss the terms and conditions of the employment with other employees and negotiating wages to suit lifestyle as per changing times. • Right to ask for safe working conditions and reservation to answering questions on age, religion, nationality, and medical condition. • Demanding certain changes and modifications regarding the working conditions to accommodate situations that might crop up due to their prevailing medical conditions. • Right to form or participate a union that aims to improve the wages, lifestyle, working environment, and emphasizes on employee rights at the workplaces.
10	**Discuss professional rights in an engineer field.(13M) (APRIL/ MAY 2015) (MAY/JUNE 2014) (NOV/DEC 2014) (Nov/Dec 2013)** BTL2 **Answer: Page: 163 - Mike W. Martin** **Professional Rights (3M)** The rights that engineers have as professionals are called Professional Rights. These professional rights include : • The basic right of professional conscience. • The right of conscientious refusal. • The right of professional recognition **Professional rights set by professional societies (10 M)** • Guided in all their relations by the highest standards of honesty and integrity. • Engineers shall at all times strive to serve the public interest. • Engineers shall avoid all conduct or practice that deceives the public. • Not disclose, without consent, confidential information concerning business affairs.

	• Engineers shall not influence in their professional duties by conflicting interests. • Engineers shall not attempt to injure, maliciously or falsely, directly or indirectly. • Guilty of unethical, illegal practice shall present information to proper authority for action. • Credit for engineering work to those to whom credit is due, recognize proprietary interests of others.
11	**Discuss the 'faithful agent argument' and 'public service argument' of collective with suitable examples. (13M) (NOV-DEC 2018)** BTL2 Answer Refer notes: Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest or the appearance of conflicts of interest. (7 M) a. Engineers shall avoid all known conflicts of interest with their employers which could influence their judgment or the quality of their services. b. Engineers shall not undertake any assignments which would knowingly create a potential conflict of interest between themselves and their clients or their employers. c. Engineers shall not accept compensation, financial or otherwise, from more than one party for services on the same project. d. Engineers shall not solicit or accept financial or other valuable considerations, for specifying products without disclosure to their clients or employers. e. Engineers shall not solicit or accept gratuities, directly or indirectly, from contractors, their agents, or employers in connection with work for which they are responsible. f. Engineers shall not participate in considerations or actions with respect to services provided by them or their organization(s) in private or product engineering practice. g. Engineers shall not solicit an engineering contract from a governmental body or other entity on which a principal, officer. h. Engineers shall exercise careful judgment in their determinations to ensure a balanced viewpoint, and avoid a conflict of interest. i. When, as a result of their studies, Engineers believe a project(s) will not be successful, they shall so advise their employer or client. j. Engineers shall treat information coming to them in the course of their assignments as confidential, and shall not use such information as a means of making personal profit. (1) They will not disclose confidential information concerning the business

affairs or technical processes

(2) Not reveal confidential information or finding of any commission or board of which they are members unless required by law or court order.

(3) Designs supplied to Engineers by clients shall not be duplicated by the Engineers for others without the express permission of the client(s).

k. Engineers shall act with fairness and justice to all parties when administering a construction (or other) contract.

l. Before undertaking work for others in which Engineers may make improvements, plans, designs, inventions, Engineers shall enter into positive agreements regarding the rights of respective parties.

m. Engineers shall admit their own errors when proven wrong and refrain from distorting or altering the facts to justify their mistakes or decisions.

n. Engineers shall not accept professional employment or assignments outside of their regular work without the knowledge of their employers.

o. Engineers shall not attempt to attract an employee from other employers or from the marketplace by false or misleading representations.

'PUBLIC SERVICE ARGUMENT' (6 M)

Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties.

a. Engineers shall recognize that the lives, safety, health and welfare of the general public are dependent upon engineering judgments.

b. Engineers shall not approve nor seal plans and/or specifications that do not conform with accepted engineering standards.

c. Should the Engineers' professional judgment be over ruled under circumstances where the safety, health, and welfare of the public are endangered.

(c.1) Engineers shall do whatever possible to provide published standards, test codes and quality control procedures that will enable the public to understand the degree of safety.

(c.2) Engineers will conduct reviews of the safety and reliability of the design, products or systems for which they are responsible before giving their approval to the plans for the design.

(c.3) Should Engineers observe conditions, which they believe, will endanger public safety or Health.

d. Should Engineers have knowledge or reason to believe that another person or firm may be in violation of any of the provisions of the Guidelines?

(d.1) They shall advise proper authority if an adequate review of the safety and reliability of the

	Products or a system has not been made. (d.2) They shall withhold approval of products of systems when changes or modifications are made which would adversely affect its performance insofar as safety and reliability are concerned. e. Engineers should seek opportunities to be of constructive service in civic affairs and work for the advancement of the safety, health and well being of their communities. f. Engineers should be committed to improving the environment to enhance the quality of life.
12	**Explain the factors that affect Risk Acceptability? And the knowledge required to assess the risk by engineer.(13M) (MAY- JUN 2016) (Nov/Dec 2013)** BTL2 **The Factors That Affect Risk Acceptability (6 M)** • Voluntarism and control • Effect of information on risk assessment • Job related pressures • Magnitude and proximity of the people facing risk **The knowledge required to assess the risk by engineer (7M)** • Data in design • Uncertainties in design • Testing for safety • Analytical testing • Risk-benefit analysis
	PART * C
1	**Discuss the significance of intellectual property rights. Also Explain the legislations covering intellectual property rights in India. (15M) (NOV/DEC 2013) (MAY-JUN 2016) (MAY/JUNE 2014) (NOV/DEC2014)** BTL2 **Answers refer notes.** **SIGNIFICANCE: (4 M)** • Clear identification of the IP. • Unambiguous title to the asset. • Qualitative and quantitative characteristics of the IP. • Earnings capacity and profitability relating to the IP. • Market share supported by, or as a result of, the IP. • Legal rights restrictions, competition, barriers to entry, risks associated with the IP. • Product life cycles and positioning.

	• Historical growth and prospects for the future. **Firms of all sizes and purpose are motivated by similar goals in the creation of such programs:** • To identify what constitutes a risk sensitive intangible asset; **(4 M)** • To address new and emerging threats to IP; • To properly allocate available risk resources given limited funds; and • To achieve compliance within the legal and regulatory environment in which they operate. The TRIPS Agreement came into effect on 1st January 1995, is considered till date most complete multilateral agreement on intellectual property. The areas of intellectual property, it covers are as following: **(7 M)** • Trademarks which include service marks as well. • Industrial designs. • Copyright and related rights (i.e. producers of broadcasting organisation, the rights of performers) • Geographical indications which include appellations of origin. • The lay-out designs (topographies) of assimilated circuits. • The information which are not closed which includes test data and trade secrets. • Patents which include protection of new varieties of plants.
2	**(i) Discuss the significance of loyalty and collegiality in team work.(15M)(MAY-JUN 2014) (NOV/DEC2014) (APRIL/ MAY 2015)** **(ii) Explain the different types of collective bargaining.(APRIL/ MAY 2015)** BTL2 **Answer: Page: 150-151 - Mike W. Martin.** • **Loyalty** **(4 M)** Loyalty is the faithful adherence to an organization, employer. **Loyalty to an employer can be either of the two types:** • **Agency-loyalty:** Acting to fulfill one's contractual duties to an employer. • **Attitude-loyalty :** A lot to do with attitudes, emotions A sense of personal identity as it does with actions. **Collegiality** **(3 M)** • To improve the respect in work place • To help to maintain the better relation in the organisation • To increase the value of relationship

	• To maximise the method of communication • Motivates unity in the workplace. • Offers differing perspectives and feedback • Improved efficiency and productivity • Provides great learning opportunities • Promotes workplace synergy **Definiton:** Collective Bargaining. **(2 M)** The Collective Bargaining is the process wherein the unions (representatives of employees or workers), and the employer meet to discuss the issues related to wage, the number of working hours, work environment and the other terms of the employment **Types of collective bargaining:** **(6 M)** • Conjunctive or Distributive Bargaining • Co-operative or Integrative Bargaining • Productivity Bargaining • Composite Bargaining
3	**Discuss the features of whistle blowing. (15M) (NOV/DEC2014) (15M)** BTL2 **Answer : Page: 177 to 178 - Mike W. Martin** **The features of whistle blowing:** • Evidence A whistleblower must have evidence that someone, usually a corporation or government contractor • Documentation The whistleblower needs to have more than just suspicions; he or she needs to collect concrete and legitimate documentation of the wrongdoing • Information Gathering Names and contact information of the parties involved in the wrongdoing, laws that he or she believes are being violated by said parties • Confidentiality The whistleblower should keep the information and the case absolutely confidential and avoid discussing it with anyone. • Settle in for the Long Haul Since cases like these often take a long time to settle, the whistleblower should prepare for a long process • Prepare for Backlash It's not uncommon for a whistleblower to be accused of being privy to the wrongdoing or even

	participating in it. • Look for New Employment Whistleblowers can get a bad reputation, which can affect finding a new job, so getting a new one before that happens is important • Be a Model Citizen Being a model citizen and not doing anything that can be used against them is important for whistleblowers. • Get Support In addition to finding an attorney for legal help, whistleblowers should look into resources like the National Whistleblowers Canter
4.	**Safety in a commodity comes with a price' – Explain. And discuss how the knowledge of risk is always better for safety with suitable examples. (15M) (NOV-DEC 2018)** BTL2 **Answer refer notes:** **Safety in a commodity comes with a price' (8 M)** • Absolute safety is never possible to attain and safety can be improved in an engineering product only with an increase in cost. • On the other hand, unsafe products incur secondary costs to the producer beyond the primary (production) costs, like warranty costs loss of goodwill, loss of customers, litigation costs, downtime costs in manufacturing, etc. • Figure indicates that P-Primary costs are high for a highly safe (low risk) product and S-Secondary costs are high for a highly risky (low safe) product. • If we draw a curve T=P+S as shown, there is a point at which costs are minimum below which the cost cannot be reduced. If the risk at Minimum Total Cost Point is not acceptable, then the producer has to choose a lower acceptable risk value in which case the total cost will be higher than M and the product designed accordingly. • It should now be clear that safety comes with a price only. **"Knowledge of risk for better safety".(7 M)** • Robert Stephenson writes that all the accidents, the harms caused and the means used to repair the damage should be recorded for the benefit of the younger Members of Profession. • A faithful account of those accidents and the damage containment was really more valuable than the description of successful work. • Hence it is imperative that knowledge of risks will definitely help to attain better safety.

	But it should be borne in mind, that still gaps remain, because i) There are some industries where information is not freely shared ii) There are always new applications of old technology that render the available information less useful.

	UNIT V GLOBAL ISSUES
	Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct.
	PART * A
1	**State the term called embezzlement. (APRIL/ MAY 2011)** BTL2 Embezzlement is a form of white-collar crime wherein a person or entity misappropriates the assets entrusted to him or her. In this type of fraud the assets are attained lawfully and the embezzler has the right to possess them, but the assets are then used for unintended purposes. Embezzlement is a breach of the fiduciary responsibilities placed upon a person.
2	**What is technology transfer? (APRIL/ MAY 2010)** BTL2 Technology transfer is a process of changing the technology to a new setting and implementing it. Technology includes hardware such as machines and installations as well as techniques such as technical, organizational and managerial skills and procedures**.**
3	**Write a note on moral leadership. APRIL/MAY2010) (NOV/DEC 2014)** BTL2 Whenever the goals of a leader become permissible and also morally valuable, it is known as moral leadership. Moral leadership also means that employing morally acceptable ways to motivate the groups to move towards morally desirable ways. The ways are depending on the situations.
4	**State the most important ethical mistake made by the multinational corporation which caused Bhopal gas plant disaster. (NOV/DEC 2010)** BTL1 • The tanks used to store Methyl Iso-cyanate were overloaded to a tune of 75%. • The emergency plant was also filled with a large amount of chemicals. • The entire refrigeration unit had been shut down as a measure to reduce the cost and this Led to increase of temperatures to a higher level. • One of the disappointed workers unscrewed a pressure gauge on a tank and inserted a hosepipe into it, knowing that it would cause damage, but not to this extent. • Scrubber has also been shut down. • Flare tower was also not in an operating condition. • Unfortunately there were no emergency drills or evacuation plants available.
5	**Define Conflict resolution. (APRIL/ MAY 2010)** BTL2 Conflict resolution means a process of resolving dispute or disagreement. It mainly aims at

	reconciling opposing arguments in a manner that promotes and protects the human rights of all parties concerned.
6	**What is contextualizing? (APRIL/MAY 2010)** BTL2 In accordance to Gilligan women try hard to preserve personal relationship with all people. This context-oriented emphasis on maintaining personal relationship is called as ethics of care in contrast With ethics of rules and rights.
7	**Give a short note on ethical pluralism and ethical relativism. (APRIL/MAY 2010)** BTL2 Ethical pluralism: According to this view there may be alternative moral perspectives that are reasonable, but no one of which must be accepted completely by all rational and morally concerned persons. Ethical relativism: Actions are morally right when they are approved by law or custom they are wrong when they violate laws or customers.
8	**What should an ethical expert witness, even though hired by a company, expected to do? (APRIL/MAY 2010)** BTL2 Engineers should not become the hired-guns to their clients, but instead remain as objective as humanly possible in their investigations and the conclusions they reach .They should avoid biases resulting from money ego, and sympathy.
9	**List down the international rights listed by Donaldson. (NOV/DEC 2014)** BTL2 Thomas Donaldson in his book _The ethics of International Business,, has listed the following as the International rights: • The right to freedom of physical movement • The right to ownership of property • The right to freedom from torture • The right to a fair trial • The right to non discriminatory treatment • The right to physical security • The right to freedom of speech and association • The right to minimal education • The right to political participation • The right to subsistence.
10	**Define appropriate technology. (Nov 2008)** BTL2 Appropriate technology refers to the identification, transfer and implementation of the most suitable technology for a new set of conditions.

11	**List out four examples for Multinational Corporation.(Nov 2010)** BTL1 Large corporations having investment and business in number of countries are known as Multinational or Transnational corporation. Some of them are : Hindustan Lever, Ford, Toyota, Sony, LG, Smith Kline Beecham, ITC, Ponds etc.
12	**Define computer ethics. (DEC/NOV2010) (NOV/DEC 2016)** BTL2 Ethics is a set of moral principles that govern the behaviour of a group or individual. Therefore, computer ethics is set of moral principles that regulate the use of computers. Some common issues of computer ethics include intellectual property rights (such as copyrighted electronic content), privacy concerns, and how computers affect society.
13	**Write a short note on globalization. (MAY/JUN2016)**BTL2 Our lives are increasingly dependent upon the goods/services produced over the world and are influenced by the business from around all the corners of the world. In general world has become a global village and have a global economy. The increasing international flow of capital, technology, trade, and people have had the effects of changing the nature of local organizations governments and people of countries and have led to social changes and developments.
14	**List the three senses of relative values. (DEC/ NOV 2012)** BTL2 • Ethical Relativism The theory that holds that morality is relative to the norms of one's culture. • Descriptive Relativism The existence of moral disagreements between cultures or individuals. • Moral Relativism More easily understood in comparison to moral absolutism. Absolutism claims that morality relies on universal principles (natural law, conscience).
15	**What are the normal issues arise in Multinational Corporation?(MAY/JUNE 2014)** BTL2 Ethical dilemmas faced by certain companies may be specific to their industry or company; other types of ethical issues are common to all types of companies. Handling ethical decisions with wisdom is especially important for small businesses, given the potentially devastating effects these companies may face if such issues aren't handled correctly**.**
16	**Differentiate the Eye witness and expert witness in the legal system. (MAY/JUNE 2014)** BTL4 An eyewitness is one who testifies what they perceived through his or her senses (e.g. Seeing, hearing, smelling, touching). That perception might be either with the unaided human sense or

	with the aid of an instrument, e.g., microscope or stethoscope, or by other scientific means, e.g. a chemical reagent which changes color in the presence of a particular substance An expert witness is one who allegedly has specialized knowledge relevant to the matter of interest, which knowledge purportedly helps to either make sense of other evidence, including other testimony, documentary evidence or physical evidence (e.g., a fingerprint)
17	**What is meant by Moral Leadership? (NOV/DEC 2013) (MAY/JUN 2016) (APRIL/ MAY2015) (NOV–DEC 2014)** BTL2 Moral Leadership is a very different kind of leadership. Rather than aspiring to being followed, Moral Leaders aim to serve. Instead of showcasing their own skills, Moral Leaders tend to develop the capacities of others.
18	**Define the term honesty and moral leadership.** BTL2 Honesty :A facet of moral character that connotes positive and virtuous attributes such as Integrity, truthfulness, and straightforwardness, along with the absence of lying, cheating, or theft "Moral Leadership": A process of social influence in which one person enlists the aid and support of others in accomplishing a common task.
19	**Write a note on business ethics. (APRIL/ MAY2015)** BTL2 Business ethics (also corporate ethics) is a form of applied ethics or professional ethics that Examines ethical principles and moral or ethical problems that arise in a business environment. It applies to all aspects of business conduct and is relevant to the conduct of individuals and entire organizations**.**
20	**What is meant by hired guns? (APRIL/ MAY 2011)** BTL2 Engineers are hired by attorneys to help them to establish the facts in away favourable to their clients. The hired guns violate the standards of honesty and also due care in conducting investigations.
21	**What is meant by corporate social responsibility?(NOV-DEC 2018)(APR-MAY 2017)** BTL2 Corporate social responsibility (CSR) is how companies manage their business processes to produce an overall positive impact on society. It covers sustainability, social impact and ethics, and done correctly should be about core business - how companies make their money - not just add-on extras such as philanthropy.
22	**What are demerits of MNC'S to host country? (NOV-DEC 2018)** BTL2 (i) Danger for Domestic Industries (ii) Repatriation of Profits

	(iii) No Benefit to Poor People (iv) Danger to Independence (v) Disregard of the National Interests of the Host Country (vi) Misuse of Mighty Status (vii) Careless Exploitation of Natural Resources
	PART * B
1	**Explain the philosophical view of nature in environmental ethics. Discuss the approaches to resolve environmental problems.(APRIL/ MAY2011) (APRIL/ MAY2015) (MAY–JUN 2014) (NOV–DEC 2013) (NOV–DEC 2014) (13M)** BTL2 **Answer: page: Refer Notes** **The philosophical view of nature: (8 M)** • Sentient – centered ethics • Bio-centric- Ethics • Eco-centric – ethics • Human - centered environmental ethics **The approaches to resolve environmental problems: (5 M)** • Cost oblivious approach • Cost benefit analysis
2	**Describe the Bhopal Gas Tragedy and its effects.(APRIL/MAY 11) (13M)** BTL2 **Answer: Page: 245-248 - Mike W. Martin** **Introduction (5 M)** Bhopal disaster, also referred to as the Bhopal gas tragedy, was a gas leak incident on the night of 2–3 December 1984 at the Union Carbide India Limited (UCIL) pesticide plant in Bhopal, Madhya Pradesh, India. It was considered as of 2010 to be the world's worst industrial disaster **Explanation (8 M)** • Liquid MIC storage • Earlier leaks • Acute effects • Gas cloud composition • Immediate aftermath • Subsequent legal action • Post-settlement activity
3	**Explain the different code of ethics of professional engineering societies. (NOV/DEC**

	2012) (13M) BTL2 **Answer: Refer Notes** **Code of ethics Meaning:(2 M)** To provide basic framework for ethical judgment for a professional. **Code of ethics of professional engineering societies.(11M)** ▪ American society of mechanical engineers ▪ American society of civil engineers ▪ Institute of electrical and electronics engineers ▪ The institution of engineers ▪ National society of professional engineers ▪ American institute of chemical engineers ▪ Association of computer machinery ▪ Computer society of India
4	**Write briefly on Engineer used as expert witness and advisers. (13 M) (APR-MAY2017) (MAY/JUNE 2013) (MAY/JUNE 2014) (NOV–DEC 2018) (NOV–DEC 2015) (MAY/JUN 2016) (NOV–DEC 2014)** BTL3 **Answer: Refer Notes** **Engineer used as expert witness. (2 M)** "An expert witness is a witness who has knowledge beyond that of the ordinary lay person enabling him/her to give testimony regarding an issue that requires expertise to understand." USLEGAL goes on to explain, "Experts are allowed to give opinion testimony which a non-expert witness may be prohibited from testifying to. In court, the party offering the expert must lay a foundation for the expert's testimony. Laying the foundation involves testifying about the expert's credentials and experience that qualifies him/her as an expert. Sometimes the opposing party will stipulate (agree to) to the expert's qualifications in the interests of judicial economy." **Abuses of engineers as expert witness: (5 M)** • Hired guns • Financial biases • Ego biases • Sympathy biases **Engineers as expert advisers: (6 M)** **Normative model of advisers:** • Hired guns • Value neutral analysts • Value guided advocates
5	**Discuss the roles and responsibilities of engineers and managers. (13 M) (MAY/JUNE 2014) (NOV–DEC 2014)** BTL2 **Answer : Refer Notes** **Roles of managers: (7 M)**

	• Interpersonal • Informational • Decisional **Responsibilities of engineers and managers: (6 M)** • Promoting ethical climate • Resolving the conflicts • Principles of conflict resolution
6	**Explain the engineers as consultants. (13 M) (MAY/JUNE 2014) (APR-MAY 2017 (NOV-DEC 2018) (NOV–DEC 2015)** BTL2 **Answer Refer notes.** **Introduction: (2M)** Engineers in consulting engineering companies come from virtually every discipline and specialty. These engineers are often referred to as consulting engineers and they participate in project teams to help the consulting engineering firm deliver services to its clients. **The responsibilities of consulting engineers: (11 M)** • Advertising • Competitive bidding • Contingency fees • Safety and client needs • Provision for resolution of disputes
7	**Discuss the following in detail Computer Ethics. (13M)(NOV/DEC2013) (NOV–DEC 2015) (APR-MAY 2017)(MAY/JUNE 2014) (NOV–DEC 2014)**BTL2 **Answer Mike W. Martin pg no 254 and 266** **Computer Ethics: (2 M)** Computer ethics deals with the procedures, values and practices that govern the process of consuming computing technology and its related disciplines without damaging or violating the moral values and beliefs of any individual, organization or entity. In 1991 the Computer Ethics Institute held its first National Computer Ethics Conference in Washington, D.C. The Ten Commandments of Computer Ethics were first presented in Dr. Ramon C. Barquin's paper prepared for the conference, "In Pursuit of a 'Ten Commandments' for Computer Ethics." **The Computer Ethics Institute published them as follows in 1992: (5 M)** • Not use a computer to harm other people. • Shall not interfere with other people's computer work.

	• Thou shall not snoop around in other people's computer files. • Not use a Computer to steal. • Should not use a computer to bear false witness. • Shall not copy or use proprietary software for which you have not paid. • Do not use other people's computer resources without authorization or proper compensation. • Not appropriate other people's intellectual output. • Do think about social consequences of program you are writing or system you are designing. • Shall always use a computer in ways, insure consideration and respect for your fellow humans. • ethics codes of conduct and resources Important unethical act under this categories: (6 M) • Bank robbery • Privacy • Hacking • Computer viruses
8	**Explain the characteristics of moral leader in detail**. **(13 M) (NOV/DEC2013) (MAY/JUNE 2014) (APR/MAY 2015) (NOV/DEC 2014)** BTL2 **Answer : Page: 39 - Mike W. Martin** **Moral Leadership (2 M)** Moral Leadership is a very different kind of leadership. Rather than aspiring to being followed, Moral Leaders aim to serve. Instead of showcasing their own skills, Moral Leaders tend to develop the capacities of others. **CHARACTERISTICS OF MORAL LEADER(11M)** ○ Justice ○ Respect others ○ Honesty ○ Humane ○ Focus on teambuilding ○ Value driven decision-making ○ Encourages initiative ○ Leadership by example ○ Values awareness

	○ No tolerance for ethical violations
9	**Discuss the corporate social responsibility in detail. (MAY/JUNE 2014) (NOV/DEC 2016) (13M)**BTL2 **Answer : Refer notes** **CORPORATE SOCIAL RESPONSIBILITY: (2 M)** Corporate Social Responsibility is the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large. **TYPES OF CORPORATE SOCIAL RESPONSIBILITY: (5 M)** ○ Environmental Responsibility ○ Philanthropic Initiatives ○ Ethical Business Practices ○ Economic Responsibility **ADVANTAGES OF CSR: (6 M)** ○ The ability to have positive impact in the community ○ It supports public value outcomes: ○ It supports being an employer of choice: ○ It encourages both professional and personal development ○ It enhances relationships with clients
10	**Explain the problems of defence industry with examples. (13M) (MAY/JUNE 2014) (13M)**BTL2 **Answer: Refer Notes (13 M)** **1.Large military build-ups:** $2 billion cost overrun on the development of C5-A cargo plane reported to the public by Ernest Fitzgerald due to poor operating efficiencies in defence industry. He pointed out how large suppliers felt secure in not complying with cost-cutting plans but small contractors were willing.25% firms hold 50%of all defence contracts and 8 firms conduct 45% of defence research. **2. Technology creep:** The arms are not only growing in size, it is also becoming better. The development of a new missile or one that can target more accurately, by one country, can upset or destabilize a diplomatic negotiation. Sometimes this fad for modernization leads to undesirably consequences. The F15 fighter planes were supposed to be fastest and most manoeuvrable of its kind but most were not available for service due to repairs, defects and lack of spares.

	Engineers should be bewaring of such pitfalls. **3. Impact of secrecy:** Secrecy poses problems to engineers. Engineers should be aware of the answers to the following questions: Should discoveries of significance to military be informed to govt.? Can they be shared with other researchers, in other countries? Should they be withheld from the scientific and public community? **4. Effect on economy:** Every dollar spent on defence produces less jobs than what could be provided for by using the resource on other neglected sectors such as education and road development.
	PART * C
1	**Discuss the various features of multinational corporation. (15M) (APR/MAY2015) (NOV/DEC 2016)** BTL2 **Answer: Refer notes.** **MULTINATIONAL CORPORATION:** Definition: (2 M) A multinational company is a business that operates in many different countries at the same time. In other words, it's a company that has business activities in more than one country. Example: (2 M) The true definition of a multinational company isn't that it manufactures in other countries, however; the true meaning is that the business has operations in multiple countries. This can take form in many different ways besides manufacturing. Take McDonalds for example. They have almost 35,000 restaurants located in 119 countries around the world. This means that not only operate the physical restaurants, they also operate supply chains to deliver the beef and other products required to keep their locations working properly. **Features of Multinational Corporations (MNCs): (11 M)** **Following are the salient features of MNCs:** ▪ Huge Assets and Turnover ▪ International Operations Through a Network of Branches ▪ Unity of Control ▪ Mighty Economic Power ▪ Advanced and Sophisticated Technology ▪ Professional Management ▪ Aggressive Advertising and Marketing ▪ Better Quality of Products

2	**Discuss the ethical issues related to weapon development. (15M) (NOV/DEC2014) (MAY/JUNE 2014) (MAY/JUN 2016) (NOV – DEC 2018)** BTL2 **Answer: Refer notes.** **Introduction: (2 M)** • Military activities including world wars have stimulated growth of technology. • The growth of internet amply illustrates this fact. • The development of warfare and the involvement of engineers bring out many ethical issues concerned with engineers. **Role of Engineers in weapons development: (13 M)** • It gives one job with high salary. • One takes pride and honor in participating in the activities towards the defense of the nation. • Engineers are capable of innovating and developing new weapons. • Many of the rational engineers feel that they cannot work on designing weapons, which are ultimately used to kill human beings. Even though they are not ultimate users of those weapons, they find it morally unacceptable to work on such areas. • One believes the he fights a war on terrorism and thereby contribute to peace and stability of country. • Ironically, the wars have never won peace, only peace can win peace. • By research and development, engineer is reducing or eliminating risk from enemy weapons. • Savings ones country from disaster. • By building up arsenals, show of force, a country can force rough country, towards regulation. • Engineers can participate effectively in arms control negotiation for surrender or peace • Bombing of Nagasaki and Hiroshima led to surrender by the Japanese in 1945. • Many engineers had to fight and convince their personal conscience. • Engineers must have the potential judgments to serve in defense works that would jeopardize the human community.
3	**Explain the advantages and disadvantages of multinational corporation. (15M) (NOV/DEC 2016)**BTL2 **Answer: Page: 155 - Mike W. Martin** **Advantages of MNCs : (8 M)** ▪ Employment Generation:

- Automatic Inflow of Foreign Capital:
- Proper Use of Idle Resources:
- Improvement in Balance of Payment Position:
- Technical Development:
- Managerial Development:
- End of Local Monopolies:
- Improvement in Standard of Living:
- Promotion of international brotherhood and culture:

Limitations of MNCs : **(7 M)**

- Danger for Domestic Industries:
- Repatriation of Profits:
- No Benefit to Poor People:
- Danger to Independence:
- Disregard of the National Interests of the Host Country:
- Misuse of Mighty Status:
- Careless Exploitation of Natural Resources:
- Selfish Promotion of Alien Culture:
- Exploitation of People, in a Systematic Manner

GE 6757 TOTAL QUALITY MANAGEMENT L T P C

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UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, and Customer retention - Costs of quality.

UNIT II TQM PRINCIPLES 9

Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS AND TECHNIQUES I 9

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT IV TQM TOOLS AND TECHNIQUES II 9

Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors.

TOTAL: 45 PERIODS

OUTCOMES: The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.

TEXT BOOK:

1. Dale H. Besterfiled, et at., "Total quality Management", Third Edition, Pearson Education Asia,

Indian Reprint, 2006. REFERENCES:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th

Edition, First Indian Edition, Cengage Learning, 2012.

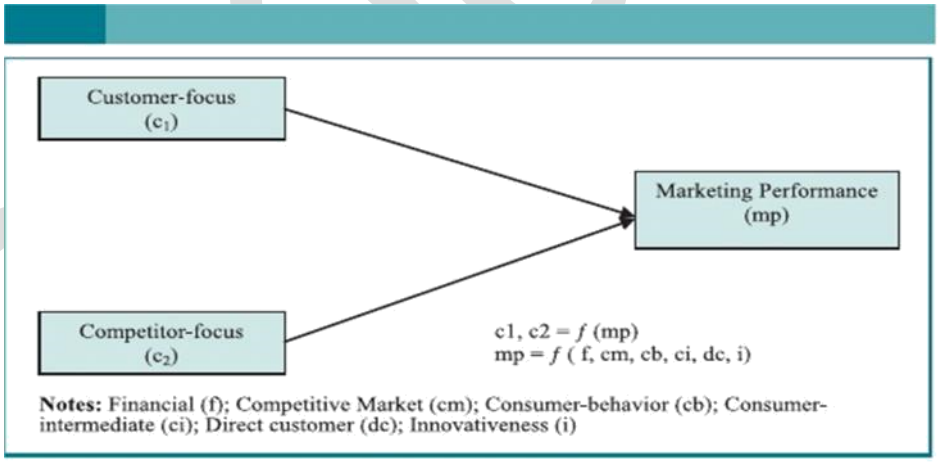
2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.

3. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.

UNIT I INTRODUCTION

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, and Customer retention - Costs of quality.

PART * A

Q.No.	Questions
1.	**Define Quality. (June 2016, June 2015, June 2014, April/May 2019)** BTL 1 Fitness for intended use. (Joseph Juran). 2. Conformance to specifications. (Philip Crosby). 3. The totality of features of a product or service that bears on its ability to satisfy a stated or implied need. Thus Quality is termed as the conformance that assures the customer the right quality / specifications of the product that it intends to provide functionally with good reliability and after service.
	What is the relationship between competition and customer focus? (May 2014) BTL 1 Customer – focus is significantly related to marketing performance food and beverages organizations in Nigeria. Competitor-focus is significantly related to marketing performance of food and beverages organizations in Nigeria 
2	**Define Total Quality Management. (Dec 2011, Dec 2013, May 2015)** BTL 1 The art of managing the total organization to achieve excellence in all spheres of activity (Bester field). The integration of all functions and processes within an organization in order to achieve the continuous improvement of the quality of goods and services.TQM aims at reducing the input costs; increases profit and return on investment by improving the quality and productivity thereby usher the company or organisation to stay in business.
3	**Mention the basic features of TQM. (June 2013)** BTL 2

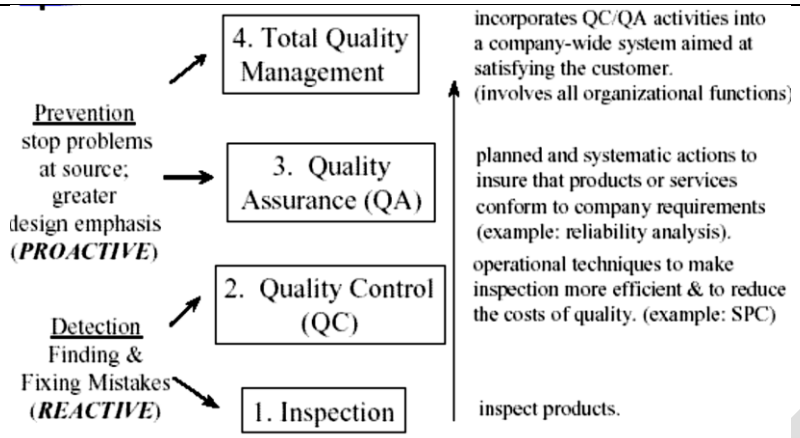
	Management commitment; focus on customer (both external and internal); employee involvement, empowerment; continuous improvement; treating suppliers as partners and establish performance measures for processes.
4	**Write the major benefits of TQM. (Nov 2011)** BTL 1 Improved quality; higher productivity, employee participation; teamwork, working relationships, customer satisfaction, employee satisfaction, communication, profitability, market share and stock price performance.
5	**Discuss some major obstacles or Barriers to TQM implementation. (Apr 2012, May 2015)** BTL 2 Lack of management commitment, Inability to change organizational culture, Improper planning, Lack of continuous training and education, Paying inadequate attention to internal and external customers, Inadequate use of empowerment and teamwork, Lack of employee involvement, Emphasis on short-term results, etc.
6	**Mention the four pillars of TQM. (April 2018)** BTL 1 Customer Satisfaction, Continuous Improvement, Quality Leadership and Systems Approach are the four main pillars of TQM.
7	**What are the different ways to create customer oriented culture in an industry? (Nov 2016)** BTL 2 1. Start at the top 2. Hire people who fit 3. Get everyone involved 4. Trust your team 5. Establish good lines of communication
8	**Write down the categories of quality cost? (Nov 2016)** BTL 2 1. Prevention costs 2. Appraisal costs 3. Internal failure costs and 4. External failure costs.
9	**Explain quality according to Juran & Deming. (Dec 2012, Dec 2015, Dec 2017, April/May 2019)** BTL 1 Juran defines quality as fitness for use in terms of design, conformance, availability, safety and field use. And this should be religiously practiced and followed across the organisation form production to aftermarket sales (service). Deming defines that quality is a predictable degree of uniformity and dependability, at low cost and suited to the market.
10	**How to measure dimensions of service quality? (Dec 2013, June 2013)** BTL 1 The aftermarket sales as referred to as Service to customer are of prime importance to business sustainability. The following ideologies helps in achieving the above said and they are Service duration, Timeliness, Completeness, Consistency, Convenience, Accuracy, Courtesy, etc.
11	**Compare quality requirements before and after TQM (Nov 2015) (April 2018)** BTL 4 **Quality Requirements Before TQM** — **Quality Requirements After TQM** Product oriented — Customer oriented Short term decisions — Long term decisions Emphasis on detection — Emphasis on prevention
12	**Explain the various quality statements. Write an example for quality statement. (June 2014, June 2016, Nov 2017)** BTL 1 The quality statements include the vision statement (universal), mission statement (task based), and quality policy (generalized) statement. Apart from the above the latest trend is the

	directions/guidelines given by the top management for the financial year which lays more emphasis on the immediate task to be planned and executed to meet the customer deadline and parallel working towards achieving long term vision of the organisation.
13	**What are the six basic concepts that a successful TQM programme requires? (Dec 2012, May 2012)** BTL2 The six basic concepts that a successful TQM programme requires 1. Top management commitment 2. Focus on the customer 3. Effective employee involvement 4. Continuous improvement 5. Treating suppliers as partners and 6. Establishing performance measures.
14	**List the dimensions of quality. What are the element of TQM? (May 2010, May 2013)** BTL2 The dimensions of quality are 1. Performance 2. Futures 3. Conformance 4. Reliability 5. Durability 6. Service 7. Response 8. Aesthetics and 9. Repetition.
15	**Define Quality Habit. (June 2011)** BTL 1 Quality is never an accident; it is always the result of high intention, sincere effort, intelligent direction and skilful execution; it represents the wise choice of many alternatives. It is a standard practice that must be followed effortlessly thereby achieving customer satisfaction and building trust and relationship with them.
16	**What is meant Zero Defects?** BTL 1 Zero Defects is a management tool aimed at the reduction of defects through prevention. It is directed at motivating people to prevent mistakes by developing a constant, conscious desire to do their job right the first time. Do it right the first time cost effectively, quality consciously and safety consciously is the mantra of today's, manufacturing system.
17	**Explain the seven deadly diseases.** BTL 1 The seven deadly diseases identified in an organisation that spoils the quality function are listed as Lack of constancy of purpose, Emphasis on short-term profits, Evaluation of performance, Mobility of management, Management by use only of visible figures, with little or no consideration of figures that are unknown or unknowable, Excessive Medical Costs, Excessive costs of liability.
18	**Define Quality Control.** BTL 1 Quality control (QC) is a procedure or set of procedures intended to ensure that a manufactured product or performed service adheres to a defined set of quality criteria or meets the requirements of the client or customer. It is a measure on the existing quality to evaluate the consistency of achieving the right quality at all times.
19	**How can quality are quantified?** BTL 2 Quality is mostly subjective but it can be quantified in terms of perceived expectations of the customers and the actual performance delivered by the product.

	Q = P / E Where, P-Performance and E-Expectations and Q-Quality Index
20	**Explain TQM triangle.** BTL 1 The essence of the total quality management concept is a triangle, each corner being a key point; the focus on the customer, continuous improvement, and teamwork.
21	**Define Deming Cycle (or) Define PDSA cycle.** BTL 1 P-D-S-A (Plan-Do-Study-Act) is a cycle of continuous improvement. Decide upon the type of quality problem to analyze and act upon with concrete solutions to the same in eliminating the quality problem from the process or product or services offered to the customer.
22	**Define SQC.** BTL 1 SQC stands for Statistical quality control. It is used to measure the degree of conformance of raw materials, processes and products to previously agreed specifications/standards.
23	**Define TQC and QA.** BTL 1 TQC stands for total quality control. TQC is the continuous process for improvement where current standards present the opportunity for the achievement of new and higher targets for improvement. This is a business philosophy that provides reliability and consistency in the delivered products/services as a check and balance system. QA stands for Quality Assurance. QA means basically the quality control is conducted in a systematic manner. It is a planned and systematic actions required to provide adequate confidence that the product or service with comply with the set standards or specification which was previously agreed upon.
24	**Define TQM as a part of competitive strategy.** BTL 2 Value = (Quality/Price). So the Customer plays an important role in determining or assessing the worthiness of the product/service and the value changes with time. Value is inversely proportional to the price criteria and economics deals it with the term so called market capitalization or Brand acquisition.
25	**Define Quality Cost and its factors(Nov/Dec 2018).** BTL 2 Quality costs are those costs associated with the non-achievement of product/service quality defined by the requirements established the organisation / customer or society. Trend analysis and Pareto analysis are used for analyzing the quality cost. 1. Prevention costs 2. Appraisal costs 3. Internal failure costs 4. External failure costs.
26	**Define importance of customer retention.** BTL 1 It costs a company six times more to sell a product to a new customer than it does to sell to an existing one. Loyal customers generate more revenue, and are also cheaper to maintain. Customer loyalty facilitates cross-selling/up-selling of a company's other products/services, and also acts as an effective barrier to the entry of competition.
27	**Write the importance of customer focus for an organization.** BTL 1 Customers are the most important asset of an organization. An organization's success depends on how many customers it has, how much they buy, how often they buy, and how long they are retained (loyalty).
28	**Define Vision statement.** BTL 2 A short declaration of what an organization aspires to be in the future. It is an ideal state that an organization continually strives to achieve. It is timeless, inspirational, and becomes deeply shared within the organization. It is of course long term strategy that the management declares with its counterparts. Vision is also referred to as long term strategy of an organisation.
29	**Write Mission statement.** BTL 2 The mission statement answers the following questions: who we are, who are our customers, what we do, and how we do it. The mission provides the guide map, milestones for achieving the vision. Mission is referred to as task based on priority and divided between departments or groups so that

	collective execution becomes effortless and ceaseless. Mission is also referred to as short term strategy and is of project specific.
	PART * B
1	**Describe the eight dimensions of quality? Discuss in detail. (**8M) **(June 2016, Dec 2011)** BTL 1 **Answer: Page No : 1.10 to 1.13 -Dr.V.Jayakumar** **Eight Dimentions** (6M) **Explanation:** (2M) 1. Performance 2. Features 3. Conformance 4. Reliability 5. Durability 6. Service 7. Response 8. Aesthetics 9. Reputation
2.	**Explain service quality in manufacturing industry. (13M) (June 2016)** BTL 4 **Answer: Page No : 1.13 to 1.16 -Dr.V.Jayakumar** **Dimensions of quantity in respect to service:** **Time:** This is the duration up to which a customer is made to wait. (1M) **Timeliness**: It refers to whether the promise can be kept or whether the service can be performed as promised. (1M) **Completeness**: It refers to whether all the items given by the customer is included. (2M) **Courtesy**: Whether the front office sales people greet each customer cheerfully and politely.**(**2M) **Consistency:** Whether the services are delivered in the same manner for every customer and every time for the same customer. (2M) **Accessibility and convenience**: Whether the service is easy to get for must the customer influence the service provider to get the required service. (5M) **Accuracy:** This is with regard to whether the service is done correctly even in the first instance- **Responsiveness**:Whether the service person reacts and cat quickly to resolve problems (2M)
3.	**State and explain the barriers to TQM implementation in an organization. (Dec 2012, Dec 2015,April/May 2019) (13M)** BTL 1 **Answer: Page No : 1.13 to 1.16 -Dr.V.Jayakumar** Headings: (8M) Content : (5M) **Barrier to Tqm:** 1. Lack of management commitment 2. Inadequate knowledge or understanding of TQM

	3. Inability to change organizational culture 4. Improper planning 5. Lack of continuous training & education 6. Inability to build a learning organization that provides for continuous improvement 7. Incompatible organizational structure , isolated individuals and departments 8. Insufficient resources 9. Inappropriate reward system 10. Use of a pre packaged program or inappropriately adapting TQM to organization 11. Ineffective measurement techniques and lack of access to data and results 12. Short-term focus or using a Band-Aid solution 13. Paying inadequate attention to internal and external customers
4.	**Explain the contributions of Deming, Juran to TQM. (June 2016, Dec 2013, April/May 2019) (13M)** BTL 2 **Answer: Page No :1.27 to 1.29;1.31 TO 1.33 -Dr.V.Jayakumar** **Demings 14 Points:** (8M) 1. Create constancy of purpose for improvement of products and service. 2. Adopt a new philosophy: we are in a new economic age. 3. Cease dependence upon inspection as a way to achieve quality. 4. End the practice of awarding business based on price tag. 5. Constantly improve the process of planning, production, and service- this system includes people. 6. Institute training on the job. 7. Institute improved supervision (leadership) 8. Drive out fear. 9. Break down barriers between departments. 10. Eliminate slogans/targets asking for increased productivity without providing methods 11. Eliminate numerical quotas. 12. Remove barriers that stand between workers and their pride of workmanship. 13. Institute programs for education and retraining. 14. Put all emphasis in the company to work to accomplish the transformation. **Juran:** contribution towards quality comprise the following aspects. (5M) 1. Internal customer 2. Cost of quality 3. Quality trilogy 4. Juran‟s 10 steps for quality improvement; 5. The breakthrough concept
5.	**Explain the concepts evolution and benefits of TQM principles. (June 2009) (13M)** BTL 2 **Answer: Page No : 1.24 -Dr.V.Jayakumar**



(9M)

To survive- companies had to make major changes- in their quality programs.
Many hired- consultants and instituted quality training programs- for their employees.
A new concept of quality was emerging.
One result is that quality began- to have a strategic meaning.
Today, successful companies -understand that quality provides - competitive advantage. They put the customer first -and define quality -as meeting or exceeding customer expectations. (4M)

6. **Explain TQM Framework and importance of each element with case study (13M) (May 2015, Dec 2015).** BTL 2

Answer: Page No : 1.21 TO 1.22 -Dr.V.Jayakumar

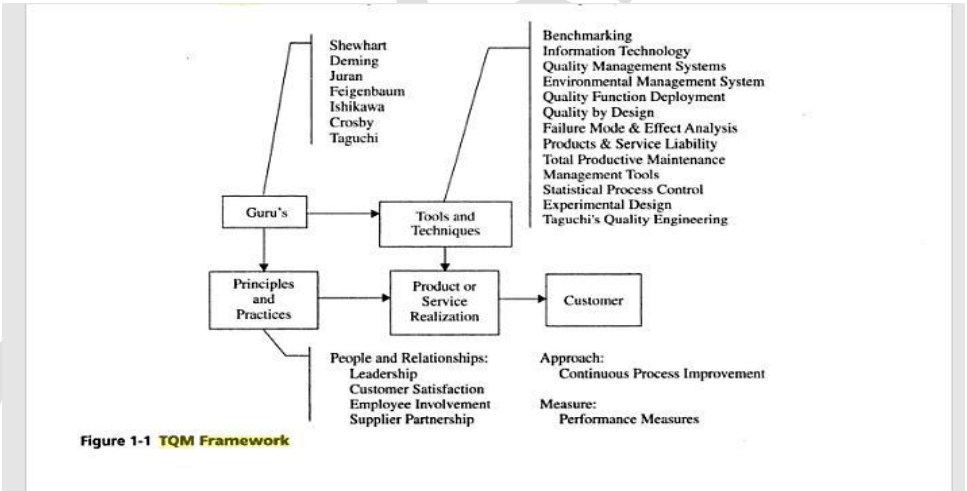


Figure 1-1 TQM Framework

(13M)

7. **Explain the basic concepts of TQM in detail. (13M) (Dec 2013, Dec 2015, Nov/Dec2018, April/May 2019)** BTL 2

Answer: Page No : 1.18 , 1.24 -Dr.V.Jayakumar

1. Focus on customer (both external and internal) (13M)
2. Employee involvement, empowerment
3. Continuous improvement
4. Treating suppliers as partners
5. Establish performance measures for processes
6. Designing products for quality
7. Quality at source

	8. Defect prevention 9. Root cause corrective action 10. Benchmarking 11. Training 12. Positive motivation 13. Team work 14. Management by fact and 15. Quick response.
8.	**Explain the concepts evolution and benefits of TQM principles.** (13M) **(June 2009)** BTL 2 **Answer: Page No : 1.18 , 1.24 -Dr.V.Jayakumar** 1. Management commitment, 2. Focus on customer (both external and internal), 3. Employee involvement and empowerment, 4. Continuous improvement, 5. Treating suppliers as partners, 6. Establish performance measures for processes, 7. Designing products for quality, 8. Quality at source, Defect prevention, 10. Root cause corrective action, 11. Benchmarking, 12. Training, 13. Positive motivation, 14.Team work, 15. Management by fact, and 16. Quick response. **(**5M) **Cause-and-effect cycle of TQM:**TQM ; High quality product/service ;High productivity, lower cost ;Lower price ;More competitive position ; High profit, growth ; Job security ; Satisfying place to work. (3M) **Stages in the evolution of quality:** Inspection; Quality Control (QC) ; Quality Assurance (QA) ; Quality Mgmt. (QM) ; TQM (2M) **Benefits of quality systems:** Increase in – system efficiency, worker morale, customer satisfaction. Decrease in – complaints, costs, production time. **(**3M)
9.	**Define customer satisfaction. Write a customer satisfaction model. (13M) (May 2011)** BTL1 **Answer: Page No :2.1 -Dr.V.Jayakumar** Service quality -comparison of **expectations** with performance. A business with high service quality -will meet customer needs -whilst remaining economically competitive. Improved service quality- increase - economic competitiveness. **(**3M) **Elements towards Customer Satisfaction** "Customer satisfaction provides - leading indicator -of consumer purchase intentions and loyalty." "Customer satisfaction data -are among the most frequently collected indicators - market perceptions. Their principal use - twofold:" (3M) "Within organizations- the collection, analysis and dissemination -of these data send a message - about the importance of tending to customers and ensuring that- they have a positive experience with the company's goods and services." (3M) "Although sales or market share can indicate how well a firm is performing *currently*, satisfaction is perhaps the best indicator of how likely it is that the firm's customers will make further purchases *in the future*. Much research has focused on the relationship between customer satisfaction and retention. Studies indicate that the ramifications of satisfaction are most strongly realized at the extremes." **(**3M)

10	**Explain the 6 basic concepts of TQM (OR) Write down the underlying principles of TQM. (13) (Nov/Dec 2011)(Nov/Dec 2015) (Nov/Dec 2016, April/May 2019)** BTL 2 **Answer: Page No :1.20 and 1.23 -Dr.V.Jayakumar** **1. Top management commitment:** Top management should participate and completely involve in the total quality programme. **(**2M) **2. Focus on the customer:** Achieving customer satisfaction is the heart of TQM. Customers include both internal and external customers. So focus on the customer is the key for any TQM programme. **(**2M) 3.**Effective involvement and utilization of the entire work force :** Total quality recognizes that each person is responsible for the quality. **(**2M) 4. **Continuous improvement :** TQM is based on the quest for process and improvement. **(**2M) 5. **Treating suppliers as partners:** Since the suppliers influence the company's quality, therefore a partnering relationship should be developed between management and the suppliers. **(**2M) **6. Establishing performance measures for the processes:** Quantitative data are necessary to measure the continuous quality improvement activity. **(**3M)
	PART – C
1.	**Explain the different methods of receiving customer feedback. How they are further used to achieve customer satisfaction? (15M) (June 2016)** BTL 2 **Answer: Page No : 2.6 and 2.8 -Dr.V.Jayakumar** **Feedback enables organization to** • Discover customer satisfaction • Discover relative priorities of quality • Compare performance with the competition • Identify customer needs • Determine opportunities for improvement **(**5M) **Tools:** (4M) 1. Comment Card 2. Customer Questionnaire **Customer Satisfaction:** "Customer satisfaction provides a leading indicator of consumer purchase intentions and loyalty." "Customer satisfaction data are among the most frequently collected indicators of market perceptions. Their principal use is twofold:" • "Within organizations, the collection, analysis and dissemination of these data send a message about the importance of tending to customers and ensuring that they have a positive experience with the company's goods and services." • "Although sales or market share can indicate how well a firm is performing *currently*, satisfaction is perhaps the best indicator of how likely it is that the firm's customers will make further purchases *in the future*. Much research has focused on the relationship between customer satisfaction and retention. Studies indicate that the ramifications of satisfaction are most strongly realized at the extremes**."** **(**6M)
2	**Explain the issues related to customer complaints and retention. (15M) (Apr 2015).** BTL 2 **Answer: Page No : 2.9 -Dr.V.Jayakumar** Actions an organization can take to handle complaints are as follows **(**7M)

- Investigate customers experiences by actively getting feedback, both positive and negative, and then acting on it promptly.
- Develop procedures for complaint resolution that include empowering front – line personnel.
- Analyze complaints, but understand that complaints do not always fit into neat categories.
- Work to identify process and material variations and then eliminate the root cause. "More inspection" is not corrective action.
- When a survey response is received, a senior manager should contact the customer and strive to resolve the concern.
- Establish customer satisfaction measures and constantly monitor them.
- Communicate complaint information, as well as the results of all investigations and solutions, to all people in the organization.
- Provide a monthly complaint report to the quality council for their evaluation and, if needed, the assignment of process improvement teams.
- Identify customers expectations beforehand rather than afterward through complaint analysis. For Customer Retention, we need to have both "Customer satisfaction & Customer loyalty".

The following steps are important for customer retention. **(**8M)

1. Top management commitment to the customer satisfaction.
2. Identify and understand the customers what they like and dislike about the organization.
3. Develop standards of quality service and performance.
4. Recruit, train and reward good staff.
5. Always stay in touch with customer.
6. Work towards continuous improvement of customer service and customer retention.
7. Reward service accomplishments by the front-line staff.
8. Customer Retention moves customer satisfaction to the next level by determining what is truly important to the customers.
9. Customer satisfaction is the connection between customer satisfaction and bottom line.

3. **Write about quality statement (15M) (May /June 2013)** BTL 2

Answer: Page : 1.37,1.38,1.40 -Dr.V.Jayakumar

Three elements of quality statements are:

1. **Vision statements -** The vision statement is a short declaration of what an organization aspires to be tomorrow**.** **(**5M)

2. Mission statement - The Mission statement is usually one paragraph, describes the function of the organization. It provides a clear statement of purpose for employees, customers and suppliers. **(**5M)

3. Quality policy statement: The quality policy is a guide for everyone in the organization as to how they provide products and service to the customers. **(**5M)

UNIT II TQM PRINCIPLES

Leadership – Strategic quality planning, Quality Councils – Employee involvement – Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal – Continuous process improvement – PDCA cycle, 5S, Kaizen – Supplier partnership – Partnering, Supplier selection, Supplier Rating.

PART * A

Q.No.	Questions
1.	**Why suppliers should be treated as partners? (Dec 2014)** BTL 3 Yes, suppliers are to be treated as partners from business point of view. The costs due to inferior materials/components from suppliers increase costs in the later stages of production. Suppliers themselves are part of the whole system and hence should be treated as long-term partners. It should be a win-win strategy for both the supplier and producer.
2	**Define 'Juran Trilogy' (Quality Trilogy) (Dec 2011)** BTL 1 The Juran Trilogy (Quality Trilogy) consists of three inter-related processes – quality planning, quality control, and quality improvement – for managing quality.
3	**Write about the roles assigned to people in Quality Circles or who constitutes QC or how is quality circle formed? (June 2014, June2016, Nov/Dec 2018)** BTL 1 The QC organization has a four-tier structure (roles and responsibilities) consisting of Members, Leaders, Facilitators, and Steering Committee. Usually the line operator will be the head of the QC team. This is one of the important aspects to be followed in an organisation marching towards Deming quality medal award.
4	**Define Empowerment. (Dec 2012, April/May 2019)** BTL 1 Empowerment means entrusting people with authority and responsibility. The real meaning of empowering people implies making decisions as and when required independently. Decisions should adhere to the policy laid down by the company and in no way deviate from the directions or principles set by the management.
5	**Give the Maslow's basic needs.** BTL 1 Maslow's basic needs are: 1. Physilogical 2.Safety 3.Society 4.Esteem and 5.Self-actualization needs.
6	**Define about Quality Circles (QC). (Nov/Dec 2018)** BTL 1 QC is a small team of people (around 8 to 10) coming from the same work area/department who voluntarily meet on a regular basis (about an hour every week) to identify, investigate, analyze and solve work-related problems. QC can be viewed from three angles: (i) as a form of participative management, (ii) as a HRD technique, and (iii) as a problem-solving technique.
7	**List the Japanese 5S principles. (Dec 2011)** BTL 1 5S Philosophy focuses on effective work place organization and standardized work procedures. 5S simplifies your work environment, reduces waste and non-value activity while improving quality efficiency and safety. **Sort – (Seiri)** the first S focuses on eliminating unnecessary items from the work place. **Set In Order (Seiton)** is the second of the 5Ss and focuses on efficient and effective storage methods.

	Shine: (Seiso) Once you have eliminated the clutter and junk that has been clogging Your work areas and identified and located the necessary items, the next step is to thoroughly clean the work area. **Standardize: (Seiketsu)** Once the first three 5S's have been implemented, you should concentrate on standardizing best practice in your work area. **Sustain: (Shitsuke)** This is by far the most difficult S to implement and achieve. Once fully implemented, the 5S process can increase morale, create positive impressions on customers, and increase efficiency and organization.
8	**Sate Kaizen principles. (Dec 2011, Nov/Dec 2018)** BTL 2 Kaizen, which is a Japanese word that means gradual and orderly continuous improvement, is a philosophy that covers all business activities and everyone in an organization. In the kaizen philosophy, improvement in all areas of business – cost, meeting delivery schedules, employee safety and skill development, supplier relations, new product development, and productivity – serve to improve the quality of the firm. Thus, any activity directed towards improvement falls under the kaizen umbrella.
9	**What do you understand by Supplier Rating? (May 2015).** BTL 1 Supplier rating system (often called a scorecard system) is usually based on quality, delivery, and service; however, some customers have added other categories, such as lead time, product support, technology, etc. The company constitutes a vendor quality team (VQT) that will facilitate an audit for evaluating the Supplier on delivery, quality, consistency, service and responsiveness.
10	**List the benefits of Team work (May 2015,April/May 2019)** BTL 5 1. Improved solutions to quality problems 2. Improved ownership of solutions 3. Improved communications 4. Improved integration.
11	**Give the traits of successful leaders. (Dec 2015)** BTL 1 1. Customers first 2. Value people 3. Build supplier partnership 4. Empower people.
12	**Define strategic quality planning. (Dec 2015)** BTL 1 It is defined as the process of deciding on objective of the organization on changes on these objectives, on the resource used to obtain these objectives and on the policies that are to govern the acquisition, use and disposition of these resources.
13	**Give the conditions necessary for empowerment.** BTL 1 The conditions required are: 1. Everyone must understand the need for change. 2. The system needs to change to the new paradigm. 3. The organization must provide information, education and still to its employees.
14	**Distinguish between 'internal customer' and 'external customer'.** BTL 4 An external customer exists outside the organization and can be defined in many ways – user, buyer, and influencer. He generally falls into one of three categories: current, prospective, or lost customer. Every function within the organization – engineering, production, order processing, etc. – has an internal customer. Every person in a process is considered a customer of the preceding operation. For example, Manufacturing is a customer for Purchasing, and Dispatching is a customer for Packaging.
15	**List the different types of teams.** BTL 2 1. Process improvement team

	2.Cross-functional team 3.Natural work team and 4.Self-directed work team.
16	**Mention some benefits of implementing 5S principles.** BTL 2 5S increases productivity, eliminates waste, reduces inventory, creates a pleasant workplace, improves safety, and increases the overall efficiency and effectiveness of people and machines.
17	**Distinguish between Reward and Recognition. (Dec 2010)** BTL 3 Recognition & reward: Creating incentives for suppliers is one way to ensure that they remain committed to a quality improvement strategy. Incentives may be in the form of a preferred supplier category with its rewards. Recognition may be in the form of publication of outstanding contributions in the customer's newsletter, a letter of commendation, or a plaque. The Quality Circle framework supports motivating people with both recognition and rewards (cash prizes).
18	**Give the basic steps to strategic quality planning.** BTL 3 1. Customer needs 2. Customer positioning 3. Predict the future 4. Gap analysis 5. Closing the gap 6. Alignment 7. Implementation
19	**Define Recognition and Reward.** BTL 2 Recognition is a form of employee motivation in which the organization publicly acknowledges the positive contributions an individual or team has made to the success of the organization. Reward is something tangible to promote desirable behavior. Recognition and reward go together to form a system for letting people know they are valuable Members of the organization.
20	**Classify rewards.** BTL 4 1. Intrinsic rewards: These are related to feelings of accomplishment or self-worth. 2. Extrinsic rewards: These are related to pay or compensation issues.
21	**Define on performance appraisal.** BTL 1 Performance appraisal is a systematic and objective assessment or evaluation of performance and contribution of an individual.
22	**Mention the steps in the PDSA cycle.** BTL 1 The basic Plan-Do-Study-Act is an effective improvement technique. The steps in the PDSA cycle are 1. Plan carefully what is to be done 2. Carry out the plan 3. Study the results 4. Act on the results by identifying what worked as planned and what didn't.
	PART - B
1	**Explain the different types of Teams formed to achieve quality and explain the various steps involved in developing a team.** (13M) **(June 2016, Dec 2012, Dec 2013)** BTL 2 **Answer : Page :4.8 to 4.12 - Dr.V.Jayakumar** **Teamwork:** cumulative actions of the team during which each member of the team subordinates his individual interests and opinions to fulfill the objectives or goals of the group. (1M)

WHY TEAMS WORK : (4M)

1. Many heads are more knowledgeable than one.
2. The whole is greater than the sum of its members.
3. Team members develop a rapport which each other.
4. Teams provide the vehicle for improved communication.

TYPES OF TEAMS : (5M)

1. Process improvement team.
2. Cross – functional team.
3. Natural work teams.
4. Self – Directed / Self – Managed work teams.

CHARACTERISTICS OF SUCCESSFUL TEAMS : (3M)

1. Sponsor 2. Team Charter
3. Team Composition 4. Training
5. Ground Rules 6. Clear Objectives
7. Accountability 8.Well-Defined decision procedure
9. Resources 10. Trust
11. Effective Problem Solving 12. Open Communication
13. Appropriate Leadership 14. Balanced Participation
15. Cohesiveness

2. **Write notes on recognition and rewards. Explain the stages of team development.** (13M) **(April/May 2019)** BTL 2

Answer: Page : 4.14 and 4.12 - Dr.V.Jayakumar

Recognition and Rewards: (5M)

Recognition is a process by which management shows acknowledgement of an employee's outstanding performance.

Various ways for Recognition and Rewards are

1. Recognition can be expressed using verbal and written praise.
2. Rewards may be in the form of certificates and plaques.
3. Reward is normally in the form of cinema tickets, dinner for family etc.
4. The financial compensation (for recognition) can be paid in terms of increased salaries, commissions, gain sharing etc.
5. The efforts of employees can be recognized by promotions, special job assignments etc.
6. A letter of appreciation from the CEO or the Top Management will increase the employee's involvement.
7. Reward may be delayed but recognition should be in a timely basis.
8. Rewards should be appropriate to the improvement level.
9. People like to be recognized than any reward.
10. Special forms of recognition include pictures on the bulletin board, articles in newsletters, letter to families etc.
11. Supervisors can give on-the-spot praise for a job which is done well.

Effects of Recognition and Reward System : (4M)

	1. Recognition and reward go together for letting people know that they are valuable members for the organization. 2. Employee involvement can be achieved by recognition and reward system. 3. Recognition and reward system reveals that the organization considers quality and productivity as important. 4. It provides the organization an opportunity to thank high achievers. 5. It provides employees a specific goal to achieve. 6. It motivates employees to improve the process. 7. It increases the morale of the workers. **Stages:** (4M) **Forming stage-** Initial stage with only group of individuals and no team work. Team Purpose, roles are created. **Storming Stage -**Initial agreement roles are challenged. Hostilities, emerge which may be resolved **Norming Stage-**Formal informal relations get established. **Performing Stage** -Team operates in a successful manner with trust, openness, healthy conflict and decisiveness among the members. **Maintenance stage –** Functioning should not deteriorate with time Q **Evaluating Stage** – Evaluating team performance
3.	**Explain in detail about Performance Appraisal. What are its benefits?** (13M) **(June 2014)** BTL 2 **Answer : Page : 4.8 to 4.17 - Dr.V.Jayakumar** The performance appraisal is used to let employees know how they are performing. The performance appraisal becomes a basis for promotions, increase in salaries, counseling and other purposes related to an employee's future. (3M) **BENEFITS OF PERFORMANCE APPRAISALS :** 1. It is necessary to prevail a good relationship between the employee and the appraiser. (2M) 2. Employee should be informed about how they are performing on a continuous basis, not just at appraisal time. (2M) 3. The appraisal should highlight strength and weakness and how to improve the performance. (2M) 4. Employee should be allowed to comment on the evaluation and protest if necessary. (2M) 5. Everyone should understand that the purpose of performance appraisal is to have employee involvement. 6. Errors in performance evaluations should be avoided. (2M) 7. Unfair and biased evaluation will render poor rating and hence should be eliminated. (2M)
4.	**Explain the concept of employee involvement and motivation for enhancing quality.** (13M) **(May 2015)**BTL 2 **Answer: Page: 4.1 to 4.2 -Dr.V.Jayakumar** Employee involvement improves quality and increases productivity because • Employees make better decisions using their expert knowledge of the process

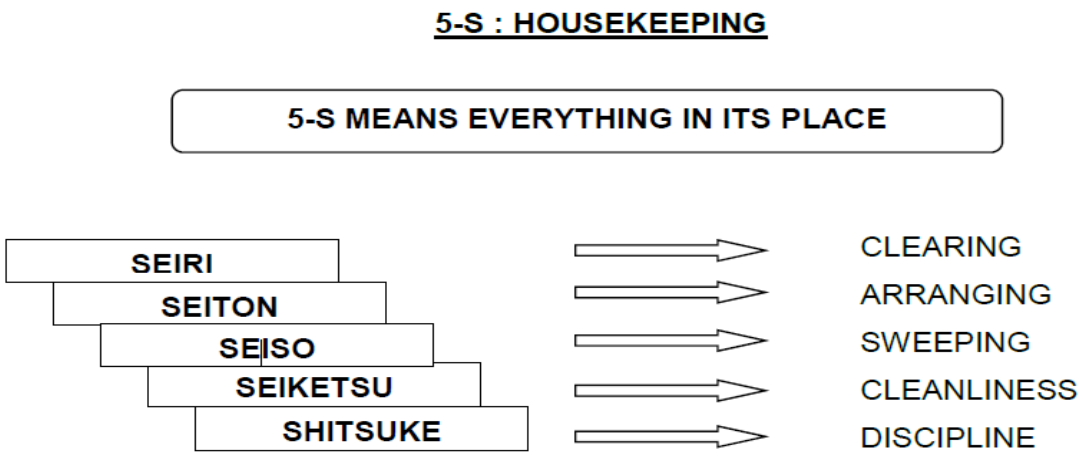
- Employees are better able to spot and pin-point areas for improvement.
- Employees are better able to take immediate corrective action.
- Employee involvement reduces labour / management friction.
- Employee involvement increases morale.
- Employees have an increased commitment to goals because they are involved.
- Employee involvement is one approach to improve quality and productivity.
- It is a means to better meet the organization's goals for quality and productivity. (8M)

MOTIVATION - MASLOW'S HIERARCHY OF NEEDS :

Self - Actualization (1M)
Esteem (1M)
Social (1M)
Security (1M)
Survival (1M)

5. **Explain all the elements in 5'S principle and also the implementation procedure of 5'S in a manufacturing company.** (13M) **(June 2016, Dec 2007, 2011, 2013)** BTL 2

Answer: Page : 5.12 to 5.13 -Dr.V.Jayakumar



5-S MEANS EVERYTHING IN ITS PLACE

This is a house keeping technique used to establish and maintain a productive and quality environment in an organization. This method is invented in Japan which will give safer, more efficient and more productive operation results in boosting of morale of workers, job involvement and satisfaction and ownership of their responsibilities (5M)

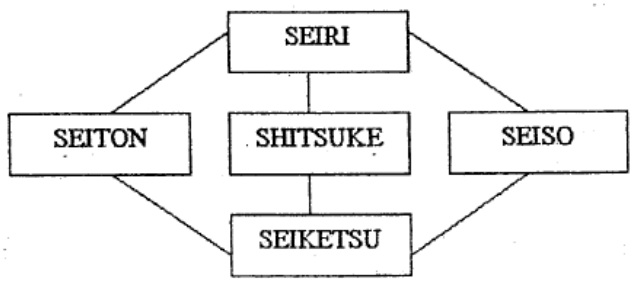
JAPANESE TERM -ENGLISH

EQUIVALENT MEANING

SEIRI Tidiness **Cleaning** – Throw away all rubbish unrelated materials in the work place
SEITON Orderliness **Arranging** – Set everything in proper place for quick retrieval and storage
SEISO Cleanliness **Sweeping** – Clean the work place, everything without fail
SEIKETSU Standardization
Maintaining Cleanliness – Standardizing the way of maintaining cleanliness **SHISUKE discipline**

Self Discipline – Practice '5S' daily. Make it a way or life. This also means commitment

RELATIONSHIP BETWEEN VARIOUS 5S



(4M)

IMPLEMENTING 5-S

1. Top Management resolve and training.
2. Formation of a top level team.
3. Understanding current circumstances.
4. Establishing priorities and targets.
5. Forming sub-teams and training.
6. Major cleaning.
7. Establishing improvement plans in each priority area.
8. Implementing the plan.
9. Verifying results.
10. Standardizing.
11. Establishing full control.
12. Looking for further improvements. (4M)

6. **Discuss about the steps involved in strategic planning.** (13M) **(June 2014, April/May 2019)**
BTL 2

Answer: Page No : 3.15 - Dr.V.Jayakumar

Goals – Long term planning (Eg : Win the war)
Objectives – Short term planning (Eg : Capture the bridge)
Goals should

- Improve customer satisfaction, employee satisfaction and process
- Be based on statistical evidence
- Be measurable
- Have a plan or method for its achievement
- Have a time frame for achieving the goal
- Finally, it should be challenging yet achievable (7M)

SEVEN STEPS TO STRATEGIC QUALITY PLANNING :

1. Customer needs
2. Customer positioning
3. Predict the future
5. Closing the gap
6. Alignment
7. Implementation

	4. Gap analysis (6M)
7.	**Explain about Kaizen concept. Discuss the three elements of partnering.** (13M) **(Nov 2011)** BTL 2 **Answer: Page: 5.21 -Dr.V.Jayakumar** **Kaizen concept:** (8M) Kaizen is a Japanese word for the philosophy that defines management's roles in continuously encouraging and implementing small improvements involving everyone. It focuses on simplification by breaking down complex progress into their sub – processes and then improving them. The Kaizen improvement focuses on the use of : • Value – added and non – value work activities. • Muda, which refers to the seven classes of waste – over-production, delay, transportation, processing, inventory, wasted motion, and defective parts. • Principles of motion study and the use of cell technology. • Principles of materials handling and use of one – piece flow. • Documentation of standard operating procedures. • The five S's for workplace organization. • Visual management. • Just – in – time principles. • Poka – Yoke. • Team dynamics. **Partnering** (3M) Partnering is a relationship between two or more parties based upon trust, dedication to common goals. The benefits of partnering are • Improved quality • Increased efficiency • Lower cost • Increased opportunity for innovation • Continuous improvement The three key elements to a partnership relationship are (2M) • Long term commitment • Trust • Shared Vision
9.	**What is supplier partnering? Indicate its important benefits.** (13M) **(Nov 2016, May 2013, Nov/Dec 2018)** BTL2 **Answer : Page : 6.2 to 6.3 - Dr.V.Jayakumar**

Successful supplier partnerships require commitment and continual nurturing. The following points as mandatory requirements of supplier partnerships; (2M)

Supplier personnel should meet with buyer personnel beyond those in the purchasing office. It is particularly important for them to meet with personnel who actually use their products so that needed improvements can be identified and made. (2M)

The price-only approach to buyer –supplier negotiations should be eliminated. Product features, quality, and delivery concerns should also be part of the negotiations. The goal of the negotiation s should be to achieve the optimum deal when price, feature, quality, and delivery issues are all factored in. (2M)

The quality of supplier products should be guaranted by the supplier's quality processes. The buyer should have no need to inspect the supplier's products. (2M)

Both partners should be capable of sharing information electronically so that the relationship is not inhibited by paperwork. Electronic data exchange e is particularly important for successful Just in Time (JIT).

The supplier should fully understand and be able to practice just-in time (JIT). Buyers should not need to maintain inventories.

ROLE OF SUPPLIER PARTNERSHIP (5M)

1. Timeliness
2. Information
3. Product evaluation
4. Monitor customer complaints
5. Awareness of product liability laws
6. Ensure necessary tests are done
7. Provide dependable products
8. Anticipate changing needs and acting on them
9. Commitment
10. Compliance with mandatory standards
11. Communication
12. Plan ahead for recalls

10	**Discuss different types of team and stages of team development.**(13M) **(Nov/Dec 2018)** BTL 2 **Answer: Page No : 4.8 and 4.13 -Dr.V.Jayakumar**

TYPES OF TEAMS

Process improvement team: Involved in improvement of sub processes or processes. Usually has 6-10 members. Disbanded when the objective is reached. May include the local supplied and customer depending on the location (2M)

Cross functional teams: 6-10 members temporary team. Members are Top management level from various functional areas of management. Discuss complex problems and break down into smaller parts to refer it to various departmental teams for further solution. (2M)

Natural work teams: Not voluntary and the total work unit is part of the team. Manager also a part of the team and the management selects the projects to be improved. Managers must also ensure that the entire team is comfortable with each other. (2M)

Self-directed / self-managed work team: Extension of natural work teams but here the group of individuals is empowered not only to do work but manage it. No manger will present but a coordinator (Which will be normally rotated among members) will be appointed. (2M)

STAGES OF TEAM DEVELOPMENT (5M)

Forming stage- Initial stage with only group of individuals and no team work. Team purpose, roles are created.

Storming Stage -Initial agreement roles are challenged. Hostilities, emerge which may be resolved

Norming Stage-Formal informal relations get established.

Performing Stage -Team operates in a successful manner with trust, openness, healthy conflict and decisiveness among the members.

Maintenance stage – Functioning should not deteriorate with time Evaluating Stage – Evaluating team performance

PART - C

1. **Give the principles of customer/supplier relationships.** (15M) **(April/May 2018)** BTL 3

Answer: Page: 6.1 - Dr.V.Jayakumar

CUSTOMER – SUPPLIER RELATIONS :

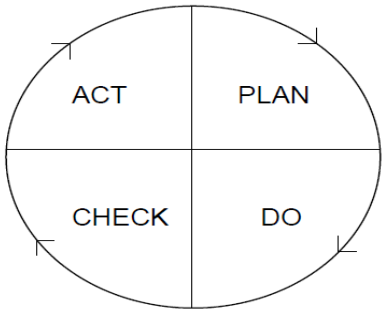
Dr. Kaoru Ishikawa has given ten principles of customer-supplier relations. They are

1. Both the customer and supplier are fully responsible for the control of quality. (2M)
2. Both the customer and supplier should be independent of each other. (1M)
3. The customer is responsible for providing the supplier with clear and sufficient requirements so that the customer can know precisely what to produce. (2M)
4. Both the customer and supplier should enter into a non-adversarial contract. (1M)
5. The supplier is responsible for providing the quality that will satisfy the customer. (2M)
6. Both the customer and supplier should decide the method to evaluate the quality of the product or services. (2M)
7. Both the customer and supplier should establish in the contract the method by which they can reach an amicable settlement in case of any dispute. (1M)
8. Both the customers and supplier should continually exchange information. (2M)
9. Both the customer and supplier should perform business activities. (1M)

10. Both the customer and supplier should have the best interest of the end user in mind. (2M)

How is PDCA cycle practiced? Give an example. (15M) **(Dec 2015, April/May 2017**) BTL 1

Answer: Page No : 5.9 -Dr.V.Jayakumar



(3M)

2

PROBLEM SOLVING METHOD :

1. IDENTIFY THE OPPORTUNITY (3M)

- Identify the Problem
- Pareto analysis of external alarm signals.
- Pareto analysis of internal alarm signals.
- Proposals from key insiders.
- Proposals from suggestion schemes.
- Field study of user's needs.
- Comments of key people outside the organization.
- Customer surveys.
- Employee surveys.
- Brainstorming by work groups.
- Form the Team
- Team should be selected.
- Goals and milestones are established.
- Define the Scope.

Criteria for a good problem statement is as follows

- It clearly describes the problem.
- It states the effect.
- It focuses on what is known, unknown etc.
- It emphasizes the impact on the customer.

2. ANALYZE THE CURRENT PROCESS (3M)

The objective is to understand the process and how it is currently performed.
Step 1: The team to develop a process flow diagram.
Step 2: The target performance measures are defined.
Step 3: Collection of all available data and information.

Common items of data and information are

1. Customer information 2. Design information
3. Process information 4. Statistical information
5. Quality information 6. Supplier information

3. DEVELOP THE OPTIMAL SOLUTION(S) (3M)

This phase has the objective of establishing potential and feasible solutions and recommending the best solution to improve the process.

- Creativity plays the major role, and brainstorming is the principal technique.
- There are three types of creativity:
- Create new processes
- Combine different processes
- Modify the existing process

4. IMPLEMENT CHANGES (1M)

This phase has the objective of preparing the implementation plan, obtaining approval and implementing the process improvements.

- Approval of the quality council.
- Obtain the advice and consent of departments, functional areas, teams, individuals etc.
- Monitor the activity.

5. STUDY THE RESULTS (1M)

This phase has the objective of monitoring and evaluating the change by tracking and studying the effectiveness of the improvement efforts.

6. STANDARDIZE THE SOLUTION (1M)

- Institutionalize by positive control of the process.
- The quality peripherals – the system, environment and supervision must be certified.
- Operators must be certified.

7. PLAN FOR THE FUTURE

The objective is to achieve improved level of process performance.

- Regularly conduct reviews of progress by the quality council.
- Establish the systems to identify area for future improvements.
- Track performance with respective internal & external customers.
- TQM tools and techniques are used to improve quality, delivery and cost.

3. **Explain vendor development in detail.** (15M) **(Dec 2015)** BTL 1

Answer: Page: 5.9 - Dr.V.Jayakumar

RELATIONSHIP DEVELOPMENT : (5M)

For establishment of supplier relationship, the following are necessary.

(a) Partnering
(b) Supplier selection
(c) Principles of customer / supplier relations
(d) Certification
(e) Periodic rating

For relationship development, the following are necessary. (5M)

(a) Inspection

- 100% inspection
- Sampling
- Audit
- Identity check

(b) Training (2M)
(c) Teams (2M)
(d) Recognition and Reward (1M)

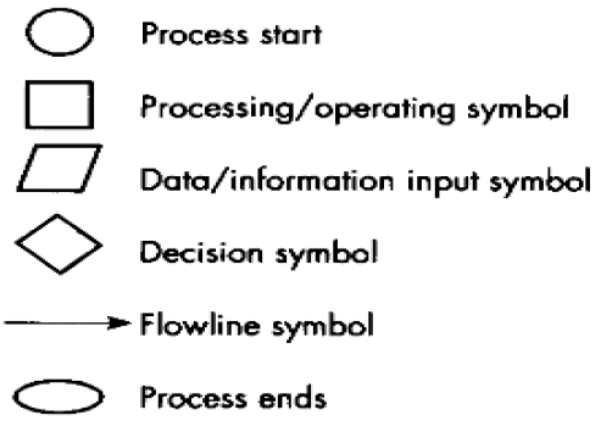
UNIT III-TQM TOOLS AND TECHNIQUES

The seven traditional tools of quality – New management tools – Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

PART * A

Q.No.	Questions
1	**List the seven tools of quality/Elemental Statistical Tools. (Dec 2013, May 2015, April/May 2019)** BTL 2 1. Check sheets, 2. Histograms 3, Cause and effect diagrams, 4. Pareto diagrams, 5. Stratification analysis, 6. Scatter diagrams, and 7. Control charts.
2	**Define six sigma. (June 2016, April/May 2019)** BTL 1 Six Sigma is similar to Zero Defects (ZD), is a philosophical benchmark or standard of excellence proposed by Philip Crosby. Six Sigma strives for perfection. It allows for only 3.4 defects per million opportunities (or 99.99966 percent accuracy).
	When do you use the scatter diagram?(Dec 2015) BTL 3 The purpose of the scatter diagram is to display what happens to one variable when another variable is changed. It is a preliminary investigation that checks whether strong or weak relationship exists between two variables.
	What are the benefits of six sigma? (Dec 2012,Nov/Dec 2018) BTL 1 A. In addition to a focus on defect, six sigma seeks to improve all aspects of operation. The key matrices include cycle time, process variation and yield. The ultimate result of six sigma will be increase in profit to the company.
	What is process capability? (June 2011) BTL 1 Process capability analyses the relationship between two aspects of process like on design specification. If the specification limit is greater than control limits the process is capable of meeting specification and if it exceeds is not capable of meeting specifications.
	What are the reasons for bench marking? Or what is the purpose of bench marking? (May 2015, Dec 2015, June 2016) BTL 1 i) Benchmarking aims at a goal setting process to facilitate comparison with the best ii) It aims at motivating and simulating company employees towards the goal of continuous quality improvement. iii) It aims at external orientation of the company iv) It aims at identifying a technological break through v) It aims at searching for industry best practices.
	What is Risk Prioritization Number? (June 2012) BTL 1 RPN is a number used to prioritize the risk of failure in Potential Failure Mode and Effect Analysis. It ranges from 1 to 1000 and it's the multiplication of severity, detection and occurrence.
2	**What is check sheet?** BTL 1 A check sheet or tally sheet is a form for systematic data gathering and registering to get a clear view of the facts. A check sheet is used to indicate the frequency of a certain occurrence.

4	**Define histogram? And its types.** BTL 1 Histogram is a bar chart / diagram showing a distribution of variable quantities or characteristics. It is graphical display of the frequency distribution of numerical data. 1. Bell-shaped. 2. Double-peaked.3. Plateau. 4. Comb. 5. Skewed. 6. Truncated.7. Isolated peak and 8. Edged peak.
6	**State cause and effect diagram.** BTL 1 The cause and effect diagram or Fishbone diagram is a graphical-tabular chart to list and analyze the potential causes of a given problem. The potential or probable causes are identified and solutions or recommendations are brainstormed, execution plan prepared for implementation. A tree comparison was drawn up to explain between causes (hidden roots) and effects (foliage visible)
8	**Write about Pareto diagram?** BTL 1 A Pareto diagram is a diagnostic tool commonly used for separating the vital few causes that account for a dominant share of quality loss. Vital few (20%) and Trivial many (80%) means 20% of causes are the reason for 80% of problems and are referred to as 80:20 rules.
9	**What is scatter diagram?** BTL 1 The scatter diagram is a simple graphical device to depict the relationship between two variables. It is called as correlation diagram aims to establish relationship between two variables.
10	
11	**What is control chart? What are the types of control charts?** BTL 1 A control chart is a graph that displays data taken over time and the variation of this data. Control charts for variables – for measurable data such as time, length, temperature, weight, pressure. Control charts for characteristics- for quantifiable data such as number of defects, typing errors in a report.
12	**When do you use control chart?** BTL 3 The purpose of control chart is to identify when the process has gone out of statistical control, thus signaling the need for some corrective action to be taken. We use to check the out of specification or rejections whether the trend is away from the nominal / mean/mid value so that the process centering can be done and can be brought within the limits of dimensions.
13	**Define statistics applications of statistical techniques. (April/May 2018)** BTL 4 Statistics is defined as the science that deals with the collection, tabulation, analysis, interpretation and presentation of quantitative data. Based on the data collected further investigations will be carried out to understand the process / product variability so that optimum controls can be introduced into the process to achieve consistency in quality and function of the product/service.
14	**Differentiate between producer's risk and consumer's risk.** BTL 4 Producer's risk: It is the probability of rejecting a good lot which otherwise would have been accepted. Consumer's risk: It is the probability of accepting a defective lot which otherwise would have been rejected.
15	
16	**What is Benchmarking? (April/May 2018)** BTL 1 Benchmarking is comparing one's existing process outcomes with the best industrial achievement (say comparing productivity improvement with industry best for pump motor product say 97%). A target for achieving the industry best is referred as Benchmarking.
17	
18	**Explain the stages of FMEA. (Nov/Dec 2018)** BTL 2

	Specifying possibilities (Functions; possible root cause; effects; detection and prevention) and quantifying risks (Probability of cause; severity of effect).
19	**List down 7 new QC Tool.** BTL 1 The relationship diagram method; KJ method or affinity diagram; the systematic method; the matrix diagram method; Matrix data analysis; PDPC method and arrow diagram method.
20	**List down the six symbols used in a flowchart.** BTL 1 
	PART - B
1	**Explain seven traditional tools for quality of TQM.** (13M) **(June 2010, Dec 2012, June 2014, Nov/Dec 2018, April/May 2019)** BTL 2 **Answer : Page :8.1 to 8.2 - Dr.V.Jayakumar** The **tools of quality** are • Check sheets (2M) • Histograms (2M) • Cause and effect diagrams (2M) • Pareto diagrams (2M) • Stratification analysis (2M) • Scatter diagrams (2M) • Control charts. Explain each in detail (1M)
2.	**Explain six sigma concepts with an example.** (13M) **(June 2013, Nov/Dec 2018)** BTL 2 **Answer : Page :4.8 to 4.12 - Dr.V.Jayakumar** **Six sigma** stands for six standard deviation from mean (sigma is the Greek letter used to represent standard deviation in statistics). (2M) • Six sigma, similar to Zero Defect (ZD), is a philosophical benchmark or standard of excellence proposed by Philip Crosby. • Six sigma methodology provides the techniques and tools to improve the capability and reduce the defects in any process.

- It was started by Motorola in 1987, in its manufacturing division.

- Six sigma strives for perfection. **It allows for only 3.4 defects per million opportunities (or 99.999666 percent accuracy).** Here a defect can be anything from a faulty party to an incorrect customer bill.
- Six sigma improves the process performance, decrease variation and maintains **consistent quality** of the process output. This leads to defect reduction and improvements in profits, product quality and customer satisfaction.
- Six sigma incorporates the basic principles and techniques used in business, statistics and engineering.
- **The objective of six sigma principle** is to achieve zero defects products/process. (5M)

NEED FOR SIX SIGMA (3M)

- A medium aircraft consists of 10,000 different parts.
- At **quality**, 27 of those parts in an assembled aircraft would be defective.
- So three sigma quality level cannot be accepted as good enough quality level. So we have to increase the sigma level (i.e., reducing the number of defectives).
- In fact, even four sigma quality also not sufficient for the aircraft case. That's why six sigma in quality level is preferred than 3 Sigma and 4 Sigma quality levels.

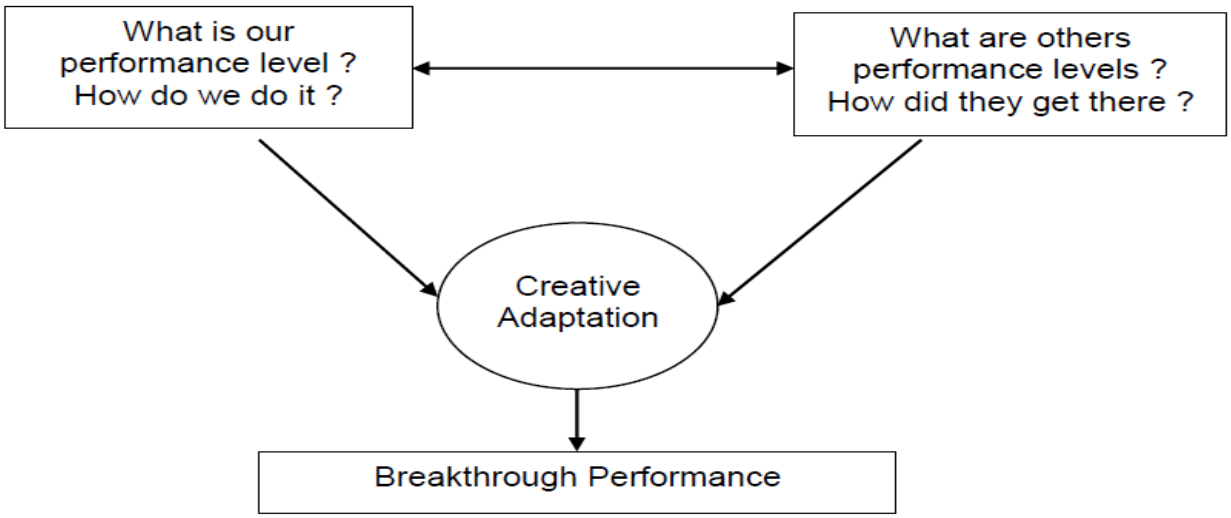
THE CONCEPT OF SIX SIGMA: (3M)

- Before studying the concept of six sigma, first let us re-introduce the concept of process capability ratio (Cp)
- (Assumption is that process is centered midway the specification limits, i.e., there is no shift in process mean)
- Process capability ratio measures how well the product requirements match with the process capabilities. The higher the value of Cp' the better the match between product and process.

3. **Explain bench marking and its steps with an example.** (13M) **(June 2016, Dec 2013, Dec 2015, Nov/Dec 2018, April/May 2019)** BTL 2
Answer : Page :10.2 and 10.5 - Dr.V.Jayakumar

Benchmarking is a systematic method by which organizations can measure themselves against the best industry practices. (1M)
Benchmarking is a systematic search for the best practices, innovative ideas, and highly effective operating procedures. (1M)

BENCHMARKING CONCEPT



(1M)

The following six steps contain the core techniques of Benchmarking

1. Decide what to benchmark (1M)

- Benchmarking can be applied to any business or production process
- The strategy is usually expressed in terms of mission and vision statements
- Best to begin with the mission and critical factors
- Choosing the scope of the Benchmarking study
- Pareto analysis – what process to investigate
- Cause and Effect diagram – for tracing outputs back

2. Understand current performance (1M)

- Understand and document the current process
- Those working in the process are the most capable of identifying and correcting problems
- While documenting, it is important to quantify
- Care should be taken during accounting information

3. Plan (1M)

- A benchmarking team should be chosen
- Organizations to serve as the benchmark need to be identified
- Time frame should be agreed upon for each of the benchmarking tasks

There are three types of benchmarking

a. Internal

b. Competitive

c. Process

4. Study Others (1M)

Benchmarking studies look for two types of information

- How best the processes are practiced
- Measurable results of these practices

Three techniques for conducting the research are
- Questionnaires
- Site visits
- Focus groups

5. Learn from the data (1M)

Answering a series of questions like
- Is there a gap between the organization's performance and the performance of the best-in-class organizations?
- What is the gap? How much is it?
- Why is there a gap? What does the best-in-class do differently that is better?
- If best-in-class practices were adopted, what would be the resulting improvement?

Benchmarking studies can reveal three different outcomes
- Negative gap
- Parity
- Positive gap

6. Using the findings (1M)

The objective is to close the gap. For this
- Findings must be communicated to the people within the organization
- Action plans must be developed to implement new processes

Groups that must agree on the change
- Process owners
- Upper management

Steps for the development and execution of action plans are
- Specify tasks
- Sequence tasks
- Determine resources needs
- Establish task schedule
- Assign responsibility for each task
- Describe expected results
- 7. Specify methods for monitoring results (4M)

4. **Explain new seven TQM tools.** (13M) **(June 2008, Dec 2011, Dec 2015, April/May 2019)**
BTL 2
Answer : Page :9.1 - Dr.V.Jayakumar

- Why, Why (2M)
- Forced Field Analysis (1M)
- Nominal Group Technique (1M)
- Affinity Diagram (1M)
- Inter-Relationship Digraph (1M)
- Tree Diagram (1M)
- Matrix Diagram (1M)

	• Prioritization Matrices (1M) • Process Decision Program Chart (2M) • Activity Network Diagram (2M)
5.	**Explain the failure mode and effect analysis (FMEA) and its types with an example.** (13M) **(June 2016,June 2014, Dec 2015**) BTL 3 **Answer : Page :11.1 - Dr.V.Jayakumar** FMEA is an analytical technique that combines the technology and experience of people in identifying foreseeable failure modes of a product or process and planning for its elimination. It is a group of activities comprising the following : 1. Recognize the potential failure of a product or process. 2. Identify actions that eliminate / reduce the potential failure. 3. Document the process. (3M) Two important types of FMEA are • Design FMEA • Process FMEA (2M) **INTENT OF FMEA :** • Continually measuring the reliability of a machine, product or process. • To detect the potential product - related failure mode. • FMEA evaluation to be conducted immediately following the design phase. (2M) **BENEFITS OF FMEA:** • Having a systematic review of components failure modes to ensure that any failure produces minimal damage. • Determining the effects of any failure on other items. • Providing input data for exchange studies. • Determining how the high-failure rate components can be adapted to high-reliability components. • Eliminating / minimizing the adverse effects that failures could generate. • Helping uncover the misjudgements, errors etc. • Reduce development time and cost of manufacturing. (3M) **FMEA TEAM :** Engineers from - Assembly - Manufacturing - Materials - Quality - Service - Supplier - Customer (2M) **FMEA DOCUMENTATION :** (1M) The purpose of FMEA documentation is • To allow all involved Engineers to have access to others thoughts • To design and manufacture using these collective thoughts (promotes team approach)
6.	**Explain about step and stages of FMEA**. (13M) **(April/May 2018)** BTL 2 **Answer : Page :11.3and 11.5- Dr.V.Jayakumar** **Step 1 Review the process or product** (2M) • With the team, clearly define the subject of the FMEA study. • Discuss the basic features, assembly, materials, construction, and desired functions.

Step 2 Brainstorm potential failure modes (2M)

- This can be a lot of fun.
- Use a variety of brainstorm techniques to get as broad a set of ideas as possible.
- A good technique is to individually create ideas the collate them using affinity grouping.
- Mix up the process with live brainstorming, anchoring, and focused concerns (i.e. high temperature, user abuse, etc).
- For most products, you may want to focus on one function or feature at a time.

Step 3 List potential effects of each failure mode (1M)

- Consider the possible failures and imagine what could then happen to the surrounding environment and people.

Step 4 Assign a severity ranking for each effect (1M)

- For each effect (consequence) provide a ranking score.
- Common scales include 3, 5, or 10 points.
- I often start with 10 point scale and adjust depending on the team and nature of the study.
- Common practice is to assign 9 or 10 for those effects that cause injury or death, or major damage to its surroundings.
- Document the scale actually used so others can interpret the study results properly.

Step 5 Assign an occurrence ranking for each failure mode (1M)

- The worksheet includes a column of causes, which may help the team judge the relative frequency of occurrence of failure modes.
- Keep in mind that a failure mode may have many potential causes.

Step 6 Assign a detection ranking for each failure mode and/or effect (1M)

Detection is a bit different in ranking then severity or occurrence. A high score means the effect occurs without warning. It is not detectable.

Detection can include one or both of the following methods for alerting of potential failure.

Step 7 Calculate the risk priority number for each effect (1M)

- Just a bit of math. Multiple the severity, occurrence, and detection scores together to find the RPN value.
- Items that high dire consequences (high severity), occur often and provide no warning result in the highest RPN numbers relative to other potential failures.

Step 8 Prioritize the failure modes for action (1M)

- I recommend a three-step process here.
- Address the severity 9 and 10 rankings as they are related to safety.
- Review the prioritized ranks for groups of failure modes that one 'fix' (redesign, evaluation, or process improvement) may address.
- The RPNs of the individual lines may not be the topped ranked value, yet collectively the action may provide significant risk reduction.

- Address the highest remaining RPNs as the represent the remaining risk to the product working as expected.
- No team that I know of addresses every potential failure. It is a balance of safety, functionality, customer expectation, and resources.

Step 9 Take action to eliminate or reduce the high-risk failure modes (1M)

- These may include gathering information, conducting experiments, considering design or process improvements, adding or removing functions, etc.
- The idea is to do something with the study.
- The prioritized list provides a guidance document that the entire team can use to focus on the highest risk areas first.

Step 10 Calculate the resulting RPN as the failure modes are reduced or eliminated (2M)

- Document the changes to the product. Ideally, the results of completed actions will reduce the risk.
- Be sure to consider new information and function and recalculate.
- FMEA is a process and as the program evolves and grows so should the FMEA.
- It's a tool that helps the team address risks. Used as such it provides value.

7. **Explain in detail check sheets and Cause & Effect diagram**. (13M**) (Dec 2013)** BTL 2

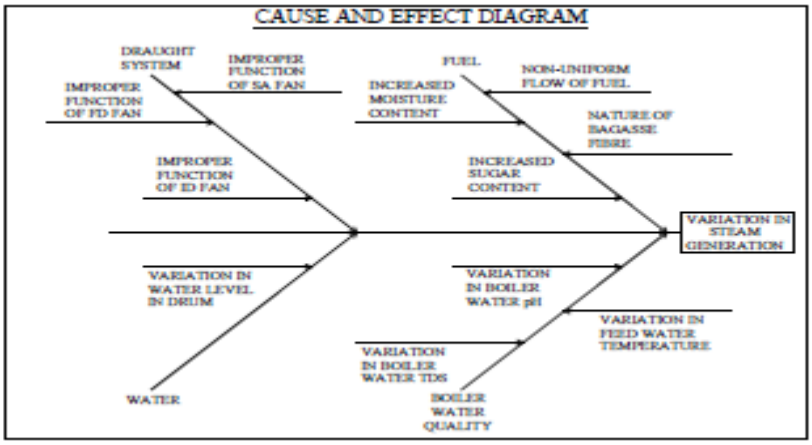
Answer : Page :4.8 to 4.12 - Dr.V.Jayakumar

The **cause and effect (CE) diagram** is a graphical-tabular chart to list and analysis the potential causes of a given problem. (2M)

The cause and effect diagram is also called the fishbone diagram because of its appearance and the Ishikawa diagram after the man who developed it in 1943. (1M)

Fig illustrates the basic structure of a cause and effect diagram.

Cause and effect diagram



(3M)

As shown in fig the diagram consists of a central stem leading to the effect (the problem), with multiple branches coming off the stem listing the various groups of possible causes of the problem.

The CE diagram has unlimited application in research, manufacturing, marketing, office operations, services and so forth. (2M)

The CE diagrams are used:

-To analyze cause and effect relationships;

-To facilitate the search for solutions of related problems;

-To standardize existing and proposed operations;

-To educate and train personnel in decision-making and corrective-action activities. (2M)

The cause and effect diagram may be constructed using the following steps:

- Define the effect (the problem) clearly and concisely.
- Mark the short description of the effect in a box. Then draw a line from this box towards left.
- List down all the possible minor and major causes through a brainstorming session.
- Mark the major causes on the branches and minor causes in the sub-branches of the CE diagrams.
- Look for possible solutions for these causes.
- Introduce the changes. (3M)

PART C

1. **Prepare a FMEA work sheet for an induction motor's shaft failure or a failure of your choice**.(15M) **(May 2015, April/May 2018)** BTL 4

Answer : Page :11.7,11.8,11.9 - Dr.V.Jayakumar

Failure mode and effect analysis also known as **risk analysis** is a preventive measure to systematically display the causes, effects, and possible actions regarding observed failures. (3M)

Objectives of FMEA:

The objective of FMEA is to anticipate failures and prevent them from occurring. FMEA prioritizes failures and attempts to eliminate their causes. (2M)

FMEA is an engineering technique is used to define, identify and eliminate known and or potential failures, problems, errors which occur in the system, design, process and service before they reach the customer. (2M)

Benefits of FMEA:

Improve product/process reliability and quality.

	• Increase customer satisfaction. • Early identification and elimination of potential product/process failure modes. • Prioritize product or process deficiencies • Capture engineering/organization knowledge • Document and track the actions taken to reduce risk • Provide focus for improved testing and development. • Minimize late changes and associated cost. • Act as catalyst for teamwork and idea exchange between functions. (8M)
2.	**Develop procedure for implementation of SIX sigma in a manufacturing organization.** (15M) **(May 2015, April/May 2018)** BTL 6 **Answer : Page :13.3 - Dr.V.Jayakumar** **NEED FOR SIX SIGMA** We know that, the three sigma quality, i.e., the natural variability equal to tolerance (= upper specification limit – lower specification limit). It means, in normal distribution curve, only 0.27% of the output would be expected to fall outside the specifications limits. (3M) **THE CONCEPT OF SIX SIGMA:** Before studying the concept of six sigma, first let us re-introduce the concept of process capability ratio (Cp) (2M) (Assumption is that process is centered midway the specification limits, i.e., there is no shift in process mean) (2M) Process capability ratio measures how well the product requirements match with the process capabilities. The higher the value of Cp' the better the match between product and process. (2M) **The real meaning of 3sigma concept:** • A medium aircraft consists of 10,000 different parts. • At 3sigma quality, 27 of those parts in an assembled aircraft would be defective. • So three sigma quality level cannot be accepted as good enough quality level. So we have to increase the sigma level (i.e., reducing the number of defectives). • In fact, even four sigma quality also not sufficient for the aircraft case. • That's why six sigma quality level is preferred than 3sigma and 4 sigma quality levels. (6M)
3.	**Explain about check sheet, Histogram to tally number of errors.** (15M) BTL 6 **Answer : Page :8.6- 8.9 - Dr.V.Jayakumar**

4. CHECK SHEETS

CHECK SHEET

Product : Bicycle

Nonconformity Type	Check	Total
Blister	𝍸 𝍸 𝍸 𝍸 I	21
Light spray	𝍸 𝍸 𝍸	15
Drips	𝍸 𝍸 𝍸 𝍸 𝍸	25
Others	𝍸 𝍸 𝍸 𝍸 𝍸	25
TOTAL		86

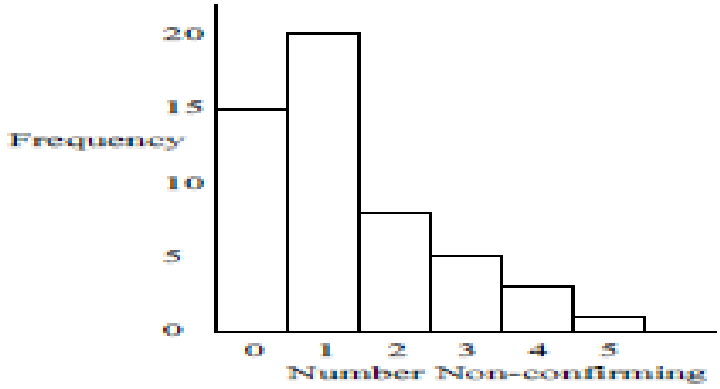
5. HISTOGRAM

Number of Errors

0	1	3	0	1	0	1	0
1	5	4	1	2	1	2	0
1	0	2	0	0	2	0	1
2	1	1	1	2	1	1	
0	4	1	3	1	1	1	
1	3	4	0	0	0	0	
1	3	0	1	2	2	3	

Tally of Number of Errors

Number Non-conforming	Tabulation	Freq.
0	𝍸 𝍸 𝍸	15
1	𝍸 𝍸 𝍸 𝍸	20
2	𝍸 III	8
3	𝍸	5
4	III	3
5	I	1



UNIT IV-TQM TOOLS AND TECHNIQUES

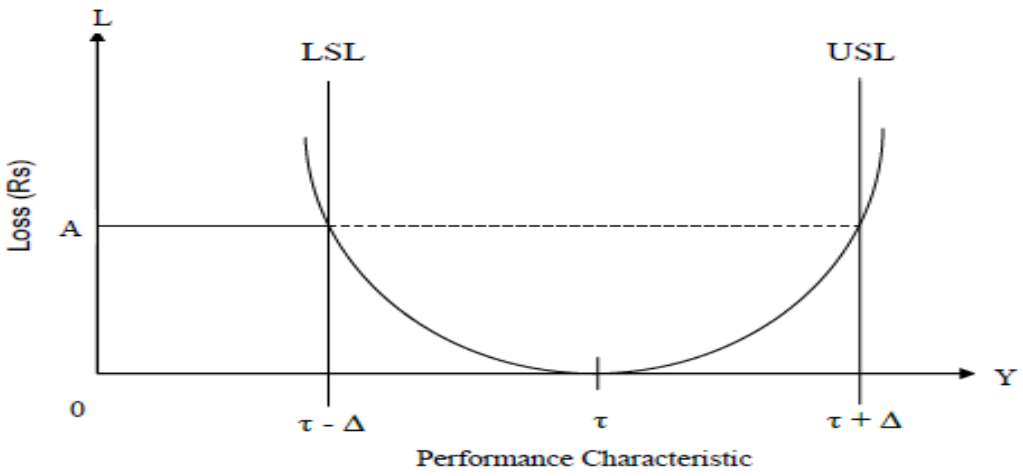
Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

PART * A

Q.No.	Questions
1	**What is quality circle and its structure? (June 2013, Dec 2013)** BTL1 QC is a group activity practiced at regular intervals which focuses on quality practices. It comprises of the line operator, supervisor and project engineering, headed by the lowest cadre, i.e., line operator. QC stresses upon the ownership concept to entrust the responsibilities and work as a team to achieve consistent quality in products/service offerings Executive committee, steering committee, facilitators, QC leader, Deputy Leader, members 5-8%.
2	**Give the essential feature of Total Productive Maintenance (TPM). (June 2012, Dec 2013)** BTL 1 TPM is keeping plant and equipment at their highest productive level through cooperation of all areas of the enterprise. TPM brings maintenance into focus as a necessary and vital part of the business. It is not regarded as a non-profit activity. Down time for maintenance is scheduled as an integral part of the manufacturing process.
3	**What are the three categories of losses identified in TPM? (June 2014)** BTL 1 (a) Losses that impede equipment efficiency (b) Losses that impede human work efficiency and (c) Losses that impede effective use of production resources.
4	**What is Taguchi's Loss function (TQLF)? (June 2012, June 2015)** BTL 1 The essence of the loss function concept is that whenever a product deviates from its target performance it generates a loss to society. This loss is minimum when performance is right on target, but it grows gradually as one deviates from the target.
5	**What is the importance of Taguchi's quality loss function (TQLF)? (Dec 2015, April/May 2019)** BTL 1 The essence of TQLF is that whenever a product deviates from its target performance, it generates a loss to society. This loss is minimal when performance is right on the target, but it grows gradually as one deviates from the target.
6	**What sparked the interest of Indian Manufactures in quality circles? (Dec 2015)** BTL 1 i) Quality circles effects on individual characteristics ii) Quality circles effects on individual relations with others iii) Quality circles effects on workers and their attitudes towards the company.
7	**Indicate the different parameters used for quality performance measurement. (May 2015, April/May 2019)** BTL 3 i) Customer ii) Production iii) Supplier iv) Research & Development v) Human resources vi) Marketing /Sales vii) Administration.
8	**What are the eight pillars of TPM?** BTL 1 The eight pillars of TPM are: 1. 5S 2. JishuHozen (Autonomous Maintenance) 3. Kobetsu Kaizen (KK)

	4. Planned Maintenance (PM) 5. Quality Maintenance (QM) 6. Training 7. Office TPM 8. Safety, Health and Environment.
9	**What is Business Process Reengineering (BPR)?** BTL 1 The fundamental rethinking and radical redesign of business processes to improve performance dramatically in terms of measures like cost, quality, service, and speed. BPR concentrates on stable and effective changes and not upside down change and changes planned are process accommodative and not adjustable.
10	**Give Taguchi's definition of quality. (April/May 2017)** BTL 2 "Loss imparted to society by a product during its life cycle", i.e. the costs incurred in the production process as well as the costs encountered during use by the customer.
11	**What is voice of customer (VOC)?** BTL 1 It is the requirements of the customers in a product and the requirements are described by them in their own words. VOC brings in the customer mind-set and does not consider with market dynamics. VOC is the basic step followed in House of quality concept.
12	**Give the seven basic steps to get an organization started toward TPM. (April/May 2018)** BTL 3 1. Management learns the new philosophy 2. Management promotes the new philosophy 3. Training is funded and developed for everyone in the organization 4. Areas of needed improvement are identified 5. Performance goals are formulated 6. An implementation plan is developed **7.** g) Autonomous work groups are established
13	**What are the steps required to construct an affinity diagram? (May 2016)** BTL 1 1. Phrase the objective 2. Record all responses 3. Group the responses **4.** iv. Organize groups in an affinity diagram.
14	**What are the performance measures of TQM?** BTL 1 Customer orientation, value based operations, performance compatibility, teamwork, development and monitoring. Current perspective includes VAVE (Value added value engineering) integrated with TQM, concentrates on productivity, as productivity is producing parts with right quality and quantity.
15	**What is QFD?(Nov/Dec 2018)** BTL 1 Quality function development may be defined as a system for translating consumer requirements into appropriate requirements at every stage, from research through product design and development, to manufacture, distribution, installation and marketing, sales and service.
16	**What is Poka Yoke?** BTL 1 Poka Yoke is Mistake proofing. Humans tend to make mistakes. Designing the product with the ability to alarm or inform the humans that their handling is wrong. Automation imbibes Poka-yoke features added to it thus separate focus on error-proofing has no longer required in a manufacturing cell.
17	**Define TPM.** BTL 2 Total Productive Maintenance was aimed at all the activities with the slogan "Maintenance for Profit". The prime objectives of TPM are improving effective operation rate of machines and

	equipments; improving reliability for the development of machines and equipments and enhancing manufacturing morale.
18	**What are the benefits of QFD?** BTL 1 i. Customer driven ii. Reduces implementation time iii. Promotes teamwork iv. Provides documentation.
19	**What sparked the interest of Indian Manufactures in quality circles?** BTL 1 i) Quality circles effects on individual characteristics ii) Quality circles effects on individual relations with others iii) Quality circles effects on workers and their attitudes towards the company.
	PART * B
1	**Explain about Taguchi's Quality Loss Function.** (13M) **(June 2013, June 2012, Dec 2014,April/May 2017)** BTL 2 **Answer : Page :15.1 to 15.9 - Dr.V.Jayakumar** Taguchi's Quality Loss Function concept combines cost, target and variation in one metric with specifications being of secondary importance. Taguchi has defined quality as the loss imparted to society from the time a product is shipped. Societal losses include failure to meet customer requirements, failure to meet ideal performance and harmful side effects. (3M) **CUSTOMERS PERCEIVE QUALITY AS MEETING THE TARGET RATHER THAN JUST MEETING THE SPECIFICATIONS.** There are three common quality loss functions 1. Nominal - the - best. 2. Smaller - the - better. 3. Larger - the - better. (3M) **NOMINAL – THE – BEST :** Although Taguchi developed so many loss functions, many situations are approximated by the quadratic function which is called the **Nominal – the – best** type.



Performance Characteristic

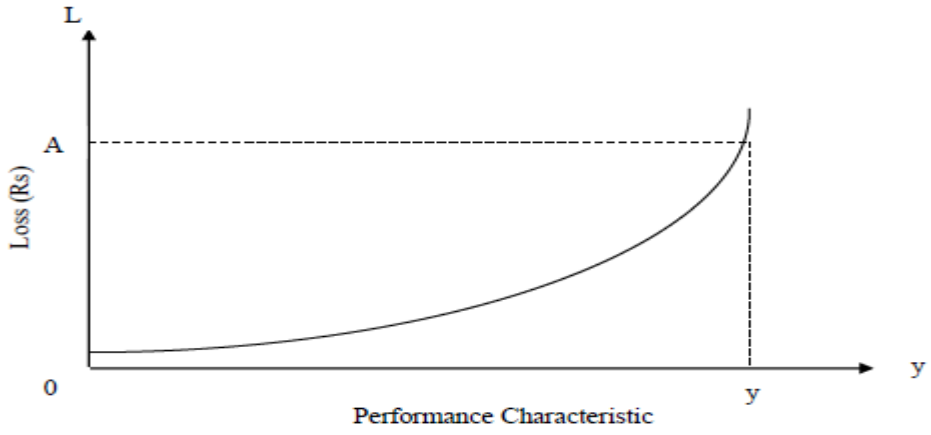
Quadratic Loss Function

(2M)

The quadratic function is shown in figure. In this situation, the loss occurs as soon as the performance characteristic, y, departs from the target τ.
At τ, the loss is Rs. 0.
At LSL (or) USL, the loss is Rs. A.
The quadratic loss function is described by the equation $L = k (y - \tau) 2$.
Where,
L = cost incurred as quality deviates from the target.
y = Performance characteristic
τ = target
k = Quality loss coefficient.
The loss coefficient is determined by setting $\Delta = (y - \tau)$, the deviation from the target. When Δ is the USL (or) LSL, the loss to the customer of repairing (or) discarding the product is Rs. A.
Thus,
$K = A / (y - \tau)2 = A / \Delta 2$. (2M)

SMALLER – THE – BETTER :

The following figure shows the smaller – the – better concepts.



Performance Characteristic

Smaller-the-better

The target value for **smaller – the – better** is 0. There are no negative values for the performance characteristic.
The radiation leakage from a microwave appliance, the response time for a computer, pollution from an automobile, out of round for a hole etc. are the performance characteristics for this concept. (2M)

LARGER – THE – BETTER :
The following figure shows the concept of the Larger – the – better.

In the Larger – the – better concept, the target value is ∞ (infinity), which gives a **zero loss**. There are no negative values and the worst case is at y = 0. Actually, larger – the – better is the reciprocal of smaller – the – better. The performance characteristics in Larger – the – better are bond strength of adhesives, welding strength etc. (1M)

2. **Briefly explain the steps involved in QFD. (13M) (Dec 2012, Dec 2013,Dec 2014, April/May 2019)** BTL 2
Answer : Page :14.7 - Dr.V.Jayakumar

QUALITY FUNCTION DEVELOPMENT PROCESS:

Phase 1: product planning

Step1: list customer requirements

Step2: List technical descriptors

Step3: Develop a relationship between WHATS AND HOWS

Step4: Develop a interrelationship matrix between HOWS

Step5: Do competitive assessments

Step6: Develop prioritized customer requirements

Step7: Develop prioritized technical descriptors. (4M)

Phase 2: part development

Step8: Deploy QFD process down to sub-components level both in terms of requirements and characteristics.

Step9: Deploy the component deployment chart. Relate the critical sub-component control characteristics. (2M)

Phase 3: process planning

Step10: Develop the relationship between the critical characteristics and process used to create the characteristics

Step11: Develop the control plan relating critical control to critical processes. (3M)

Phase 4: production planning

	Step 12: Tabulate operating instructions from process requirements Step13: develop prototype and do testing Step14: Launch the final product to the market. (4M)
3.	**Explain each section of the basic structures of house of quality by selecting a suitable product.** (13M) **(June 2016, Jun 2010, June 2013, June 2014, May 2015, Dec 2015, April/May 2019)** BTL 2 **Answer : Page :14.3 - Dr.V.Jayakumar** The primary planning tool used in QFD is the house of quality. The house of quality converts the voice of the customer into product design characteristics. QFD uses a series of matrix diagrams, also called 'quality tables', resembles connected houses. (2M) **Basic structure of house of quality:** 1. Customer requirements (1M) 2. Prioritized customer requirements (2M) 3. Technical descriptors (1M) 4. Relationship matrix (1M) 5. prioritized technical descriptors (2M) 6. Competitive assessments (2M) 7. Develop a relationship matrix between WHATS AND HOWS (2M)
4.	**With an example explain QFD methodology.** (13M) **(Dec 2013, May 2015, April/May 2019)** BTL 2 **Answer : Page :14.6 - Dr.V.Jayakumar** **Definition:** Quality function deployment may be defined as a system for translating consumer requirements into appropriate requirements at every stage, from research through product design and development, to manufacture, distribution, installation and marketing, sales and service. (2M) **OBJECTIVES OF QFD:** 1. To identify the true voice of the customer and to use this knowledge to develop products which satisfy customers. 2. To help in the organization and analysis of all the pertinent information associated with the project. 3. Quality function development aims at translating the customers voice into product specifications. (2M) **QC** is a group activity practiced at regular intervals which focuses on quality practices. Structure of Quality circle involves the following: 1. Executive Committee, 2. Steering committee,

3. Facilitators,
4. QC Leader
5. Deputy Leader

Members (2M)

This is required in Industries in order :

1. To establish baseline measures and reveal trends
2. To determine which processes need to be improved
3. To indicate process gain and losses
4. To compare goals with actual performance
5. To provide information to make informed decisions
6. To determine overall performance of the organization (3M)

The commonly used techniques are

1. Time series trend graphs
2. Control charts
3. Capability index
4. Taguchi loss function
5. Cost of poor quality
6. Quality awards (4M)

5. **Briefly explain the steps involved in QFD. (13M) (Dec 2012, Dec 2013, Dec 2014, April/May 2017, April/May 2019)** BTL 2
Answer : Page :14.7 - Dr.V.Jayakumar

QUALITY FUNCTION DEVELOPMENT PROCESS:

Phase 1: product planning

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	Step8: Deploy QFD process down to sub-components level both in terms of requirements and characteristics. Step9: Deploy the component deployment chart. Relate the critical sub-component control characteristics. (2M) **Phase 3: process planning** Step10: Develop the relationship between the critical characteristics and process used to create the characteristics Step11: Develop the control plan relating critical control to critical processes. (3M) **Phase 4: production planning** Step 12: Tabulate operating instructions from process requirements Step13: develop prototype and do testing Step14: Launch the final product to the market. (4M)
6.	**Explain the types and the analysis techniques of cost of quality.** (13M) **(June 2013)** BTL 2 **Answer : Page :14.2 - Dr.V.Jayakumar** 1. Prevention costs-These are costs that are incurred in preventing a quality problem from arising. 2. Appraisal costs- These are costs that are incurred in assessing the products/services conform to requirements. (6M) 3. Internal failure costs- These are costs required to identify, repair, replace, or dispose of defective products/services prior to delivery to the customer. (4M) 4. External failure costs- Cost of warranty, cost of loss of image, cost of service etc. (3M)
7.	**What is six sigma concept? (OR) Develop procedure for implementation of six sigma in a manufacturing organization.** (13M) **(May 2013, May 2012, Nov 2011, May 2014, Nov 2014, Nov 2016, Nov/Dec 2018**) BTL 4 **Answer : Page :13.3 - Dr.V.Jayakumar** **Six sigma:** A vision of quality which equates with only 3.4 defects per million opportunities (DPMO) for each product or service transaction and strives for perfection. Six sigma is a systematic method for process and product improvement and for measuring performance variation. It is also a metric for valuating performance we quality and a standard of excellence. (4M) **Six sigma process:** DMAIC

Define --> **M**easure --> **A**nalyze --> **I**mprove -->**C**ontrol

- **Define**: Define the Problem or Project Goal that needs to be addressed.
- **Measure**: Measure and determine customers needs and specifications.
- **Analyze**: Analyze the process to meet the customer needs. (4M)

Advantages of six sigma:

1. Improved customer satisfaction
2. Ensures products/service meeting customer requirements
3. Reduction of waste and defects
4. Variation reduction well-defined roles and responsibilities
5. Empowering all employees for better improvement.
   Improved communication (5M)

PART*C

1. **With an example, draw QFD methodology and explain.** (15M) **(Dec 2013, May 2015, April/May 2019)** BTL 2
Answer : Page :14.6 - Dr.V.Jayakumar

Phase 1: product planning

Step1: list customer requirements

Step2: List technical descriptors

Step3: Develop a relationship between WHATS AND HOWS

Step4: Develop a interrelationship matrix between HOWS

Step5: Do competitive assessments

Step6: Develop prioritized customer requirements

Step7: Develop prioritized technical descriptors. (5M)

Phase 2: part development

Step8: Deploy QFD process down to sub-components level both in terms of requirements and characteristics.

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Phase 3: process planning

	Step10: Develop the relationship between the critical characteristics and process used to create the characteristics Step11: Develop the control plan relating critical control to critical processes. (3M) Phase 4: production planning Step 12: Tabulate operating instructions from process requirements Step13: develop prototype and do testing Step14: Launch the final product to the market. (5M)
2.	**Explain the stages involved in TPM.** (15M) **(May 2014, April/May 2019)** BTL 2 **Answer : Page :16.6 - Dr.V.Jayakumar** **TPM** is keeping plant and equipment at their highest productive level through cooperation of all areas of the enterprise. TPM brings maintenance into focus as a necessary and vital part of the business. It is not regarded as a non-profit activity. Down time for maintenance is scheduled as an integral part of the manufacturing process. (3M) 1. The overall goals of TPM are: a. Maintaining and improving equipment capacity. (2M) b. Maintaining equipment for life. (2M) 2. Using support from all areas of operation. (3M) 3. Encouraging inputs from all employees. (3M) Using teams for continuous improvement. (2M)
3.	**Explain the pillars of TPM and its benefits and how they are implemented.** (15M) **(June 2016, May 2015,Nov 2015, April/May 2019)** BTL 2 **Answer : Page : 16.6- Dr.V.Jayakumar** **TPM PHILOSOPHY – CONCEPT OF TPM** : Total Productive Maintenance (TPM) is an extension of the Total Quality Management (TQM) philosophy to the maintenance function. (2M) TPM has the following steps: 1. Management should learn the new philosophy of TPM. (2M) 2. Management should promote the new philosophy of TPM. (1M) 3. Training should be funded and developed for everyone in the organization. (1M) 4. Areas of needed improvement should be identified. Loss measurements to identify improvement needs are Down time losses, Reduced speed losses,Poor quality losses (3M) 5. Performance goals should be formulated. (2M) 6. An implementation plan should be developed. (2M)

	7Autonomous worth groups should be established.	(2M)

UNIT V-QUALITY SYSTEMS	
Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors.	
PART * A	
Q.No.	**Questions**
1	**What are the general requirements of quality management system? (Dec 2015)** BTL1 The organization shall establish, document, implement and maintain a quality management system and continually improve its effectiveness in accordance with the requirements of this International Standard.
2	**What are ISO 9000 standards or Objectives of ISO 9000 quality standards? (June 2007, 2014, Dec 2013, Dec 2014)** BTL1 ISO 9000 are a set of quality standards aimed at promoting the growth of international trade by facilitating harmonious interactions between suppliers and customers located in diverse locations globally. It is a quality management system [QMS] to ensure quality of products and services.
3	**Compare QS 9000 with TS 16949 quality systems. (May 2015)** BTL4 Product approach — Process approach Customer satisfaction — Employees motivation More focus on documentation — Less focus on documentation
4	**Define quality system audit. (April/May 2019)** BTL1 Quality system audits is a systematic, independent examination to determine whether quality activities and results comply with planned arrangements, whether these arrangements are implemented effectively, and whether these are suitable to achieve objectives.
5	**What is third party audit? (Dec 2017)** BTL1 The third party certification audit is carried out much in the same way as first party and second party quality system assessments and audits. However, the big difference is that an independent accredited auditing body carries out the assessment and audit, as opposed to carrying it out by the organization themselves.
6	**What is Environment Management Systems Standards? (Dec 2018)** BTL1 An EMS meeting the requirements of ISO 14001:2004 is a management tool enabling an organization of any size or type to: 1. Identify and control the environmental impact of its activities, products or services 2. To improve its environmental performance continually 3. To implement a systematic approach to setting environmental objectives and targets, to achieving these and to demonstrating that they have been achieved.
7	**What is QS 9000 and who have developed the system. (June 2015)** BTL1 QS 9000 is an extension of ISO 9000 and is only for automotive industries, this was developed by three big industries like Ford, Chrysler and General Motors of U.S.A in 1994.

8	**List the various clauses of ISO 9001-2000 standards? (May 2017)** BTL5 1. Scope 2. Normative reference 3. Terms and definitions 4. Quality management systems 5. Management responsibility 6. Resource management 7. Product realization 8. Measuring, analysis and improvement.
9	**What is quality system? (June 2016)** BTL1 Aggregate of the organizational activities, incentives, plans, policies, procedures, resources, responsibilities and the infrastructure required in formulating and implementing a total quality management approach.
10	**What are the items covered by ISO 9000 regarding quality? (Dec 2018) (BTL 1)** 1. Fundamental and vocabulary 2. Requirements 3. Guidelines for performance improvement
11	**Write short notes on ISO Certification. (Dec 2015)** BTL2 ISO defined the term quality systems as follows: The quality system is the organizational structure, responsibilities, procedures, processes and resources for implementing quality management.
12	**What are the different stages in conducting quality audit? (April/May 2019)** BTL1 1. Audit planning – schedules, personnel, notifications, checklist 2. Performance – opening meetings, audit process, noting of non-conformities 3. Reporting – Observations, suggestions for corrective action 4. Follow-up – implementation of corrective action.
13	**What are the documentation requirements of quality management systems? (April/May 2017)** BTL1 documented statements of a quality policy and quality objectives 1. quality manual 2. documented procedures and records required by this International Standard 3. documents including records 4. determined by the organization to be necessary to ensure the effective planning, operation and control of its processes
14	**What is quality manual?** BTL1 The organization shall establish and maintain a quality manual that includes; 1. the scope of the quality management system, including details of and justification for any exclusions 2. the documented procedures established for the quality management system or reference to them 3. A description of the interaction between the processes of the quality management system.
15	**What is the need for ISO standards? (April/May 2018)** BTL1 ISO 9000 is needed to unify the quality terms and definitions used by industrialized nations and use terms to demonstrate a supplier's capability of controlling its processes. ISO 9000 and ISO 9002 are customer centric quality systems that focus on satisfying the customer by all means.
16	**Draw the documentation pyramid. (Dec 2011)** BTL2

	 The ISO 9001 Documentation Pyramid
17	**Give the objectives of internal audit.** BTL3 1. Determine the actual performance conforms to the documented quality systems 2. Initiate corrective action activities in response to deficiencies 3. Follow up on noncompliance items of previous audits 4. Provide continued improvement in the system through feedback to management.
18	**What are the benefits of ISO 14001? (Nov/Dec 2018, April/May 2019)** BTL1 1. Facilitate trade and remove trade barriers 2. Improve environmental performance of planet earth 3. To build consensus that there is a need for environment management and a common terminology for EMS.
19	**Explain the management's responsibility for ISO.** BTL1 Top management shall provide evidence of its commitment to the development and implementation of the quality management system and continually improving its effectiveness by a) communicating to the organization the importance of meeting customer as well as statutory and regulatory requirements, b) establishing the quality policy, c) ensuring that quality objectives are established, d) conducting management reviews, and e) ensuring the availability of resources.
20	**What are the different types of audit?** BTL1 First party audit (internal), Second party audit (by customer), and Third party audit (by independent agency). Another classification: System audit, Process audit, Product audit, Adequacy audit, and Compliance audit.
	PART * B
1	**Explain the elements and implementation of ISO 9000 (ISO 9000:2000) standards.** (13M) **(Dec 2012,2013, 2014, June 2014, June 2016, Nov/Dec 2018, April/May 2019)** BTL2 **Answer : Page :18.27 - Dr.V.Jayakumar** **1. ELEMENTS OF ISO** 1. Management responsibility

2. The Quality system
3. Contract review
4. Design control
5. Document and data control
6. Purchasing
7. Control of customer-supplied product
8. Product identification and traceability
9. Process control
10. Inspection and testing
11. Control of inspection, measuring and test equipment
12. Inspection and test status
13. Control of nonconforming product
14. Corrective and preventive action
15. Handling, storage, packaging, preservation and delivery
16. Control of quality records
17. Internal quality audits
18. Training
19. Servicing
20. Statistical techniques. (10M)

2. Implementation steps

1. Top management commitment
2. Appoint the management representative
3. Awareness
4. Appoint an implementation team
5. Training
6. Time schedule
7. Select element owners
8. Review the present system
9. Write the document
10. Install the new system.
11. Internal audit
12. Management review
13. Pre-assessment
14. Registration (3M)

2. **Explain the features and procedures to obtain ISO 14000 environmental certification.** (13M) **(Dec 2013, May 2015, Nov/Dec 2018)** BTL2

Answer : Page :19.6 - Dr.V.Jayakumar

An EMS meeting the requirements of ISO 14001:2004 is a management tool enabling an organization of any size or type to:

Identify and control the environmental impact of its activities, products or services, and to

Improve its environmental performance continually, and to

	Implement a systematic approach to setting environmental objectives and targets, to achieving these and to demonstrating that they have been achieved. (5M) General requirements 1. Environmental policy 2. Planning 3. Implementation and operation 4. Checking and corrective action 5. Management review (8M)
3.	**Discuss about four important documents to be prepared for ISO 9000 certification. (April/May 2017, April/May 2018)** (13M) BTL2 **Answer : Page :18.30 - Dr.V.Jayakumar** **Steps in ISO certification:** 1. Top management commitment 2. Appoint the management representative 3. Awareness 4. Appoint the implementation team 5. Training 6. Time schedule 7. Select element owners 8. Review the present system 9. Write the documents 10. Install the new system 11. Internal audit 12. Management review 13. Pre-assessment 14. Registration 15. Award of ISO 9000 certification. Each point must be explained briefly. (10M) Documents: 1 State the quality policy and objectives 2: Description of the activities needed to implement the system 3: Detailed work Documents 4: Results of implementing the quality system (3M)
4.	**What are the needs for documentation in Quality Management System and the documents to be prepared for QMS?** (13M) **(April/May 2015, Nov/Dec 2014, Nov/Dec 2010, May/June 2012, April/May 2018)** BTL2 **Answer : Page :18.30 - Dr.V.Jayakumar** **Documentation of Quality System:** **I. Necessity for Documentation** 1. It is understood that the proper documentation is the pre-requisite for implementing quality system. 2. The document serves as a reference for the management, the staff and other agencies whose involvement is essential for implementation of the quality system. Advantages of having a documented quality system 3. Documentation serves as a reference

4. Brings about clarity of objectives and target
5. Provides standardization in work procedures
6. Brings about confidence consistency in operations
7. Develops confidence amongst employees
8. Generates customer's confidence
9. Provides a basis for continuous improvement etc. (5M)

II. Documents to be prepare

1. statments of the quality policy and objectives.
2: Description of the activities needed to implement the system.
3: Detailed work Documents.
4: Results of implementing the quality system (3M)

Quality Policy Manual (What?, Why?)

1. This is the first level of documentation. This is the document that defines „what will be done" and „why".
2. The „why" can be stated just once as a quality policy statement. This statement should be a short and simple definition of the organization's quality intensions
3. The policy manual communicates the quality policy and objectives of an organization.
4. This manual is a living document. Because if reflects the current system being followed in the organization. (3M)

Quality System Procedures (Who? When? Where?)

Second level of documentation

1. These procedures describes the methods that will be used to implement and perform the stated policies
2. These procedures define who should perform specific tasks, when the task should be done, and where documentation will be made.
3. These documents collectively define the organization's operations from receiving an enquiry to delivery completed product or service. (2M)

5.

What are the benefits of implementing ISO 14000 standards.(13M) **(Dec 2017)** BTL 2
Answer : Page :19.20 - Dr.V.Jayakumar

1. This third level of documentation is company specific. It gives details of hoe individual work processes (machining, welding etc) are carried out within a company.
2. Work instructions should also specify how the work should be done. who should undertake the work and what records are to be maintained.
3. The work instructions may be in the form of a detailed drawing, recipe, routing sheet, specific job function, photograph, video or simply a sample for comparison of conformity.
4. The work instructions should be written by the employees who perform the task. (5M)

Records, Formats, Forms (Evidence)

1. Records provide evidence of activity having been performed in compliance with quality system procedure.

2. Records may be forms that are filled out, a stamp of approval on a product, or a signature and date on some type of document.
3. Records are used to provide traceability of actions taken on a specific product or batch of products. (3M)

Benefits of documentation:

1. Documentation regularizes the method of performing the day-to-day activities.
2. It provides formats for standardizing practices
3. It provides reference for assessing degree of enforcement in practice.
4. It facilitates trouble shooting for tracing back on the processes
5. It demonstrates the ISO quality system certification. (5M)

6.

Explain the features of ISO 14000 and procedure to obtain ISO 14000 certification.(13M) **(April 2015, Nov 2010, Nov 2013, Nov 2014, Nov 2011, May 2014, Dec 2016, April/May 2018)** BTL2

Answer : Page :4.8 to 4.12 - Dr.V.Jayakumar

1. An ISO 14000 standards are a set of norms for Environmental Management System (EMS) either at organization and process level or product level
2. The overall objective of ISO14000 Environmental management Standard is to encourage environmental protection and pollution prevention while taking into account the economic needs of society.
3. An EMS meet g the requirements of ISO 14001:2004 is a management tool enabling an organization of any size or type to:
4. Identify and control the environmental impact of its activities, products or services, and to
5. Improve its environmental performance continually, and to
6. Implement a systematic approach to setting environmental objectives and targets, to achieving these and to demonstrating that they have been achieved. (5M)

Concepts of ISO 14001
(Environmental Management System Model)

The EMS model consists of following five stages.
1. Environmental policy
2. Planning
3. Implementation and operation
4. Checking and corrective action
5. Management review
6. Checking and corrective act on
7. Continuous improvement (3M)

Stage1: Environmental policy

Environmental policy should address the following issues:

1. Management commitment to continual improvement
2. Prevention of pollution

3. Creating a framework for setting objectives
4. Communication requirement with shareholders. (2M)

Stage 2: Planning

This Planning stage contains four elements such as:

1. Environment aspects of an organization‟s activities, products and services should
2. be identified in order to determine the environmental impact.
3. Legal and other requirements: Organization should identify and have access to all legal and other requirements to which it subscribes.
4. Objectives and targets: The organization should establish and maintain the objectives and target at each relevant function and level.
5. Environmental management program(s): The organization should establish and maintain a program(s) for achieving the objectives and target. (1M)

Stage 3: Implementation and operation

1. This stage has seven elements such as:
2. Structure and responsibility
3. Training, awareness and competency
4. Communication
5. EMS documentation
6. Document control
7. Operational control
8. Emergency preparedness and response

Stage 4: Checking and corrective action

This stage has four elements such as:

1. Monitoring and measuring
2. Non-conformance and corrective and pr v ntive action
3. Records
4. EMS audit. (1M)

Stage 5: Management review

Management should review and revise the system in order to ensure the continuing suitability, uacy, and effectiveness of the EMS.The management must evaluate the feedback data and make ovements to the systems. (1M)

7. **uirements of ISO 14001(Elements/Clauses of Environmental Management System) (EMS uirements).** (13M) BTL2

Answer : Page :19.9 - Dr.V.Jayakumar

Four sections of ISO 14001 are:

Section1: Scope
Section2: Normative reference
Section3: Definitions

Section4: EMS requirements

General requirements

1. The organization shall establish and maintain an environmental management system that includes policy, planning, implementation, operation, checking, corrective action and management review. These requirements are given in the rest of the standard.
2. Because the document is available to the public and other stakeholders, the organization may include a brief description of the company. (1M)

Environmental policy

The organization's policy statement should be based on its mission, objectives and its value. It should reflect management commitment, leadership and direction for the environmental activities.

Top management shall define the organization's environmental policy and ensure that

1. It is appropriate to the nature, scale and environmental impacts of its activities, products or services
2. It includes a commitment to continual improvement and prevention of pollution
3. It includes a commitment to comply w th relevant environmental legislation and regulations, and with other requir m nts to which the organization subscribes
4. It provides the framework for setting and r vi w ng environmental objectives and targets.
5. It is documented, implemented and maintained a d communicated to all employees
6. It is available to the public.

Planning

This area has four elements:

1. Environmental aspects
2. Legal and other requirements
3. Objectives and targets
4. Environmental management program(s).
5. Environmental aspects (2M)

Legal and other requirements

The organization shall establish and maintain a procedure to identify and have access to legal and other requirements to which the organization subscribes, that are applicable to the environmental aspects of its activities, products or services.

According to ISO 14004 , issues to be considered in the procedure should include, how the organization :

1. Access and identifies legal and other requirements b. Keep track of legal and other requirements.
2. Keeps track of any changes in the legal and other requirements.

3. Communicates relevant information about l gal and other requirements to employees in their organization. (2M)

Environmental management programs.

The organization shall establish and maintain (a) program(s) for achieving its objectives and targets.

Following requirements can be achieved with a simple form:

1. State the objective clearly
2. State the purpose of the objective
3. Describe how the objective can be achieved
4. Identify the team leader.
5. Assign departments and individual specific tasks
6. Establish a schedule for completing the task.
7. Establish program review, this includes format, content and review schedule. (2M)

Implementation and operation

Operational control Emergency preparedness a d response Structure and responsibility

1. Roles, responsibility and author shall be defined, documented and communicated to all personnel. They must be given necessary freedom and authority to take necessary actions.
2. Training needs should be identified on a regular basis, to ensure effectiveness. Two types of Training: general awareness and job competency.

Communication

1. The key aspect of any management program is how effective it communicates with all stakeholders. The standard requires that procedures should be established and maintained for internal communication among all employees.
2. Internal communication between the various levels and functions of the organization. Receiving, documenting and responding to relevant communication from external interested parties
3. Effective communication should ensure that questions are answered and that understanding is complete and accurate. (2M)

Environmental management system documentation

The organization shall establish and maintain information describe the core elements of the management system and their interaction provide direction to related documentation.

Document control

1. The organization has established and maintained procedures for controlling all documents required by the ISO 14001 standard.
2. The purpose of Document Control is to ensure that current versions of relevant documents are available at all locations. (2M)

Benefits of EMS.

	Global Facilitate trade and remove trade barriers 1. improve environmental performance of planet earth 2. Build consensus that there is a need for environment management and a common terminology for EMS. **Organizational** Assuring customers of a commitment to environmental management 1. Meeting customer requirements 2. Maintaining a good public / community lations image 3. Satisfying investor criteria and improving access to capital 4. Obtaining insurance at reasonable cost 5. Increasing market share that results from a competitive advantage 6. Reducing incidents that result in liability. (2M)
8.	**Discuss the benefits of ISO 9000 certification**.(13M) **(May 2013, May 2014, May 2016)** BTL2 **Answer : Page :18.2 - Dr.V.Jayakumar** **Benefits of ISO 9000.** 1. It forms a solid foundation for improvement, consistency and profitability 2. It provides good platform for continuous quality improvement 3. It provides a status symbol for the organization and acts as powerful marketing tool 4. It increases the potential market share 5. It improves employees morale and ensures their total involvement 6. It establishes a firm base for management of growth , change and continuing improvement 7. It increases awareness of employees in company requirements and activities 8. It ensures customer satisfaction 9. It generates customer confidence through world-class products/services 10. It ensures confidence with all stakeholders in the organization including suppliers, investors, shareholders etc. 11. It improves documentation, operating standards, and housekeeping. 12. It improves the perception of product quality. **13.** It helps in reducing the wastage and reduction in the cost of production. (13M)
	PART*C
1.	1. **Write brief notes on Quality Auditing in QMS .**(15M) **(April/May 2015, Nov/Dec 2011, May/June 2017) BTL4** **Answer : Page :18.32 - Dr.V.Jayakumar** Quality audit is the process of systematic examination of a quality system carried out by an internal or exter al quality auditor or an audit team. It is an important part of organization's quality management system and is a key element in the ISO quality system standard, ISO 9001. (5M)

Features of Quality Audits:

1. The quality audit typically applies to quality systems or elements such as processes, products or services .Such audits are often called „quality system audits", „process quality audits". "Product quality audits, and „service quality service" respectively.
2. Quality audits are carried by staffs who are not directly responsible in the areas being audited. But preferably auditors should work in cooperation with relevant personnel.
3. Quality audit is an information gathering activity. It is not a „police" kind of activity.
4. Quality audit may be conducted for internal or external purposes. They need not cover whole quality system, at once , but may cover elements of it. (5M)

Types of audits:

1. **First party audit (Internal audit)**, audit is done by an organization, where the auditee is its own client ie, audit is done by the organization, working on itself.
2. **Second party audit**:This refers to audit by one organization on another organization (auditee).This type of audit is normally done on a supplier by a customer.
3. **Third party audit (External audit):** This refers to audit by an independent organization on a supplier, for accreditation assessment purposes. The third party certification audit is carried out much in the same way as first party and second party quality system assessments and audits. (5M)

2.

Explain the Objectives and stages of Quality Audits (Need for Quality Audits) (15M) BTL 2

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1. To determine the conformity or non-conformity of the quality system elements with regard to specified requirements.
2. To determine the effectiveness of the implemented quality system in meeting specified quality objectives
3. To meet regulatory requirements, if applicable.
4. To evaluate an organization"s own quality system against a quality system standard, (2M)

Stages of an Audit:

Stage 1:Audit Planning:

1. Audit Schedules: It is a matrix of the timings, which details wh n each audit element is to be checked throughout the year
2. Audit Personnel: It refers to the appointment of the auditor.
3. Notification of auditee: This is the formal and timely request by audit to auditee for making available all quality system documents relevant to the audit.
4. Preparation of checklist: This lists all specific questions to be asked during audit. (3M)

Stage 2:Execution

1. Opening/entry meetings: Opening meeting is organized to initially brief the auditee about the scope of audit.

2. Audit process: Audit is run to schedule and should cover entire scope, as planned. Regular liaison meetings should be held.
3. Audit deficiencies: During auditing, clear and precise discrepancy reports are raised. All discrepancies should be based on sound and objective evidence. (5M)

Stage 3: Audit Reporting

1. Audit reporting deals with the recording of any non-conformity and summarizing the audit findings.
2. Observations of non-conformities, or suggestions for corrective actions
3. Identification of the reference documents against which audit is
4. conducted(Quality system standard), company‟s quality manual etc. (5M)

Stage 4: Audit Follow-up

1. The auditor is responsible o ly for identifying the non-conformity. But the auditee is responsible for determining and initiating corrective action needed to correct a non-conformity.
2. Corrective actions and subsequent follow-up should be completed within a time period.

3. **What is the role of senior management commitment in the implementation of quality system?** (15M) **(May/June 2016, April/May 2019)** BTL2

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Implementation steps

Step 1:Top management commitment

1. The most important step in implementing a quality stem is to get the full support of upper management.
2. The top management must be willing to commit the resources necessary to achieve certification. (2M)

Step 2: Appoint the management representative

1. This step is the Appointment of a management representative. The representative can be a member of the top management group.
2. Management representative is responsible for coordinating the implementation and maintenance of the quality system. (2M)

Step 3: Awareness

1. The next step is to create awareness about the ISO 9000 QMS.
2. Since implementation of the quality system requires involvement of all members in the organization, the members should understand the process and implications of ISO program. (1M)

Step 4: Appoint an implementation team

1. Now the implementation team should be formed
2. This team should be drawn from all levels and areas of the organization.
3. The team should identify the QMS processes and their sequence and interaction. (1M)

Step 5: Training

1. The implementation team, supervisors and internal audit team should be trained
2. This activity c n be accomplished through in-house training programs, seminars ,workshop , etc. (1M)

Step 6:Time schedule

1. This activity develops a time schedule for the implementation and registration of the system
2. This time frame will vary, depending on the size and type of the organization, (1M)

Step 7: Select element owners

1. The implementation team selects own rs for each of the system elements. Many of these owners for each of the system elements. Many of these owners will be members of the implementation team
2. Each owners has the option of selecting a team to assist in the process. (1M)

STEP 8:Review the present system

1. A review of the present quality system should be performed.
2. Copies of all the quality manuals, procedures, work instructions and forms presently in use are obtained (1M)

Step 9:Write the document

This documentation of work instructions should be done by the employee who performs the job.

Step 10: Install the new system.

1. The policies, procedures and work instructions should be integrated into the day-t- day working of the organization.
2. Now the new system is installed (1M)

Step 11: Internal audit

1. An internal audit of the quality system should be conducted
2. This step ensures that the system is working effectively and to provide management with information for the comprehensive management review. (1M)

Step 12: Management review

The management review should be conducted in order to determine the effectiveness of the system in achieving the stated quality goals (1M)

Step 13:Pre-assessment

	It is an optional step. If a good job is done on the previous steps, then preassessment is not necessary. (1M) **Step 14: Registration** The registration activity includes: choosing a registrar, Submitting an application and conducting the registrar‟s system audit. (1M)