GRT INSTITUTE OF ENGINEERING AND TECHNOLOGY, Tiruttani.

(Approved by AICTE, New Delhi Affiliated to Anna University, Chennai.)

Department of Electronics & Communication Engineering

IV Year - VIIth Semester

CONTENTS

MINIMUM LEARNING MATERIAL

REGULATION – 2013

SYLLABUS

EC6701 RF AND MICROWAVE ENGINEERING L T P C

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UNIT I TWO PORT NETWORK THEORY 9

Review of Low frequency parameters: Impedance, Admittance, Hybrid and ABCD parameters, Different types of interconnection of Two port networks, High Frequency parameters, Formulation of S parameters, Properties of S parameters, Reciprocal and lossless Network, Transmission matrix, RF behavior of Resistors, Capacitors and Inductors.

UNIT II RF AMPLIFIERS AND MATCHING NETWORKS 9

Characteristics of Amplifiers, Amplifier power relations, Stability considerations, Stabilization Methods, Noise Figure, Constant VSWR, Broadband, High power and Multistage Amplifiers, Impedance matching using discrete components, Two component matching Networks, Frequency response and quality factor, T and Pi Matching Networks, Microstrip Line Matching Networks.

UNIT III PASSIVE AND ACTIVE MICROWAVE DEVICES 9

Terminations, Attenuators, Phase shifters, Directional couplers, Hybrid Junctions, Power dividers, Circulator, Isolator, Impedance matching devices: Tuning screw, Stub and quarter wave transformers. Crystal and Schottkey diode detector and mixers, PIN diode switch, Gunn diode oscillator, IMPATT diode oscillator and amplifier, Varactor diode, Introduction to MIC.

UNIT IV MICROWAVE GENERATION 9

Review of conventional vacuum Triodes, Tetrodes and Pentodes, High frequency effects in vacuum Tubes, Theory and application of Two cavity Klystron Amplifier, Reflex Klystron oscillator, Traveling wave tube amplifier, Magnetron oscillator using Cylindrical, Linear, Coaxial Voltage tunable Magnetrons, Backward wave Crossed field amplifier and oscillator.

UNIT V MICROWAVE MEASUREMENTS 9

Measuring Instruments : Principle of operation and application of VSWR meter, Power meter, Spectrum analyzer, Network analyzer, Measurement of Impedance, Frequency, Power, VSWR, Q-factor, Dielectric constant, Scattering coefficients, Attenuation, S-parameters

TOTAL PERIODS: 45

TEXT BOOKS:

T1. Reinhold Ludwig and Gene Bogdanov, “RF Circuit Design: Theory and Applications”, Pearson Education Inc., 2011

T2. Robert E Colin, “Foundations for Microwave Engineering”, John Wiley & Sons Inc, 2005

REFERENCES:

R1. David M. Pozar, “Microwave Engineering”, Wiley India (P) Ltd, New Delhi, 2008.

R2. Thomas H Lee, “Planar Microwave Engineering: A Practical Guide to Theory, Measurements and Circuits”, Cambridge University Press, 2004.

R3. Mathew M Radmanesh, “RF and Microwave Electronics”, Prentice Hall, 2000.

R4. Annapurna Das and Sisir K Das, “Microwave Engineering”, Tata Mc Graw Hill Publishing Company Ltd, New Delhi, 2005

UNIT- 1
TWO PORT NETWORK THEORY
PART-A

1. Define scattering matrix.

Scattering matrix is a square matrix which gives all the combinations of power relationships between the various input and output port of a microwave junction.

2. Why the S-parameters are used in microwaves?

The h, Y, Z and ABCD parameters are difficult at microwave frequencies due to following reasons.

- Equipment is not readily available to measure total voltage and total current at the ports of the networks.
- Short circuit and open circuit are difficult to achieve over a wide range of frequencies.
- Presence of active devices makes the circuit unstable for short (or) open circuit.

3. What are the properties of [S] matrix? [Nov/Dec 2014]

[s] is always a square matrix of order (nxn) .

[s] is a symmetric matrix: i.e. $S_{ij}=S_{ji}$

[s] is a unitary matrix: i.e. [S][S*]=[I]

Under perfect matched conditions, the diagonal elements of [s] are zero.

4. State the reciprocity theorem.

The theorem state that when some amount of electromotive force (or voltage) is applied at one point (e.g., in branch k, v_k) in a passive linear network, that will produce the current at any other point (e.g., branch m, i_m). The same amount of current (in branch k, i_k) is produced when the same electromotive force (or voltage) is applied in the new location (branch m, v_m); that is, $V_k/i_m = v_m/i_k$

5. Define lossless network.

In any lossless passive network, its containing no resistive elements, always the power entering the circuit will be equal to the power leaving the network which leads to the conserved in power.

6. Write the unitary property for a lossless junction.

For any lossless network the sum of the products of each term of any one row or of any column of the S-matrix multiplied by its complex conjugate is unity.

7. Mention the many forms of wire.

Wire in a circuit can takes on many forms,

I. Wire wound resistors II. Wire wound inductors III. Leaded capacitors, IV. Elements-to- element interconnection applications.

8. Write about the skin effect in a wire.

As frequency increases, the electrical signal propagates less and less in the inside of the conductor. The current density increases near the outside perimeter of the wire and causes higher impedance for the signal. This will act as resistance of the wire. $R=\rho l/A$. Where, A-Effective cross-sectional area. When area (A) decreases, the resistance of the wire will be increases.

9. Mention the purpose of resistor.

1.In transistor bias networks, to establish an operating point, 2. In attenuators, to control the flow of power. 3. In signal combiners, to produce a higher output power, 4. In transmission lines, to create matched conditions.

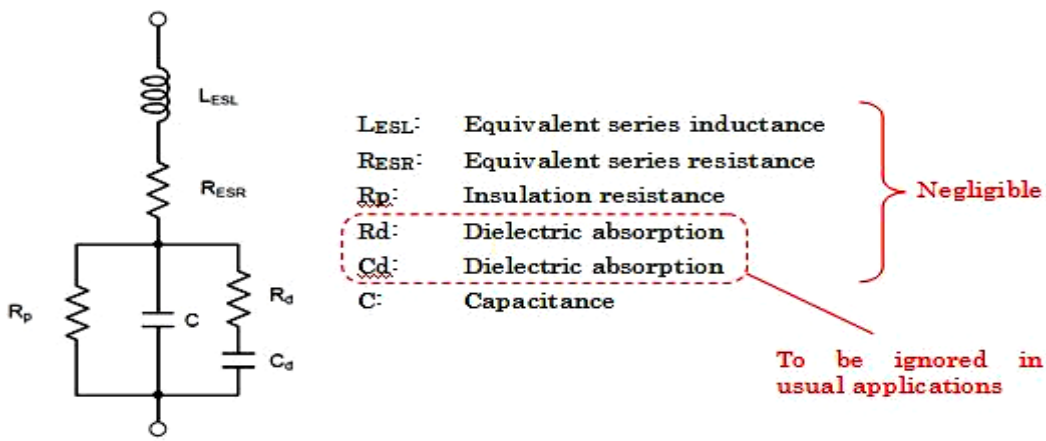
10. Mention the types of resistors.

- Carbon composition resistors, which have a high capacitance due to carbon granules parasitic capacitance.
- Wire wound resistors, which have high lead inductance.
- Metal film resistors of temperature-stable materials.
- Thin-film chip resistors of aluminum or beryllium-based materials.

11. Give the equation for T- parameter.

$$\begin{bmatrix} V1 \\ I1 \end{bmatrix} = \begin{bmatrix} AB \\ CD \end{bmatrix} \begin{bmatrix} V2 \\ -I2 \end{bmatrix}$$

12. Draw the equivalent circuit of capacitor. [APR/MAY 2015]



13. Mention the limitations in measuring Z,Y, and ABCD parameters at microwave frequencies.[Nov/Dec 2014]

- The source remains ideally constant in power, regardless of circuit charges,
- Besides frequency measurement the other possible parameter.
- In Unitary property of a [S] provide the check of power balance of lossless structure, which is possible only with S-Parameter.
- The [S] is defined for a given set of reference planes only. The voltage and current both vary in magnitude and phase with complex impedance values.

14. A 5 dB attenuator is specified as having VSWR of 1.2, Assuming that the device is reciprocal find the S-Parameter. [NOV/DEC 2015]

VSWR = 1.2

α(db) = -20 log $|S21|$

5 = -20 log $|S21|$

$|S21| = |S12| = 10^{-5/20} = 0562$

$|S22| = |S11|$ = VSWR -1/VSWR+1 = 0.2/0.2=0.909

$$|S| = \begin{bmatrix} 0.9090.0562 \\ 05620.0909 \end{bmatrix}$$

15.What are the advantages of scattering parameter?

- Constant ideal power.
- Frequency measurement and other frequency measurement are power and phase level
- [S] Provide low balance lossless structure.

16. Which component is represented by the scattering matrix

Rectangular waveguide, circular waveguide, rectangular circular waveguide.

17. Name the properties of S- parameters.

- Zero diagonal element.
- Symmetry of [S] for a reciprocal network. $S_{ij = Sji (i=1)}$
- [S] is a Unitary matrix [s] [S]* =1
- The sum of the product of each term of any row multiplied by the complex conjugate of any other row is zero. $^{n}\sum S_{ik}S_{ij}^{*}=0$ for K=j; i=1

18. Write the applications of inductors.

Inductors have a variety of applications in RF circuits such as,

- Resonance circuits, Filters, Phase shifters, Delay networks, RF chokes

19. Express power input and power output under matched condition for a two- port network in terms wave components.

Power input and power output of two port matched condition: P_{in} = ½

20.Define reciprocal and symmetrical networks.

Some amount of electromagnetic force is applied at a point in a passive linear network that will produce the current at any other point. Some amount of current is produced when the same amount electromagnetic force is applied in the same location.

21. Define VSWR?

Voltage standing wave ratio is defined as the ratio of maximum voltage to the minimum voltage.

VSWR=Vmax/Vmin.

22. What is the principle of Microwave phase shifter?

When a wave propagates on a line, a phase difference prevails between any two arbitrary points along its paths. The phase difference between two points,

23. What are junctions? Give some examples.

A microwave circuit consists of several microwave devices connected in some way to achieve the desired transmission of MW signal. The interconnection of two or more microwave may be regarded as MW junction. Eg: Magic Tee, Hybrid Ring

24. List the frequency bands available in microwave and radio frequency ranges.

RF Frequency range: 300 MHz – 1 GHz; Microwave Frequency range: 1 GHz – 300 GHz

25. Define S-parameters.

The power wave descriptors that define the input output relation of a network in terms of incident and reflected power waves are called as scattering or S-parameters.

26. Mention any four differences between high frequency and low frequency circuits.

High frequency circuits	Low frequency circuits
The incident and reflected powers can be calculated directly.	Such a direct correspondence is impossible.
Short wave length	Long Wave length
High Energy	Low energy
Ultraviolet light	Infrared light

PART –B

1. Explain in detail about low frequency parameters.
2. Discuss about high frequency parameters.
3. How microwave junction can be described by scattering matrix. Derive the scattering matrix relation between the input and output of an nxn junction?
4. Discuss about various losses available in microwave?
5. Explain the symmetry property in a reciprocal network.
6. Explain the unitary property in a lossless junction.
7. Explain the transmission matrix for 2-port networks.
8. State and explain the properties of S-parameters.
9. Discuss about behavior of wire at RF with neat diagrams.
10. Write in detail about resistors and its types.
11. Give a detailed note on Inductors.
12. Explain in detail about capacitors

UNIT – 2
RF AMPLIFIERS AND MATCHING NETWORKS
PART-A

1. Write the function of matching networks? [Nov/Dec 2015]

Matching networks can help stabilize the amplifier by keeping the source and load impedances in the appropriate range.

2. What is function of input and output matching networks?

Input and output matching networks are needed to reduce undesired reflections and improve the power flow capabilities.

3. What are the parameters used to evaluate the performance of an amplifier? Key parameters of amplifier, to evaluate the performance are

(i). Gain and gain flatness (in dB)
(ii). Operating frequency and bandwidth (in Hz)
(iii). Output power (in dB)
(iv). Power supply requirements (in V and A)
(v). Input and output reflection coefficients (VSWR)
(vi). Noise figure (in dB)

4. Define transducer power gain.

Transducer power gain is nothing but the gain of the amplifier when placed between source and load.

G_T = Power delivered to the load / Available power from the source

5. Define unilateral power gain. [Nov/Dec 2014]

It is the amplifier power gain, when feedback effect of amplifier is neglected i.e.S_{12}=0. 6)

6. What is available Power Gain (G_A)at Load? [Nov/Dec 2015]

The available power gain for load side matching (□L = □□ut)is given as,

$$G_A = \frac{\text{Power available from the network}}{\text{Power available from the source}} = \frac{P_N}{P_A}$$

7. Define Operating Power Gain.

The operating power gain is defined as "the ratio of power delivered to the load to the power supplied to the amplifier".

$$G = \frac{\text{Power delivered to the load}}{\text{Power supplied to the amplifier}} \quad \frac{P_L}{Pin}$$

8. Write a short note on feedback of RF circuit.

- If |□|>1, then the magnitude of the return voltage wave increases called *positive feedback*, which causes instability (oscillator).
- If |□|<1, then the return voltage wave is totally avoided (amplifier). It's called as *negativefeedback.*

9. Define unconditional stability.

Unconditional stability refers to the situation where the amplifier remains stable for any passive source and load at the selected frequency and bias conditions.

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Unconditional stability refers to the situation where the amplifier remains stable for any passive source and load at the selected frequency and bias conditions.

14. Define noise figure.

Noise figure F is defined as "the ratio of the input SNR to the output SNR".

$$F = \frac{\text{InputSNR}}{\text{Output SNR}}$$

15. Give the expression for Unilateral figure of merit.

$$U = \frac{|S_{11}||S_{12}||S_{21}||S_{22}|}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$$

16. Define transducer power gain.

The certain areas of the smith chart, within which the combination of inductance and capacitance cannot be used to translate the impedance to the centre of chart to perform an impedance match.

17. Write the expression for noise figure figure of two port amplifier.

$F=1+2Td/T_o[1/rø+1/(rø)^2]$

18. What is the need for impedance matching networks?

It is not matched perfectly maximum power is not transferred to the load and power will be wasted due to the reflection from the load. This reduces the efficiency of the transformation.

19. Distinguish between conditional and unconditional stabilities of amplifier.

- Conditional stability gain may be increase or decrease to cause oscillation.
- Un conditional stability against further increase and cause oscillation and
- amplifier remains stable.
- Any positive source and load at selected frequency and lias condition.

20. A GaAs MOSFET has the following parameters S_{11}=0.65,<-154º, S_{12}= 0.02 <40º,S_{21}=2.04<185ºand S_{22} =0.55<-30º.Calculate its maximum power stable gain.

When S_{12} =0. K=1.032

Gain stable =G_m=G_α=$\left|\frac{S21}{S12}\right|$ (K-$\sqrt{K2-1}$)

21. What are the consideration in selecting a matching Networks.

Matching networks should stabilize the amplifier and reduce undesired reflection and improve the power flow capabilities.

22. Define power gain of amplifier in term of S-parameters and reflection coefficients

Power gain G =(1-$[\Gamma 2]^2$) $|S21|^2$ / (1-$[\Gamma in]^2$1)-$S_{22}|\Gamma|^2$

Reflection Coefficient Fg = $\frac{Zg - Zo}{Zg + Zo}$

23. Why impedance matching is required, what are the other constrains required.

When a transmitter line is not required terminated by its characteristics impedance. Maximum power is not transferred to the load and power will be wasted due to reflection from the load.

24. Define unilateral power gain. **[Nov/Dec 2014]**

G_T=$\frac{\text{Power delivered to the load}}{\text{Available power from the source}}$

25. What is Microwave attenuator?

A device used to control the amount of Microwave power transferred from one point to another on a Microwave transmission system is called Microwave attenuator.

26. Distinguish between conditional and unconditional stabilities of Amplifier.

Unconditional Stability

An amplifier is said to be Unconditionally Stable in a frequency range if and only if

$|\Gamma_{in}| < 1$ & $|\Gamma_{out}| < 1$

$|\Gamma_s| < 1$ & $|\Gamma_L| < 1$

For all passive Z_s and Z_L Values

An amplifier is said to be Conditionally Stable in a frequency range if and only if

$|\Gamma_{in}| < 1$ & $|\Gamma_{out}| < 1$

$|\Gamma_s| < 1$ & $|\Gamma_L| < 1$

Only for certain range of passive Z_s and Z_L Values not for all values

27. Define Noise figure.

It is also defined as the ratio between input SNR to output SNR

Noise Figure= $\frac{\text{Input SNR}}{\text{Output SNR}}$

Noise Factor (NF) =10 log (F) dB

28) Calculate VSWR of an Amplifies, if the amplifier has reflection coefficient of 0.2533.

VSWR $_{OMN}$ = (1+$|\Gamma_{OMN}|$) / (1- $|\Gamma_{OMN}|$) = (1+0.2533) / (1-0.2533) = **1.6785**

PART-B

1. Discuss various aspects of amplifier-power relations for RF transistor amplifier design.
2. Explain stability considerations for RF transistor amplifier design.
3. Explain various stabilization methods.
4. Discuss gain considerations for RF amplifier.
5. A microwave amplifier is characterized by its S-parameters. Derive equation for power gain available gain and transducer gain.
6. Design a Lumped circuit 'LC' network for matching Z_L=10+j10Ω to a 50Ω transmission line at 1GHz
7. Explain the following.
   (i) Impedance matching Networks
   (ii) Micro stripline matching network
8. Explain about single-stub and double –stub matching networks.
9. Design an Pi-matching network that transforms a load impedance of ZL=(10-j10) Ω into an output impedance of Z_{in} =d(20+j40)Ω. Assuming F=2.4GHZ.
10. Discuss the Smith –chart approach to display the L-Section and T-Section matching networks.

UNIT - 3
PASSIVE AND ACTIVE MICROWAVE DEVICES
PART-A

1. Define microwave.

Microwaves are *electromagnetic waves (EM)* with wavelength ranging from *1cm to 1mm.* The corresponding frequency range is *1 GHZ* (=10^9 Hz) *to 300GHz* (=10^{11}Hz). Therefore signals, because of their inherently high frequencies, have relatively short wavelengths, hence the name "micro" waves.

2. What are the major bands available in microwave frequencies?

The microwave frequencies span the following three major bands at the highest end of RF spectrum.

- Ultra High Frequency (UHF) 0.3 to 3 GHz.
- Super High Frequency (SHF) 3 to 30 GHz.
- Extra High Frequency (EHF) 30 to 300 GHz.

3. Describe IEEE microwave frequency bands.

Frequency	Microwave band designation
3-30MHz	HF
30-300MHz	VHF
0.3-1GHz	UHF
1-2GHz	L
2-4GHz	S
4-8GHz	C
8-12GHz	X
12-18GHz	Ku
18-27GHz	K
27-40GHz	Ka

4. Define quality factor (Q) of capacitor.

The measure of the ability of element to store energy equal to 2π times the average energy stored divided by the energy dissipated per cycle.

5. Write the applications of Inductors.

- Resonance Circuits
- Filters
- Phase Filters
- Delay Networks
- RF Chokes.

6. Write the applications of microwaves.

- Microwave becomes a very powerful tool in microwave radio spectroscopy for analysis.
- Microwave landing system (MLS), used to guide aircraft to land safety at airports.
- Special microwave equipment known as diathermy machines are used in medicine for heating body muscles and tissues without hurting the skin.
- Microwave ovens are a common appliance in most kitchens today.

7. Why is magic tee referred to as E-H tee?

The magic tee is a combination of the E-plane tee and H-plane tee. It is a four port hybrid circuit. It is also known as hybrid tee.

8. What is waveguide?

A waveguide is a hollow metal tube designed to carry microwave energy from one place to another.

9. Define tee junction.

In microwave circuits a waveguide or co-axial line with three independent ports is commonly referred to as a tee junction.

10. Define difference and Sum arm.

- In E-plane tee, the power out of port 3 is proportional to the difference between instantaneous powers entering from port 1 and port 2. Therefore, this third port is called as difference arm.
- In a H=plane tee, if two input waves are fed into port1 and port2 of the collinear arm, the output wave at port3will be in phase and additive. Because of this, the third port is called as sum arm.

11. Write the applications of magic tee. (NOV/DEC 2015)

A magic tee has several applications,

- Measurement of impedance, As duplexer, As mixer, As an isolator

12. What is hybrid ring?

The hybrid ring is a 4-port junction. The 4-ports are connected in the form of an angular ring at proper intervals by means of series junctions. It also called Rat-Race circuits.

13. Name some uses of waveguide twists.

- Waveguide twists are used to change the plane of polarization of a propagating wave.
- Waveguide twists are helpful in converting vertical to horizontal polarizations or vice versa.

14. Define gradual twists.

The gradual twists change the plane of polarizations in a continuous fashion.

15. Write the characteristics of a three-port tee junction.

a) A short circuit may always be placed in one of the arms of a three-port junction in such a way that no power can be transferred through the other two arms.
b) If the junction is symmetric about of its arms, a short circuit can always be placed in that arm so that no reflections occur in power transmission between the other two arms.
c) It is impossible for a general three port junction of arbitrary to present matched impedances at all three arms.

16. Mention the different types of directional couplers.

- Two-hole directional coupler, Four-hole directional coupler, Reverse- coupling directional coupler (Schwinger coupler), Bethe- hole directional coupler.

17. Define Isolator. (NOV/DEC 2016)

An isolator or uni line is a two-port non-reciprocal device which produces a minimum attenuation to wave in one direction and very high attenuation in the opposite direction.

18. Write the properties of ferrites.

Properties of ferrites:

1. Ferrites possess strong magnetic properties.
2. Ferrites are most suitable for use in microwave device in order to reduce the reflected power.
3. Ferrites possess high resistivity; hence they can be used up to 100 GHz
4. Ferrites also exhibit non-reciprocal property.

19. What is gyrator? (MAY/JUNE 2012, NOV/DEC 2013, APRIL/MAY 2016)

It is a two port device that has a relative phase difference of 180^0 for transmission from port 1 to port 2 and no phase shift for transmission from port 2 to port 1.

20. Write the applications of circulator.

i. A circulator can be used as a duplexer for a radar antenna system.
ii. Two three port circulator scan be used in tunnel diode or parametric amplifiers.
iii. Circulators can be used as low power devices as they can handle low powers only.

21. Define Faraday rotation isolator.

Isolators can be made by inserting a ferrite rod along the axis of a rectangular waveguide. Here the isolator is called as faraday-rotation isolator.

22. Draw a structure of two hole direction coupler. (NOV/DEC 2011)

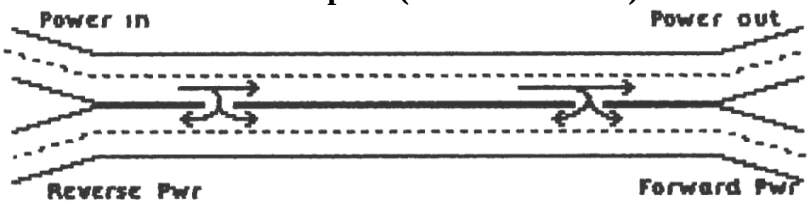
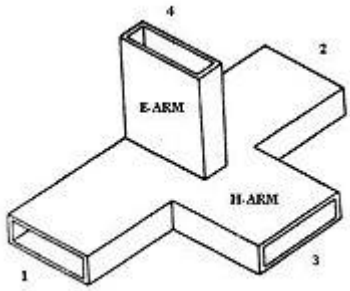


Fig. 7 A Directional Coupler

23.Draw the diagram of H-plane Tee junction. (NOV/DEC 2012)



24. Give the significance of Rat-race junctions. (MAY/JUNE 2013)

A rat-race coupler (also known as a hybrid ring coupler) is a type of coupler used in RF and Microwave systems. In its simplest form, it is a 3dB coupler and is thus an alternative to a magic tee. Compared to the magic tee, it has the advantage of being easy to realize in planar technologies such as microstrip and stripline, although waveguide rat races are also practical. Unlike magic tees, a rat-race needs no matching structure to achieve correct operation.

25. What are the composition of ferrite? (NOV/DEC 2013) , (APR/MAY 2016)

Software ferrite: Manganese-zinc ferrite (MnZn), and Nickel-zinc ferrite (NiZn)
Hardware ferrite: Strontium ferrite, Barium ferrite, Cobalt ferrite

26. What are ferrites? (MAY/JUNE 2014)

Ferrite is a type of ceramic compound composed of iron oxide (Fe_2O_3) combined chemically with one or more additional metallic elements. They are both electrically nonconductive and ferromagnetic, meaning they can be magnetized or attracted to a magnet.

27. Mention the applications of Gyrator and Isolator. (NOV/DEC 2014)

In Klystrons and magnetrons to improve the frequency stability.

28. Write the necessary conditions for Gunn effect. (NOV/DEC 2014)

1. Gunn oscillator mode 2. Stable amplification mode 3. LSA oscillating mode 4. Bias circuit oscillation mode

29. What are the properties of S matrix? (APR/MAY 2015)

1. Symmetry property 2. Unity property 3. Zero Property 4. Phase shift property

30. What is the working principle of varactor diode? (NOV/DEC 2015, APRIL/MAY 2016)

The varactor diode was named because of the variable reactor or variable reactance or variable capacitor or variable capacitance property of these diodes. A varactor diode is considered as a special type of diode that is widely used in the electronics industry and is used in various electronics applications. Varactor diode is also a semiconductor microwave solid-state device, it is frequently used in applications where variable capacitance is desired which can be achieved by controlling voltage.

31. What are the applications of MMICs?

- MMICs are currently being used for variety of applications including space and military because they meet the requirements for shock, temperature conditions and severe vibration.
- MMICs have been the advances in the development of microwave solid-state devices.

32. What are the different techniques used to fabricate MMIC?

1. Diffusion and ion implantation, 2. Oxidation and film deposition, 3. Epitaxial growth, 4. Lithography, 5. Etching and photo resist, 6. Deposition

33. Write the difficulties of MMICs.

1. Once MMICs fabricated, there is no provision for adjusting any device parameters such as tuning screws variable short etc.
2. Accurate design of circuit is complex.
3. Low value of Q, the high frequency stability are very difficult
4. Low power handling capacity than waveguides.

34. Compare PIN and PN diode. (Nov/Dec 2016)

S. No.	PIN Diode	PN Diode
1	Thin layer of intrinsic semiconductor material is present in between P and N region.	Intrinsic layer is absent
2	Intrinsic region reduces the junction capacitances.	No Intrinsic region
3	Forward conductivity is a linear function of the diode bias current	Forward conductivity is a non linear function of the diode bias current

PART-B

1. Explain the concept of N port scattering matrix representation. (May 2015, Dec 2014)
2. With neat diagram explain the operation of phase shifter and show its phase change is $2\theta + 4\beta l$. (May 2015)
3. With neat diagram explain the operation of the following devices: (May 2015)
   (i) Gyrator (ii) Two hole directional coupler.
4. Discuss the properties of scattering matrix. Determine the scattering matrix representation of E plane Tee junction. (Dec 2014)
5. Explain the operating principle of a microwave circulator with neat schematic diagram. (Dec 2014)
6. An air filled rectangular cavity resonator has dimensions of a=5cm, b=2cm and d=15cm. Compute the resonant frequency of the dominant mode for an air-filled cavity. The resonant frequency of the dominant mode for a dielectric filled cavity of ε_r=2.56. (Dec 2014)
7. With the help of S matrix concept prove the following properties. (May 2014)
   (i) Symmetry (ii) Unity (iii) Zero (iv) Phase shift
8. Draw and explain the operation of Magic Tee. Explain its application in the construction of a 4-port circulator. (May 2014)
9. Find the directivity in dB for a coupler if same power is applied in turn to input and output of the coupler with output terminated in each case in matched impedance. The auxiliary output readings are 450 mW and 0.710μW. (May 2014)
10. Draw and explain the various types of attenuators and phase shifters. What is Gyrator? (May 2014)
11. Explain the properties of E-plane Tee? Derive the expression of scattering matrix for directional coupler. (May 2013)
12. Explain the properties of magic Tee and derive scattering matrix for it. (May 2013)
13. Describe the following with neat sketch. (Dec 2013)
    (i) Magic Tee (ii) Directional coupler
14. Explain the operation of following microwave passive devices. (Dec 2013)
    (i) Circulator (ii) Isolator
15. Explain how directional coupler can be used to measure reflected power. (Dec 2012)
16. Explain the properties of H-plane Tee and give reasons why it is called shunt Tee. Derive its scattering matrix. (Dec 2012)
17. Derive the equation for the scattering matrix of magic Tee. (Dec 2012)
18. Differentiate between circulators and isolators. (Dec 2012)
19. Explain the concept of two-hole directional coupler and derive its S-matrix. (May 2012)
20. Draw and explain the operation of an Isolator. (May 2012)
21. Explain the construction of Magic Tee and derive its S-matrix. How can an isolator be designed using 3 port circulators? (May 2012)
22. Describe the principle of microwave transmission through ferrite. Explain how a gyrator is designed based on this effect. (May 2012)
23. Is it possible to match all the 3 ports of a lossless reciprocal microwave component? Prove the same.
24. Explain the construction, working and applications of cylindrical cavity resonator.
25. With a neat sketch explain the following:
    (i)Corners (ii) Bends (iii)Twists (iv) Hybrid rings

UNIT-4
MICROWAVE GENERATION
PART-A

1. What are the advantages of microwave transistors?

Microwave transistors are miniaturized designs to reduce device and package parasitic capacitances and inductances and to overcome the finite transit time of the charge carriers in the semiconductor materials.

2. Write the applications of bipolar transistors.

Bipolar transistors are suitable for oscillator and power amplifier applications in addition to small-signal amplifiers.

3. What are the different modes of bipolar transistor?

A bipolar transistor can operate in four different modes depending on the voltage polarities across the two junctions,

1. Normal (active) mode, 2. Saturation mode, 3. Cutoff mode, 4. Inverse (inverted)

4. Write the advantages of unipolar transistor?

It may have voltage gain in addition to current gain. Efficiency is higher, Noise Figure is low, Its operating frequency is up to X band, Its input resistance is very high, up to several mega ohms.

5. What are MESFET?

Field Effect Transistors (FETs) at microwave frequencies are mostly fabricated in GaAs and use a Metal semiconductor (MES) Schottkey junction for gate contact. This device is referred to as MESFET or Metal-semiconductor Field Effect Transistors.

6. Write the expression for pinch off voltage in JFET.

As the drain voltage V_d is further increased, the space charge regions expand and join together, so that all free electron carriers are completely depleted in the joined region. This condition is called pinch off.(Pinch off voltage, $\mathbf{V_p = q\, N_d\, a^2/2\ \square_s}$)

7. Write the applications of GaAs MESFET.

i. The GaAs MESETs the substrate is doped with chromium (Cr), which has an energy level near the center of the GaAs band gap. This is a very high resistivity substrate and it is commonly called the semi-insulator GaAs structure.
ii. Used in broad band amplifier applications.

8. Define pinch off voltage.

The pinch off voltage is the gate reverse voltage that removes all the free charge from the channel.

9. Name the modes of operation for n-channel and p-channel.

There are basically four modes of operation for n-channel and p-channel MOSFETs,

a) n-channel enhancement mode (normally OFF)
b) n-channel depletion mode (normally ON)
c) p-channel enhancement mode (normally OFF)
d) p-channel depletion mode (normally ON)

10. Describe tunneling phenomenon.

When the doping level is increased the depletion, region reduces. Due to thin depletion region, even for very small forward bias many carriers penetrate through the junction and appear at the other side. This phenomenon of penetration of carriers through the depletion region is known as tunneling.

11. What are the key characteristics of a tunnel diode?

The key characteristics of a tunnel diode are its negative resistance region.

12. What are the applications of tunnel diode?

1. Relaxation oscillator,
2. Microwave oscillator,
3. Storage device,
4. Pulse generator,
5. High speed switching networks

13. Define varactor diode.

Varactor diodes are p-n junction diodes which provide a voltage variable junction capacitance in microwave circuits when reverse biased.

14. What is resonant frequency?

Resonant frequency f_r at which the energy in the cavity attains maximum value=$2W_e$ or $2W_m$. The total energy is therefore twice the electric or magnetic energy stored in the resonator.

15. Define Quality factor.

Quality factor Q which is a measure of the frequency selectivity of a cavity.

$$Q = \frac{2\pi\ x \text{ maximum energy stored}}{\text{Energy dissipated per cycle}}$$

16. What is transferred electron effect?

Some materials like GaAs exhibit a –ive differential mobility when biased above a threshold value of the electric field. The electrons in the lower – energy band will be transferred into the higher-energy band. The behavior is called transferred electron effect and the device is called transferred electron device or Gunn diode.

17. Compare voltage and current controlled modes.

S.No.	Voltage controlled	Current controlled
1.	The current density can be Multivalued.	The voltage value can multivalued.
2.	High field domains are formed, Separating two low field regions.	It splits the sample results in high current filaments running along the field directly.

18. Why Gunn diode amplifier is called travelling domain amplifier?

In the Gunn-diode amplifier, the value of n_0L must be larger than $10^{12}/cm^2$ in order to establish traveling domain oscillations, due to this larger output power can be obtained. Because of the presence of high field domains, this amplifier is called a travelling domain amplifier (TDA).

19. Define TWT. (MAY/JUNE 2012)

A traveling-wave tube (TWT) is a specialized vacuum tube that is used in electronics to amplify radio frequency (RF) signals in the microwave range. The TWT belongs to a category of "linear beam" tubes, such as the klystron, in which the radio wave is amplified by absorbing power from a beam of electrons as it passes down the tube.

20. What are the types of TWT?

There are various types of TWT, two major categories are:

Helix TWT: In which the radio waves interact with the electron beam while traveling down a wire helix which surrounds the beam. These have wide bandwidth, but output power is limited to a few hundred watts.

Coupled cavity TWT: In which the radio wave interacts with the beam in a series of cavity resonators through which the beam passes. These function as narrowband power amplifiers.

21.What are the advantages of TWT?

A major advantage of the TWT over some other microwave tubes is its ability to amplify a wide range of frequencies, a wide bandwidth. The bandwidth of the helix TWT can be as high as two octaves, while the cavity versions have bandwidths of 10–20%. Operating frequencies range from 300 MHz to 50 GHz. The power gain of the tube is on the order of 40 to 70 decibels, and output power ranges from a few watts to megawatts

22. Define two cavity reflex klystrons.

The simplest klystron tube is the two-cavity klystron. In this tube, there are two microwave cavity resonators, the "catcher" and the "buncher". When used as an amplifier, the weak microwave signal to be amplified is applied to the buncher cavity through a coaxial cable or waveguide, and the amplified signal is extracted from the catcher cavity.

23. Define magnetron. (NOV/DEC 2012, NOV/DEC 2016)

The cavity magnetron is a high-powered vacuum tube that generates microwaves using the interaction of a stream of electrons with a magnetic field while moving past a series of open metal cavities (cavity resonators). Bunches of electrons passing by the openings to the cavities excite radio wave oscillations in the cavity, much as a guitar's strings excite sound in its sound box. The frequency of the microwaves produced, the resonant frequency, is determined by the cavities' physical dimensions. Unlike other microwave tubes, such as the klystron and traveling-wave tube (TWT), the magnetron cannot function as an amplifier, increasing the power of an applied microwave signal; it serves solely as an oscillator, generating a microwave signal from direct current power supplied to the tube.

24. What is the role of slow wave structure in TWT? (MAY/JUNE 2013, APRIL 2016)

The Traveling-Wave Tube (TWT) is an amplifier of microwave energy. It accomplishes this through the interaction of an electron beam and an RF circuit known as a slow wave structure. The term "slow wave" comes from the fact that the RF wave velocity as it travels down the circuit is much less than that of light in free-space. As the electron beam travels down this interaction region an energy exchange takes place between the particles and the RF circuit wave.

As an example if one was to apply five watts of RF energy to the input of a TWT RF circuit, they may find one hundred watts at the output RF terminal. In this way the linear beam device, TWT or Klystron for instance, provides gain to the applied signal.

25. Define velocity modulation.

The variation in electron velocity in the drift space is known as velocity modulation.

26. Define bunching.

The electrons passing the first cavity gap at zeros of the gap voltage pass through with unchanged velocity, those passing through the +ive half cycles of gap voltage undergo an increase in velocity, those passing through the –ive half cycles of gap voltage undergo an decrease in velocity, As a result of these, electron bunch together in drift space. This is called bunching.

27. What do you meant by Applegate diagram?

The electrons passing through the buncher grids are accelerated / retarded / passed through with unchanged initial dc velocity depending upon when they encounter the RF signal field at the buncher cavity gap at positive / negative / zero crossing phase of the cycle, respectively, as shown by distance-time plot. This is called the Applegate diagram.

28. State the applications of reflex klystrons.

This type is widely used in the laboratory for microwave measurements. In microwave receivers as local oscillators in commercial and military applications. Also plays a role in airborne Doppler radars as well as missiles.

29. Give the comparison between TWTA and klystron amplifier. (NOV/DEC 2013, APR/MAY 2015)

Comparison between TWTA and klystron amplifier is,

Sl.No	Klystron amplifier	TWTA
1.	Linear beam or 'O' type device.	Linear beamor 'O' type device.
2.	Uses cavities for input and output Circuits.	Uses non – resonant wave circuit.
3.	Narrow band device due to use of resonant cavities.	Wide band device because use of non – resonant wave circuit

30. Write the application of TWT.

Medium Power Satellite.
High Power Satellite transponder output.
Radar transmitter

31. Why magnetron is called as cross field devices?

In a magnetron, the dc magnetic field and dc electric field are perpendicular to each other and hence magnetron is called as a cross field device.

32. Write short notes on negative resistance magnetron.

Negative – resistance magnetrons ordinarily operate at frequencies below the microwave region. This type of magnetron uses a static negative resistance between two anode segments but has low efficiency and is useful only at low frequencies.

33. Write the applications of magnetron.

The magnetrons are widely used on,

- Radar transmitters
- Industrial heating
- Microwave ovens.

34.What is Tetrodes and Pentodes?

A **Tetrode** is a vacuum tube (called valve in British English) having four active electrodes. The four electrodes in order from the centre are: a thermionic cathode, first and second grids and a plate (called anode in British English).

A **pentode** is an electronic device having five active electrodes. The term most commonly applies to a three-grid amplifying vacuum tube (thermionic valve). The pentode consists of an evacuated glass envelope containing five electrodes in this order: a cathode heated by a filament, a control grid, a screen grid, a suppressor grid, and a plate (anode).

PART-B

1. Explain the working principle of Gunn diode with two valley model and plot its characteristics. (May 2015)
2. With neat diagram, explain the construction and characteristics of tunnel diode. Compare tunnel diode and Gunn diode. (Dec 2014)
3. Discuss the working principle of parametric amplifier. (Dec 2014)
4. Explain merits, demerits and application of parametric device. (Dec 2014)
5. Explain the operating principle of a Gunn diode. Describe its domain formation and various modes of operations. (May 2014)
6. Explain the operating principles of varactor and step recovery diodes. (May 2014)
7. What are the materials used for MMIC fabrication? Explain with neat diagrams the fabrication process of MMIC's. (May 2014)
8. With the aid of suitable sketch discuss construction, materials, characteristics and working of IMPATT diode. (May 2013)
9. With the help of two-valley theory, explain how negative resistance can be created in Gunn diode. Mention its applications. (May 2013, Dec 2012)
10. Explain the principle of operation of Tunnel diode and TRAPATT device. (Dec 2013)
11. Describe the Gunn Effect with the aid of two valley model theory. (Dec 2013)
12. Draw the physical structure and doping profile of IMPATT diode and explain in detail. (Dec 2013)
13. Explain the tunneling action in a tunnel diode. (Dec 2012)
14. What are avalanche transit time devices? Draw the construction and explain the working of IMPATT diode. (May 2015, Dec 2012)
15. Explain any four modes of operation of a Gunn diode. (May 2012)
16. Explain the design and operation of parametric amplifiers. (May 2012)
17. With energy band structures, explain the tunneling phenomenon in Tunnel diodes. (May 2012)
18. An IMPATT diode has a drift length of 2 μm. Determine the drift time of the carriers and the operating frequency of IMPATT diode. (May 2012)
19. With neat diagram, explain the working principle of Gunn diode. Mention its applications. (Dec 2011)
20. Explain the characteristics and working of (Dec 2011)
    (i) Avalanche transit time diode (ii) Parametric amplifier
21. Derive the Manley Rowe power relation. Use the above relation to find the power gain of an up and down converter.
22. Using RWH theory, explain two valley model of GaAs.
23. Explain the construction, working principle and modes of microwave BJT.
24. Explain the construction, working principle and operation of microwave FET.

UNIT-5
MICROWAVE MEASUREMENTS
Part-A

1. Define microwave sensor. (MAY/JUNE 2012)

The microwave power meter consists of a power sensor, which converts the microwave power into heat energy. The corresponding temperature rise provides a change in the electrical parameters resulting in an output current in low frequency circuitry and indicates the power.

2. What are drawbacks of using power meter with single bridge?

- The change of resistance due to a mismatch at the microwave input port results in incorrect reading
- The thermistor is sensitive to changes in the ambient temperature resulting in false reading.

3. Mention the drawbacks in calorimeter measurements.

The main disadvantage in calorimeter measurements are the thermal inertia caused by the lag between the application of microwave power and the parameter readings.

4. What are the classifications of power measurements? (APRIL 2016)

The classifications of power measurements are

a. Low power (less than 10mW)
b. Medium power (from 10mW to 10W)
c. High power(>10W)

5.Distinguish between thermistor and barretter?

Sl.No	Barretter	Thermistor
1.	Barretter has a positive temperature coefficient, i.e., resistance increases with temperature.	Thermistor has negative temperature coefficient.
2.	They are less sensitive.	They are more sensitive.
3.	They need less bias current.	Thermistors need more bias current.
4.	Barretters are usually operated at 100 ohm	Thermistors are operated at 100 ohm to 200ohm.

6. Distinguish between low frequency measurements and microwave measurements.[Apr/May 2015]

Sl.No	Low frequency measurements	Microwave measurements
1.	At low frequency, it is convenient to measure voltage and current and use them to calculate power.	At microwave frequencies, the amplitudes of the voltages and current on a transmission line are the functions of a distance and are not easily measurable.
2.	At low frequency, circuits use *lumped elements.*	At microwave frequencies, the circuit elements are distributed.

7. Define spectrum analyzer.

A spectrum analyzer is a broadband super heterodyne receiver which provides a plot of amplitude versus frequency of received signal.

8.Define power meter.

Power meter is used to measure the amount of power in the microwave signals. It is used at RF and microwave frequencies.

9.Define VSWR meter. [May/June 2014, April 2016]

A VSWR meter is a sensitive high gain, high quality factor, low noise voltage amplifier. It is tuned at a frequency of 1 khz at which microwave signal in modulated.

10.Define power measurement.

It is defined as same as power at low frequencies i.e it is the product of rms voltage, rms current and power factor.

11.Name the errors in microwave power measurement.

1.Instrumental, 2.Substitution, 3.Mount inefficiency error

12.List the microwave test equipments.[Nov/Dec 2015]

1.Slotted line carriage 2. Tunable detector 3. Power meter 4. Spectrum analyser 5. VSWR Meter

13. Define attenuation measurement.

It is defined as

$\alpha = 10 \log (P_i/P_O)$

where P_i= Input power P_O=Output power

14. What are the methods of antenna measurement?

1.Direct ratio measuring method 2. RF substitution method

15.What are the methods to measure VSWR?

1.Slotted line 2. Double minimum methods

16.Define return loss.

It is defined as the ratio of power of incident wave to power of reflected wave

Return loss = Incident power/Reflected power

17. Define frequency measurement.

Frequency measurement is very important in many applications of alternating current, especially in AC power systems designed to run efficiently at one frequency and one frequency only. If the AC is being generated by an electromechanical alternator, the frequency will be directly proportional to the shaft speed of the machine, and frequency could be measured simply by measuring the speed of the shaft

18. Define Directivity of an Antenna?

The directivity of an antenna is the ratio of the radiated intensity in the direction at which intensity is maximum to the average radiated intensity.

19. Define Pattern of an Antenna?

The pattern of an antenna is the relationship of radiated intensity at a fixed distance to the angle at which intensity is measured.

20. Define Gain?

It is defined as the product of directivity and power efficiency.

21. What is network analyzer?(NOV 2016)

The network analyzer is an instrument that measure the network parameters of electrical networks. It is the mostly used microwave measurements instrument. It measures both amplitude and phase over the wide range of frequencies.

PART-B

1. What is velocity modulation? Explain how velocity modulation is utilized in klystron.
2. Derive an expression for the efficiency of a two cavity klystron amplifier.
3. Derive the expression for velocity modulation in klystron oscillator.
4. Explain the working of a TWT amplifier with neat sketch.
5. Derive Hull – cutoff condition with respect to magnetron.
6. Explain the construction and working of cylindrical magnetron.
7. Write short notes on
   (i). Low VSWR
   (ii). High VSWR
8. Explain about power meter using double bridge?
9. Explain the method of measuring impedance of a given load, with suitable diagram?
10. Explain frequency and wavelength measurements with neat diagrams?
11. Write short notes on
    (i). Average power
    (ii). Bolometer sensor
    (iii). Schottky Barrier Diode sensor
    (iv). Thermocouple sensor

Anna University Question Papers

Reg. No. :

Question Paper Code : 21469

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Seventh Semester

Electronics and Communication Engineering

EC 2403/EC 73/10144 EC 703 — RF AND MICROWAVE ENGINEERING

(Regulations 2008/2010)

(Common to PTEC 2403 – RF and Microwave Engineering for B.E. (Part-Time) Sixth Semester Electronics and Communication Engineering – Regulations 2009)

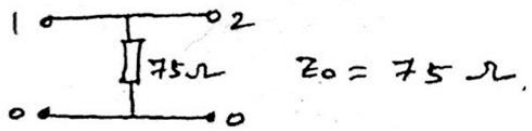
Time : Three hours Maximum : 100 marks

Smith Chart is to be provided.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Find the 'S' parameters for the following network.



2. Identify the type of component with S parameters of $S_{11} = S_{12} = 0$, $S_{21} \neq S_{22}$.

3. Define maximum available gain.

4. What are the advantages of microstrip line matching networks?

5. What are the applications of Magic Tee?

6. What are the S parameters of the rotary type attenuator with rotation angle of 30°?

7. What is the working principle of varactor diode?

8. State Gunn effect.

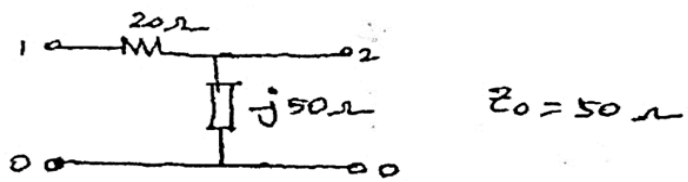
9. What are the limitations of conventional tubes at microwave frequency?

10. What are the methods used to measure the attenuation at microwave frequency?

PART B — (5 × 16 = 80 marks)

11. (a) (i) State and verify the symmetry property of the reciprocal networks. (8)

(ii) Find the S parameters for the following circuit. (8)



Or

(b) (i) Draw the high frequency equivalent of wire, resistor, inductor and capacitor and explain. (8)

(ii) Evaluate the S parameters from the Z parameters. (8)

$$[Z]=\begin{bmatrix} 2+3j & 5j \\ 3j & -j \end{bmatrix},\ Z_0 = 50\Omega.$$

12. (a) Design all the possible configurations of discrete two element matching network that match the source impedance $Z_S = (50 + j\,25)\Omega$ to the load $Z_L = (25 - j15)\,\Omega$. Assume the characteristic impedance of 75 Ω at operating frequency 2 GHz. (16)

Or

(b) Draw the 8 dB gain circle of the transistor with following S parameters at 1 GHz. $S_{11} = 0.46 < -97°$, $S_{12} = 0.06 < -22°$, $S_{21} = 7.1 < 112°$ and $S_{22} = 0.57 < -48°$. (16)

13. (a) (i) Explain the working principle of E plane Tee and derive its S parameters. (8)

(ii) Explain the working of phase shifter with neat diagram. (8)

Or

(b) (i) Explain the working of circulator and explain its applications. (10)

(ii) Explain the working principle of isolator. (6)

14. (a) Explain the working principle of Gunn diode oscillator and its modes. (16)

Or

(b) Explain the working principle of IMPATT diode with neat diagram. (16)

15. (a) Explain the working principle of Travelling Wave Tube Amplifier (TWTA). (16)

Or

(b) Explain the working principle of reflex klystron oscillator and derive the expression for power and efficiency. (16)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 71469

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Seventh Semester

Electronics and Communication Engineering

EC 2403/EC 73/10144 EC 703 — RF AND MICROWAVE ENGINEERING

(Regulation 2008/2010)

(Common to PTEC 2403 – RF and Microwave Engineering for B.E. (Part-Time) Sixth Semester Electronics and Communication Engineering – Regulation 2009)

Time : Three hours Maximum : 100 marks

Smith chart is to be provided.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Mention any four differences between low frequency and high frequency microwave circuits.
2. Draw the high frequency equivalent circuit of the resistor and inductor.
3. Draw the VSWR circle for reflection co efficient 1.
4. Draw the contour of Nodal Quality Factor $Q = 3$.
5. Name any two microwave passive devices which make use of Faraday rotation.
6. What are the properties of S matrix?
7. Draw the equivalent circuit of Varactor diode.
8. What is the need for matching network?
9. What are the limitations of conventional vacuum devices?
10. Mention the major differences between the TWT and Klystron.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Derive Z and Y matrix formulation of multi port network. (8)

(ii) State and prove the symmetry of S matrix for a reciprocal network. (8)

Or

(b) Explain the scattering matrix for lossless junction.

12. (a) (i) Write the mathematical analysis of amplifier stability. (8)

(ii) Design a microwave amplifier for maximum transducer power gain. (8)

Or

(b) Using the Smith chart design any two possible configuration of discrete two element matching networks to match the source impedance $Z_S = (50 + j25)\Omega$ to the load $Z_L = (25 - j50)\Omega$. Assume the characteristic impedance of $Z_0 = 50\,\Omega$ and operating frequency of 2 GHz. (16)

13. (a) (i) Explain the concept of N port scattering matrix representation. (8)

(ii) With neat diagram explain the operation of phase shifter and show its phase change is $2\theta + 4\beta l$. (8)

Or

(b) With neat diagram explain the operation of the following devices :

(i) Gyrator (8)

(ii) Two hole directional coupler. (8)

14. (a) Explain the working principle of Gunn diode with two valley model and plot its characteristics.

Or

(b) What are avalanche transit time devices? Explain the operation and construction of IMPATT diode.

15. (a) Explain the π mode of operation of magnetron. Mention few high frequency limitations.

Or

(b) (i) Describe how can the power of a microwave generator be measured using bolometer. (10)

(ii) Calculate the SWR of a transmission system operating at 10 GHz. Assume TE_{10} wave transmissions inside a wave guide of dimensions a = 4 cm, b = 2.5 cm. The distance measured between twice minimum power points = 1 mm on a slotted line. (6)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 91421

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2011.

Seventh Semester

Electronics and Communication Engineering

EC 2403/EC 73/10144 EC 703 — RF AND MICROWAVE ENGINEERING

(Regulation 2008/2010)

(Common to PTEC 2403 – RF and Microwave Engineering for B.E. (Part-Time) Sixth Semester Electronics and Communication Engineering – Regulation 2009)

Time : Three hours Maximum : 100 marks

Smith chart is to be provided.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the high frequency limitations of conventional tubes?

2. Given $[y] = \begin{bmatrix} 3.2 & 1 \\ 1 & 3.2 \end{bmatrix}$ find S parameters.

3. Define unilateral power gain.

4. State the significance of microstrip matching networks.

5. A 6dB attenuator is specified as having VSWR of 1.2. Assuming that the device is reciprocal, find the S parameters.

6. Mention the application of Gyrator and Isolator.

7. Write the necessary conditions for Gunn effect.

8. A Si Mw transistor has a maximum electric field intensity Em of 3×10^5 V/cm and its carrier has a drift velocity of 4×10^6 cm/s. The emitter collector length is $4\mu m$. Find maximum possible transit time cut off frequency.

9. Compare two cavity klystron and traveling wave tube.

10. What is the significance of VSWR measurement?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Discuss the importance of low frequency and high frequency parameters of RF two port networks. (6)

(ii) The two port devices represented by the following matrices are cascaded. Find the scattering matrix of the resulting device. Determine its properties (symmetry, reciprocity, losses and match).

(1) $\begin{bmatrix} 0.1 & 0.8 \\ 0.8 & 0.1 \end{bmatrix}$ (5)

(2) $\begin{bmatrix} 0.4 & 0.6 \\ 0.6 & 0.4 \end{bmatrix}$ (5)

Or

(b) Verify the lossless and reciprocity properties of any two port network using scattering matrix. (16)

12. (a) (i) With reference to RF transitor amplifier, discuss the considerations for stability and gain. (8)

(ii) Show that the noise figure of a three stage amplifier is $F = F_1 + \frac{F_2 - 1}{GA_1} + \frac{F_3 - 1}{GA_2}$ where F_1, F_2 and F_3 are noise figures and GA_1 and GA_2 are power gains. (8)

Or

(b) (i) Explain in detail the concept of T and Microstripline matching networks. (10)

(ii) Describe the Smith chart. How can it be used to determine an unknown impedence? (6)

13. (a) (i) Explain the concept of N port scattering matrix representation. (6)

(ii) Discuss the properties of scattering matrix. Determine the scattering matrix representation of E plane Tee Junction. (10)

Or

(b) (i) Explain the operating principle of a microwave circulator with neat schematic diagram. (8)

(ii) An air filled rectangular cavity resonator has dimensions of a = 5 cm, b = 2 cm and d = 15 cm. Compute the resonant frequency of the dominant mode for an air filled cavity. The resonant frequency of the dominant mode for a dielectric filled cavity of $\varepsilon_r = 2.56$. (8)

14. (a) With neat diagram, explain the construction and characteristics of tunnel diode. Compare tunnel diode and Gunndiode.

Or

(b) (i) Discuss the working principles of parametric amplifier. (8)

(ii) Explain merits, demerits and application of parametric device. (8)

15. (a) Derive the equation of velocity modulated wave and discuss the concept of bunching effect in two cavity klystron.

Or

(b) (i) An X band pulsed cylinderical magnetron has the following operating parameters :

Anode voltage $V_0 = 26$ kV

Beam current $I_0 = 27$ A

Magnetic flux density $B_0 = 0.336$ Wb/m^2

Radius of cathode cylinder a = 5 cm

Radius of vane edge to center b = 10 cm.

Determine cyclotron angular frequency, cut off voltage for a fixed B_0 and cut off magnetic flux density for a fixed V_0. (10)

(ii) Explain SWR measurement with neat block diagram. (6)

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Question Paper Code : 21378

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Seventh Semester

Electronics and Communication Engineering

EC 2403/EC 73/10144 EC 703 – RF AND MICROWAVE ENGINEERING

(Regulation 2008)

(Common to PTEC 2403 – RF and Microwave Engineering for B.E.(Part –Time) Sixth Semester Electronics and Communication Engineering – Regulation 2009)

Time : Three hours Maximum : 100 marks

Smith chart is to be provided.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define reciprocal and symmetrical networks.

2. Express power input and power output under matched conditions for a two-port network in terms of wave components.

3. Why impendence matching is required. What are other constrains required.

4. Draw typical output stability circle and input stability circle.

5. Give the significance of Rat-race junctions.

6. Power at the input port is 900mw. If this power is incident on 20dB coupler with directivity 40dB, What is the coupled power and transmitted power .

7. What is Gunn effect? Name the materials that exhibit Gunn effect?

8. Draw the voltage wave forms of a TRAPATT diode.

9. Name the errors possible in VSWR measurements.

10. What is the role of slow wave structures in TWT?

PART B — (5 × 16 = 80 marks)

11. (a) State an explain the properties of S-parameters. Derive the S parameters of a Directional Coupler.

Or

(b) Formulate S-matrix fro n-port network compute ABCD for a T-network.

12. (a) Derive the transducer power gain for a transistor amplifier. Design LC network to match source impendence Zs =(50+j25) Ω to the load Z_L= (25-j50) Ω. Assume Z_o= 50 Ω , f= 2GH3. Use smith chart.

Or

(b) Discuss the smith chart approach to design the L-section and T-section matching networks.

13. (a) Explain the properties of E-plane Tee? Drive the expression of scattering matrix for directional coupler.

Or

(b) Explain the properties of magic Tee and derive scattering matrix for it.

14. (a) With the acid of suitable sketch discuss construction, materials characteristics and working of IMPATT diode.

Or

(b) With the help of two-valley theory, explain how negative resistance is created in Gunn diodes.

15. (a) (i) Describe how the frequency of a given source in measured.

(ii) Explain the measurement of high VSWR with the help of block diagram.

Or

(b) Explain the principle of operation of the cavity klystron with neat sketch.

A 250KW pulsed cylindraical magnetration has the following parameters.

Anode voltage	= 25 KV
Peak anode current	= 25A
Magnetic field B	= 0.35Wb/m^2
Radius of cathode	= 4CM
Radius of cylinder	= 8CM

Calculate efficiency of the magnetron, cyclotron frequency, cut-off magnetic field.

Reg. No. : [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

Question Paper Code : 51418

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2014.

Seventh Semester

Electronics and Communication Engineering

EC 2403/EC 73/10144 EC 703 — RF AND MICROWAVE ENGINEERING

(Regulation 2008/2010)

(Common to PTEC 2403 – RF and Microwave Engineering for B.E. (Part-Time) Sixth Semester Electronics and Communication Engineering – Regulation 2009)

Time : Three hours Maximum : 100 marks

Smith chart is to be provided.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. List any four reasons for the wide use of RF.
2. Give the relationship between [s] and [z].
3. Define Stability.
4. What are the needs for impedance matching networks?
5. What are the factors that reduce the efficiency of IMPATT diode?
6. What is negative resistance in Gunn diode?
7. What are matched terminators?
8. What are ferrites? Why is it needed in circulators?
9. What are the errors in impedance measurement?
10. Define : Convection current of TWT.

PART B — (5 × 16 = 80 marks)

11. (a) With the help of S matrix concept prove the following properties.
    (i) Symmetry
    (ii) Unity
    (iii) Zero and
    (iv) Phase shift. (4 × 4 = 16)

Or

(b) (i) When do you prefer transmission matrix? Obtain the ABCD matrix of a transformer with turns ratio of N : 1. (8)

(ii) The impedance matrix of a certain lumped element network is given by $[Z_{ij}] = \begin{bmatrix} 4 & 2 \\ 2 & 4 \end{bmatrix}$. Determine the equivalent scattering parameter matrix $[S_{ij}] = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}$ for the $[Z_{ij}]$. (8)

12. (a) Design a matching network to match a $Z_L = (10 + j10)\Omega$ to a 50Ω line. Specify the values of L and C at frequency of $1GHZ$. (Use smith chart). (16)

Or

(b) Derive expressions for the following of a micro stripline matching network.

(i) w/h ratio and

(ii) Total Q factor (Q_T). (8 × 2 = 16)

13. (a) (i) Draw and explain the operation of Magic Tee. Explain its application in the construction of a 4 – port circulator. (8)

(ii) Find the directivity in dB for a coupler if same power is applied in turn to input and output of the coupler with output terminated in each case in a matched impedance. The auxiliary output readings are 450 mW and 0.710 μW. (8)

Or

(b) Draw and explain the various types of attenuators and phase shifters. What is a gyrator? (16)

14. (a) (i) Explain the operating principle of a Gunn diode. Describe its domain formation and various modes of operations. (8)

(ii) Explain the operating principles of varactor and step recovery diodes. (8)

Or

(b) What are the materials used for MMIC fabrication? Explain with neat diagrams the fabrication process of MMICs. (16)

15. (a) Explain the launching process of a two - cavity klystron and derive expression for its optimum bunching distance L_{opt}. (16)

Or

(b) (i) Describe the measurement of power at microwave frequencies in detail. (8)

(ii) Explain the procedure to measure the impedance of a load. (8)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 31378

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

Seventh Semester

Electronics and Communication Engineering

EC 2403/EC 73/10144 EC 703 — RF AND MICROWAVE ENGINEERING

(Regulation 2008 / 2010)

(Common to PTEC 2403 — RF and Microwave Engineering for B.E. (Part-Time) Sixth Semester Electronics and Communication Engineering - Regulation 2009)

Time : Three hours Maximum : 100 marks

Smith chart is to be provided.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Draw the equivalent circuit of an inductor at radio frequency.

2. What is ESR?

3. Define transducer power gain.

4. Give the expression that relates nodal quality factor (Q_n) with loaded quality factor (Q_L).

5. What are the composition of ferrite?

6. What is Gyrator?

7. What is a step recovery diode.

8. Mention the ideal characteristics of dielectric material in MMIC.

9. Distinguish between TWT and Klystron.

10. Define SWR.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Write a detailed note on ABCD parameters. (8)

(ii) The input of an amplifier has a VSWR of 2 and the output has a VSWR of 3. Find the magnitudes of the S-Parameters S_{11} and S_{22} under matched condition. (8)

Or

(b) (i) A four port network has the scattering-matrix shown below.

$$[S] = \begin{bmatrix} 0.1\angle 90^\circ & 0.6\angle -45^\circ & 0.6\angle 45^\circ & 0 \\ 0.6\angle -45^\circ & 0 & 0 & 0.6\angle 45^\circ \\ 0.6\angle +45^\circ & 0 & 0 & 0.6\angle -45^\circ \\ 0 & 0.6\angle 45^\circ & 0.6\angle -45^\circ & 0 \end{bmatrix}$$

(1) Is this network lossless?

(2) Is this network reciprocal?

(3) What is the return loss at port 1 when all other ports are matched?

Justify your answer. (10)

(ii) Find the Z parameters Z_{11} and Z_{22} of the two port T-network shown in figure 11 (b) (ii). (6)

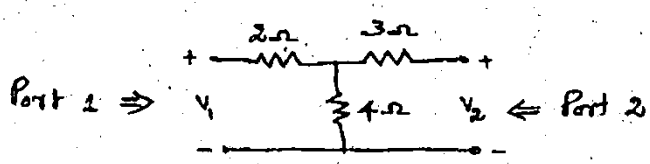

Figure 11 (b) (ii)

12. (a) (i) A MESFET operated at 5.7 GHz has the following S-parameters :

$S_{11} = 0.5\angle -60^\circ$, $S_{12} = 0.02\angle 0^\circ$

$S_{21} = 6.5\angle 115^\circ$, $S_{22} = 0.6\angle -35^\circ$

Verify the circuit, whether it is unconditionally stable or not? (6)

(ii) Write brief note on :

(1) Operating power gain (3)

(2) Available power gain (3)

(3) Noise figure. (4)

Or

(b) Discuss the design procedure for T and π matching networks.

13. (a) Describe the following with neat sketch

(i) Magic Tee (8)

(ii) Directional coupler. (8)

Or

(b) Explain the operation of following microwave passive devices.

(i) Circulator (8)

(ii) Isolator. (8)

14. (a) Explain the principle of operation of Tunnel diode and TRAPATT device.

Or

(b) (i) Describe the Gunn effect with the aid of Two-valley model theory. (8)

(ii) Draw the physical structure and doping profile of IMPATT diode and explain in detail. (8)

15. (a) Explain the working principle of Reflex Klystron and derive the expression of bunching parameter.

Or

(b) (i) Write a detailed note on cylindrical magnetron. (8)

(ii) Explain the procedure for measuring impedance at microwave frequency with the aid of slotted line. (8)

Reg. No. | | | | | | | | | | | | |

Question Paper Code : 51469

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2016

Seventh Semester

Electronics and Communication Engineering

EC 2403/EC 73/10144 EC 703-RF AND MICROWAVE ENGINEERING

(Regulations 2008/2010)

(Common to PTEC 2403- RF and Microwave Engineering for B.E. (Part-Time) Sixth Semester Electronics and Communication Engineering – Regulations 2009)

Time : Three Hours **Maximum : 100 Marks**

Smith Chart is to be provided

Answer ALL questions.

PART – A (10 × 2 = 20 Marks)

1. Mention any four differences between low frequency and high frequency microwave circuits.

2. Draw the high frequency equivalent circuit of the resistor and inductor.

3. Distinguish between conditional and unconditional stabilities of Amplifier.

4. A GaAs MESFET has the following parameters :

   $S_{11} = 0.65\angle -154^\circ$, $S_{12} = 0.02\angle 40^\circ$, $S_{21} = 2.04\angle 185^\circ$ and $S_{22} = 0.55\angle -30^\circ$

   Calculate its maximum stable power gain.

5. What are the composition of ferrite ?

6. What is Gyrator ?

7. What is the working principle of varactor diode ?

8. What is the need for matching network ?

9. Name the errors possible in VSWR measurements.

10. What is the role of slow wave structures in TWT ?

PART – B (5 × 16 = 80 Marks)

11. (a) (i) Derive Z and Y matrix formulation of multi port network. **(8)**

(ii) State and prove the symmetry of S matrix for a reciprocal network. **(8)**

OR

(b) Explain the scattering matrix for lossless junction.

12. (a) The S- parameters for a transistor is given below. Determine its stability and draw the input and output stability circles (Use Smith Chart).

$S_{11} = 0.385\angle -53^\circ$, $S_{12} = 0.045\angle 90^\circ$, $S_{21} = 2.7\angle 78^\circ$ and $S_{22} = 0.89\angle -26.5^\circ$

OR

(b) (i) Describe the process of visualizing the noise performance of a transistor by plotting noise circles on the $\sqrt{S}$ Plane. **(8)**

(ii) Explain microstripline matching networks. **(8)**

13. (a) (i) Explain the working principle of E Plane Tee and derive its S parameters. **(8)**

(ii) Explain the working of phase shifter with neat diagram. **(8)**

OR

(b) (i) Explain the working of circulator and explain its applications. **(10)**

(ii) Explain the working principle of isolator. **(6)**

Reg. No. : [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

Question Paper Code : 80352

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016

Seventh Semester

Electronics and Communication Engineering

EC 6701 — RF AND MICROWAVE ENGINEERING

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. List the radio frequency bands available in microwave and radio frequency ranges.

2. Define S-parameters.

3. Define Noise figure.

4. Calculate VSWR of an amplifier, if the amplifier has reflection coefficient 0.2533.

5. Compare PIN and PN diode.

6. What is isolator? And why isolators are called uniline?

7. What is magnetron?

8. What is Tetrodes and Pentodes?

9. What is network analyzer?

10. Classify microwave powers with its range.

PART B — (5 × 16 = 80 marks)

11. (a) (i) What is transmission (T) matrix? Obtain and explain the relationship with [S] and vice versa. (8)

(ii) Compute the intrinsic wave impedance, phase velocity and wavelengths of an electromagnetic wave in free space and a printed circuit board (PCB) material whose dielectric constant is 4.6 for the frequency f = 30 MHz and 3 GHz. (8)

Or

(b) (i) Explain and analyze any reciprocal lossless network with derivation. (10)

(ii) Discuss on the application of RF and microwave area. (6)

12. (a) Derive the equation for power gain, available power gain and transducer power gain. (16)

Or

(b) Investigate the stability regions of a transistor whose S-parameters are recorded as follows :

$S_{12} = 0.2\angle -10^\circ$; $S_{11} = 0.7\angle -70^\circ$; $S_{21} = 5.5\angle 85^\circ$ and $S_{22} = 0.7\angle -45^\circ$ at 750 MHz. (16)

13. (a) Discuss briefly about working principle, operation, characteristics and application of varactor diode. (16)

Or

(b) What is circulator? With neat diagram, explain the working principle, construction, operation of four-port circulator using magic-tee. Verify the circulator theory with necessary S-parameter equations.

14. (a) Explain the working principle and operation of multi-cavity Klystron amplifier and derive the expressions for its output power. (16)

Or

(b) A travelling wave tube (TWT) operates under the following parameters :

Beam Voltage $V_0 = 3$ kV

Beam Current $I_0 = 30$ mA

Characteristic impedance of helix $= Z_0 = 10\ \Omega$

Circuit length $= N = 50$ m

Frequency $f = 10$ GHz

Determine :

(i) Gain parameters C.

(ii) Output power gain A_p in decibels.

(iii) All four propagation constants. (16)

15. (a) Explain the impedance measurement technique using slotted line and reflectometer. (8 + 8)

Or

(b) Explain the measurement of high VSWR with the help of block diagram. (16)

EC6702 OPTICAL COMMUNICATION AND NETWORKS

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION TO OPTICAL FIBERS 9

Evolution of fiber optic system- Element of an Optical Fiber Transmission link-- Total internal reflection-Acceptance angle –Numerical aperture – Skew rays Ray Optics-Optical Fiber Modes and Configurations -Mode theory of Circular Wave guides- Overview of Modes-Key Modal concepts-Linearly Polarized Modes -Single Mode Fibers-Graded Index fiber structure

UNIT II SIGNAL DEGRADATION OPTICAL FIBERS 9

Attenuation - Absorption losses, Scattering losses, Bending Losses, Core and Cladding losses, Signal Distortion in Optical Wave guides-Information Capacity determination -Group Delay-Material Dispersion, Wave guide Dispersion, Signal distortion in SM fibers-Polarization Mode dispersion, Intermodal dispersion, Pulse Broadening in GI fibers-Mode Coupling -Design Optimization of SM fibers-RI profile and cut-off wavelength

UNIT III FIBER OPTICAL SOURCES AND COUPLING 9

Direct and indirect Band gap materials-LED structures -Light source materials -Quantum efficiency and LED power, Modulation of a LED, lasers Diodes-Modes and Threshold condition -Rate equations -External Quantum efficiency -Resonant frequencies -Laser Diodes, Temperature effects, Introduction to Quantum laser, Fiber amplifiers- Power Launching and coupling, Lencing schemes, Fiber -to- Fiber joints, Fiber splicing-Signal to Noise ratio , Detector response time

UNIT IV FIBER OPTIC RECEIVER AND MEASUREMENTS 9

Fundamental receiver operation, Pre amplifiers, Error sources – Receiver Configuration– Probability of Error – Quantum limit.Fiber Attenuation measurements- Dispersion measurements – Fiber Refractive index profile measurements – Fiber cut- off Wave length Measurements – Fiber Numerical Aperture Measurements – Fiber diameter measurements

UNIT V OPTICAL NETWORKS AND SYSTEM TRANSMISSION 9

Basic Networks – SONET / SDH – Broadcast – and –select WDM Networks –Wavelength Routed Networks – Non linear effects on Network performance –-Link Power budget -Rise time budget-Noise Effects on System Performance-Operational Principles of WDM Performance of WDM + EDFA system – Solutions – Optical CDMA – Ultra High Capacity Networks

TOTAL PERIODS: 45

TEXT BOOKS:

T1. Gerd Keiser, "Optical Fiber Communication" Mc Graw -Hill International, 4th Edition., 2010.

T2. John M. Senior , “Optical Fiber Communication”, Second Edition, Pearson Education, 2007

REFERENCES:

R1. Ramaswami, Sivarajan and Sasaki “Optical Networks”, Morgan Kaufmann, 2009

R2. J.Senior, "Optical Communication, Principles and Practice", Prentice Hall of India, 3rd Edition, 2008

R3. J.Gower, "Optical Communication System", Prentice Hall of India, 2001

UNIT – 1
INTRODUCTION TO OPTICAL FIBERS
PART-A

1. What are the advantages of optical communication?

- Ultra high bandwidth
- Low transmission loss
- Small size and Weight
- No electromagnetic interference
- Electrical isolation

2. Mention the limitation of fiber optical communication system.

- High Cost
- Fiber splicing is expensive
- Susceptivity to physical damage

3. Differentiate Monomode and multimode fibers.

S.No	Monomode fiber	Multimode fiber
1	Core radius is small	It is large.
2	Supports one mode of propagation	Supports hundreds of modes
3	Losses are minimum	Dispersion losses are more
4	For long distance communication	For shorter distance communication
5	Supports larger bandwidth	Supports lesser bandwidth

4. What is the necessity of cladding for an optical fiber.

- To provide proper light guidance inside the core
- To avoid leakage of light from the fiber
- To avoid mechanical s t r e n g t h for the fiber
- To protect the core from scratchers & other mechanical damages

5. Why do we prefer step index single mode fiber for long distance communication?

- Low attenuation due to smaller core diameter
- Higher bandwidth
- Very low dispersion

6. Define Numerical aperture of a step index fiber.

Numerical aperture of the fiber is the light collecting efficiency of the fiber & is the measure of the amount of light rays that can be accepted by the fiber.

$$NA = (n_1^2 - n_2^2)^{1/2} = n_1(2\Delta)^{1/2}$$

7. What types of fibers are used commonly?

- Based on refractive index profile
- Step index
- Graded index
- Based on propagation
- Mono-mode or single mode
- Multimode

8. Define acceptance angle.

The maximum angle to the axis at which light may enter the fiber in order to be propagated. This is referred to as the "acceptance angle" $\Theta a = \sin^{-1}(NA) = \sin^{-1}(n_1^2 - n_2^2)^{1/2}$

9. Define critical angle.

The angle of refraction is always greater (i.e.,90°) than the angle of incidence (i.e.,<90°) under this condition the refraction & the angle of incidence is known as the critical angle ϕ_c.

$$\phi_c = \sin^{-1}(n_2/n_1)$$

10. Define refraction.

It is the bending of light ray that occurs when the light rays pass from one medium to another.

11. What is meant by refractive index of material?

The refractive index n is the defined as the ratio of the velocity of light in a vacuum to the velocity of light in the medium.

$$n = \frac{\text{Speed of light in free space (c)}}{\text{Speed of light in a given material (v)}}$$

12. What is skew ray?

Skew rays are not transmitted through the fiber axis. The skew rays follow a helical path in the optical fiber. It is very difficult to track the skew rays as they do not lie in a single plane.

13. What are leaky modes in optical fibers?

In Leaky modes the fields are confined partially in the fiber core and attenuated as the propagate along the fiber length due to radiation and tunnel effect.

14. What are meridional rays?

Meridional rays are the rays following zigzag path where they travel through fiber and for every reflection it will cross the fiber axis.

15. What is tunnel effect in optical fiber?

The leaky modes are continuously radiating their power out of the core as they propagate along the fiber. This power radiation out of the waveguide in quantum mechanical phenomenon is referred to as "tunnel effect".

16. What is group velocity? (Nov/Dec 2015)

If L is the distance travelled by the pulse, β is the propagation constant along axis then the group velocity in the velocity at which energy is a pulse travels along the fiber.

$$V_g = C(d\beta/dk)$$

17. What is group delay?

In an optical fiber there are various modes present. Then the optical input which is propagated along the fiber, will travel in various modes. Because of these modes velocity of the signal will vary also they may be a delay in the optical signal of these various modes. This is called as the group delay.

18. Define Total internal reflection (TIR) & mention necessary conditions for TIR. (Nov/Dec 2015)

The ray has an angle of incidence at the interface which is greater than the critical angle ($\phi_i > \phi_c$) and is

totally reflected back into the air at the same angle to the normal. This action is known as TIR.

Necessary conditions for TIR

- $n_1 > n_2$
- $\phi_i > \phi_c$

19. Differentiate step index and graded index fibers.

S.No	Step Index Fiber	Graded Index Fiber
1	The refractive index of core is uniform throughout & undergoes an abrupt change at the core cladding boundary.	The core refractive index is made to vary as a function of radial distance from the centreof the Fiber.
2	The light propagation is by skew rays.	The light propagation is by meridional rays.

20. A multimode step index fiber with a core diameter of 80 µm and a relative index difference of 1.5% is operating at a wavelength of 0.85. If the core refractive index is 1.48. Determine a)Normalized frequency of fiber b)The number of guided modes.

Given:

N_1=1.48, λ=0.85 µm, core diameter = 80 µm a= 40 µm, Δ=1.5%

- $V = 2\lambda/\lambda\ an_1(2\Delta)^{1/2}$

  $=2\lambda*40*10\text{-}6*1.48*(2*0.015)^{1/2}$

  V =75.8
- $M_S = v^2/2$

  $= (75.8)^2/2$

  M_S =2873

21. What are the advantages and disadvantages of multimode fibers?

Advantages of multimode fibers:

- Since the core radius is large, launching of optical power into the fiber is easier.
- LED sources can be used which is very less expensive.

Disadvantages:

- Intermodal dispersion is present
- Supports lesser bandwidth
- Used for only short distance transmission.

22. A step index fiber has a core refractive index of 1.48 and a cladding refractive index of 1.46. Determine the solid acceptance angle. (Nov/Dec 2013)

GIVEN: n_1=1.48 n_2=1.46

Acceptance angle $\Theta_{a(max)} = \sin^{-1}(n_1^2 - n_2^2)^{1/2}$

$= 14^0$

23. Assume that there is a glass rod of refractive index 1.5, surrounded by air. Find the critical incident angle. (Nov/Dec 2011)

Critical angle

$\phi_c = \sin^{-1}(n_2/n_1)$ Where, n_2-refractive index of outer medium n_1-refractive index of their medium

given,

$n_1=1.5, n_2=1$

$\Phi_C==42.067^0$

24. The relative refractive index difference (Δ) for an optical fiber is 1%. Determine the critical angle at the core cladding interface if the core refractive index is 1.46.

Given :

$\Delta=1.1$, $n_1=1.46$

$\Delta=n_1-n_2/n_1$

$1.1*1.46=1.46-n_2$

$n_2= 1.4454$

Critical angle

$\phi_C= \sin^{-1}(n_2/n_1)$

$= \sin^{-1}(1.44/1.46)$

$=81.89^0$

25. A step index fiber has a normalized frequency (v) of 26.6 at 1300nm. If the core radius is 25 µm, find the numerical aperture.

Given :

$V=26.6$ $\lambda=1300nm$ $a = 25\ \mu m$ NA=?

$V= 2\Pi a/\lambda\ (NA)$

$26.6=2\Pi*25*10^{-6}/1300*10^{-9}(NA)$ NA=0.22

26. A silica optical fiber with a core diameter large enough to be considered by ray theory analysis has a core refractive index of 1.55 and a cladding refractive index of 1.52. Determine the numerical aperture and critical angle in air for the fiber. (May/June 2013)

Numerical aperture(N.A)=$(n_1^2-n^2)^{1/2}$

$=((1.55)^2-(1.52)^2)^{1/2}$

Critical angle

$\phi_C= \sin^{-1}(n_2/n_1)$

$= \sin^{-1}(1.52/1.55)$

$= 78.7^0$

27. Calculate the cut off wavelength of a single mode fiber with core radius of 4µm and Δ=0.003. (Nov/Dec 2012)

Given:

The cut off wavelength of a single mode fiber is,

$$V= \frac{2\pi a n_1(2\Delta)^{1/2}}{\lambda}$$

$$\lambda= \frac{2\pi a n_1(2\Delta)^{1/2}}{V}$$

$$= \frac{2\pi(4*10^{-4})1(2*0.003)^{1/2}}{2.405} = 3.1\ \mu m$$

28. For a fiber with core refractive index of 1.54 and fractional refractive index difference of 0.01, calculate its numerical aperture. (Nov/Dec 2012)

Given:

$n_1 = 1.54$,Δ=1.1, NA=? NA =

$n_1(2\Delta)^{1/2}$

$= 1.54\ (2*1.1)^{1/2}$

$= 1.694$

29. What is a Linearly polarized mode? (May/June 2013)

A mode for which the field components in the direction of propagation are small compared to components perpendicular to that direction is called LP mode.

PART-B

1. With the help of a block diagram explain the different components of a optical fiber link. (Nov/dec 2013)
2. A Si fiber with silica core refractive index of 1.458, v = 75 and NA = 0.3 is to be operated at 820nm. What should be its core size and cladding refractive index? Calculate the total number of modes entering this fiber.
3. Derive expression for the linearly polarized modes in optical fibers and obtain the equation for V number. (Nov/Dec 2012)
4. Starting from the Maxwell's equation, derive the expression for the wave equation of an electromagnetic wave propagating through optical fiber. (Nov/Dec 2012)
5. Derive the ray theory behind the optical fiber communication by total internal reflection. State the application of Snell's law in it. (Nov/Dec 2012)
6. Discuss the signal distortion in single mode fibers.
7. Discuss the propagation modes in single -mode fiber. (May/Jun 2013)
8. Discuss the structure of graded index fiber.
9. What are fiber modes? Explain mode theory for optical fibers in detail. (May/Jun 2014)
10. Compare Single mode fibers and Graded index fibers. Explain the requirements for fiber materials.

UNIT-2
SIGNAL DEGRADATION OPTICAL FIBERS
PART-A

1. What are the losses (or) signal attenuation mechanism in a fiber?

- Absorption
- scattering
- Radiative losses

2. Define signal attenuation of fiber loss? (Nov/Dec 2011)

It is defined as the ratio of the input optical power P_i into a fiber to the output optical power P_o from the fiber. The symbol α is commonly used to express the attenuation in decibels per Kilometer.

$$\alpha_{db} = [10\log(p_i/p_0)]/ L$$

where L is fiber length.

3. Name three different mechanism caused by absorption.

(a) absorption by atomic defects in the glass composition.
(b) extrinsic absorption by impurity atoms in the glass material.
(c) intrinsic absorption by the basic constituent atoms of the fiber material.

4. How will scattering losses arises?

Scattering losses in glass arise from

a) microscopic variations in the material density b) compositional fluctuations
c) structuralinhomodeneities or structural defects due to fiber fabrication.

5. What are types of scattering losses?

a) Linear Scattering Loss	Rayleigh scattering
	Mie scattering
b) Non - Linear Scattering Loss	Stimulated Brillouin scattering
	Stimulated Raman Scattering

6. What are types of bending losses?

There are two types of bending losses

a) macroscopic bending losses (or bending losses)
b) microscopic bending losses.

7. Mention the way to reduce macro bending losses?

Macro bending losses may be reduced by

a) designing fibers with large relative refractive index difference b) operating at the shortest wavelength possible.

8. Define dispersion in optical fiber? (Nov/Dec 2013)

Dispersion of the transmitted optical signal causes distortion or both digital and analog transmission along optical fibers, term 'dispersion' refers to spreading of light pulse as it propagates through fiber.

9. What are the type of dispersion?

a) intramodal dispersion

- material (or) chromatic dispersion
- waveguide dispersion

- group velocity dispersion (GVD) (Or) modal dispersion.

b) intermodal dispersion.

10. What is meant by material (or) Chromatic dixpersion? (Nov/Dec 2012)

It arises from the variation of the refractive index of the core material as a function of wavelength. This causes a wavelength dependence of the group velocity of any given mode. i.e., pulse spreading occurs even when different wavelengths follow the same path.

11. Define Group Velocity Dispersion (GVD)?

Intra model dipersion is pulse spreading that occurs within a single mode. The spreading arises from the finite spectral emission width of an optical source. This phenomenon is known as Group Velocity Dispersion (GVD).

12. What is intermodal dispersion? What is it cause?

Intermodal dispersion arises due to the variation of group velocity for each mode at a Single frequency. Different modes arrive at the exit end of the fiber at different times. So there is multimode dispersion and hence there is broadening of the signal pulses.

13. Define polarization?

polarization refers to the electric - field orientation of a light signal, which can vary significantly along the length of the fiber.

14. Define Birefrigence?

Polarization modes propagate with different phase velocities and the difference between their effective refractive indices is called the birefringence, $B_f = (\beta_x - \beta_y)/(2\pi/\lambda)$

15. Define cutoff wavelength of the fiber.

The cutoff wavelength is defined as the minimum value of wavelength that can be transmitted through the fiber. The wavelengths greater than the cutoff wavelength can be transmitted.

16. What is intermodal dispersion? What is it cause?

Intermodal dispersion arises due to the variation of group velocity for each mode at a Single frequency. Different modes arrive at the exit end of the fiber at different times. So there is multimode dispersion and hence there is broadening of the signal pulses.

17. Distinguish intrinsic and extrinsic absorption.

S.NO	INTRINSIC	EXTRINSIC
1.	Associated with sio2	Results from transition metal ions such as cr,cu,Mg etc.
2.	Infrared absorption by si-o Coupling	Transition metal ions loss at λ=0.8µm
3.	UV absorption is due to electronic absorption bands	Also results from OH ions.

18. What is the need for mode coupling in optical fiber?

The mode coupling will increase the distortion less rapidly after a certain initial length of fiber due to this mode coupling and differential mode losses.

19. What are micro bends? How they are formed?

Micro bends are repetitive small scale fluctuations in the radius of curvature of the fiber axis. They are formed either by non-uniformities in the manufacture of the fiber or by non- uniform lateral pressures created during cabling of fibers.

20. What factors cause Rayleigh scattering in optical fibers?

- From microscope variations in the material density
- From compositional variations.
- From structural inhomogenities (or) defects occurring during fiber manufacture.

21. A multimode graded index fiber exhibits total pulse broadening of 0.1µs over a distance of 15km. Estimate the maximum possible bandwidth on the link assuming Rz coding without intersymbol interference.

Given: Pulse broadening=0.1µs

L=15km

The maximum possible bandwidth which is equivalent to the

B_T=1/(2*pulse broadening) =1/(2*0.1*10^{-6}) =5MHz

22. The optical power launched into the fiber is 10µw. the transmission distance is 10km. the optical power at the output of fiber is 2µw. a. Calculate the signal attenuation/unit km length. b. Calculate the overall signal attenuation.

Given:

P_i=10 µw, P_o=2µw, L=10km

a) Signal Attenuation per km $\alpha_{db/km}$ = [10log(P_i/ P_o)]/L

=[10log((10*10^{-6})/(2*10^{-6}))]/10 = 0.69 db/km

b) Overall signal attenuation = 10* $\alpha_{db/km}$ = 6.9db

23. What do you mean by polarization dispersion in a fiber? (Nov/ Dec 2015)

Polarization mode dispersion (PMD) is a form of modal dispersion where two different polarizations of light in a waveguide, which normally travel at the same speed, travel at different speeds due to random imperfections and asymmetries, causing random spreading of optical pulses. Unless it is compensated, which is difficult, this ultimately limits the rate at which data can be transmitted over a fiber.

PART-B

1. Discuss absorption losses in optical fibers, comparing the intrinsic and extrinsic absorption mechanisms. (Nov/Dec 2013)
2. Briefly describe linear scattering losses in optical fibers. (Nov/Dec 2012)
   a) Rayleigh Scattering b) Mie Scattering
3. Describe the phenomenon of modal noise in optical fibers and suggest how it may be avoided.
4. Discuss dispersion mechanism for single mode fibers with dominating effects and describe how intramodal dispersion may be minimized within the single mode region.
5. Explain in detail modal birefringence and beat length in single mode fibers.
6. Give the theory of material dispersion and find an expression for material dispersion. (May/Jun 2013)
7. Explain the fiber bend losses with suitable diagram.
8. Discuss about the intermodal dispersion.
9. Discuss about the core and cladding losses.
10. Explain the attenuation and losses in fiber. (May/Jun 2014)

UNIT-3
FIBER OPTICAL SOURCES & MEASUREMENTS
PART-A

1. Why is optical confinement important in LED?

Optical confinement is used to preventing absorption of emitted radiation by the material surrounding the pn junction

2. List the different types of mechanical misalignments that can occur between two joined fibers.

- Lateral (axial)
- Angular
- Longitudinal (end separation)

3. What are the advantages of LED?

- Less expensive
- Less complex
- Long life time
- Used for short distance communication

4. Write down the difference between LED & LASER diode. (NOV/DEC 2013)

S.No	LED	LASER Doide
1.	Optical output is incoherent	Optical output is coherent
2.	No optical cavity exist for wavelength selectivity	The optical energy is produced in an optical resonant cavity
3.	No spatial temporal coherence	The optical energy has spatial & temporal coherence
4.	The output radiation has a broad spectral width	It is highly monochromatic & output beam is very directional

5. Why LED is suitable for fiber transmission system?

- They have adequate output power for a wide range
- Their optical power output can be directly modulated by varying the input current
- They have high efficiency

6. Define internal quantum efficiency? (NOV/DEC 2015)

It is defined as the ratio of radiative recombination rate to the total recombination rate

$$\eta_{int} = R_r / (R_r + R_{nr})$$

7. Define external quantum efficiency?

It is defined as the ratio of photons emitted from the LED to the number of photons generated internally. It is used to find the emitted power.

8. Write the advantages of LED & LASER diode

Compact size, High efficiency, Good reliability, Right wavelength range, Small emissive area, compatible with fiber core dimensions, Possibility of direct modulation at relatively high frequency.

9. What is splicing & mention its techniques?

- A fiber splice is a permanent or semi-permanent joint between two fibers. hence the process of joining two fiber is called as splicing.
- They are used to create long optical links or in situation where frequent connection & disconnect are not needed.

TECHNIQUES:

- splicing or Welding, Mechanical splicing

10. write the requirement of a good connector

- At connector joint, it should offer low coupling loss
- Connectors of the same type must be compatible from one manufacture to another
- In the fiber link, the connector design should be simple so that it can be easily installed
- Connector joint should not be affected by temperature, dust and moisture, I.e., it has low environment sensitivity

11. Compare & contrast between EDG & surface emitting LED's. (nov/dec 2012)

S.No	Edge emitting LED	Surface Emitted LED
1.	The light is collected from the edge of the LED	the light is collect from the surface of the LED
2.	It reduces the losses caused by the absorption in the active layer	It increases the losses by self-absorption in the active region
3.	It emits a more directional light pattern than surface emitting LED's	The plane of active light emitting region is perpendicular to fiber axis
4.	edge emitters, we use very high-radiance-type devices with ≃ 500-Å thick active layers	surface emitters with 2-2.5μ m thick active layers and emitting up to 15-mW optical power at 300 mA have been fabricated

12. Define coupling efficiency.

It is defined as a measure of the amount of optical power emitted from a source that can be coupled into a fiber,

$\eta_f = P_F/P_S$

P_F : Is power coupled into fiber; P_S : Is power emitted from the light source

13. Define fiber to fiber coupling loss

$L_f = -10\log \eta_f$

14. Mention the parameters on which optical power loss at the joint depends

- Input power distribution at the joint
- Length of the fiber between the optical source & the joint
- Geometric & waveguide characteristics of the two fiber ends
- Fiber end – face qualitied

15. Define rise time, fall time & carrier life time?

RISE TIME: it is measured from 10 to 90 percent of the leading edge of the output pulse

FALL TIME: it is measured from 90 to 10 percent of the falling edge of the output pulse

CARRIER LIFE TIME: the time taken for an electron & hole recombine is known as the carrier life time

16. What is meant by Hetrojunction structure? (NOV/DEC 2015)

It is an interface between two adjoining single crystal semiconductors with different band gap energies

17. Why Si is not used to fabricate LED & LASER diode? (NOV/DEC 2011)

Silicon is an indirect band gap semi-conductor. So it is not used to fabricate LED & LASER diodes.

18. Compare direct and indirect bandgap material.

S.NO	INDIRECT BANDGAP MATERIAL	DIRECT BANDGAP MATERIAL
1.	Direct transition is possible from valance to conduction band	It is not possible
2.	Electrons and holes have same momentum values	Different momentum values
3.	Ex : GaAs, InP, InGa As	Ex: Ge,Si.

19. What are the factors of splicing?

- Geometric difference between two fiber, fiber misalignments, mechanical strength of the splice

20. What are the advantages of fiber amplifier?

- Low noise level, High bandwidth, High dynamic range, High gain, High sensitivity

PART B

1. What is meant by indirect band gap semiconductor material?
2. Explain & Draw the structures of edge-emitting LED and surface emitting LED? (MAY/JUNE 2014)
3. Discuss the LASER diode principle, modes and threshold conditions with necessary diagrams.
4. explain the laser diode structures and radiation patterns
5. draw & explain the structure of Fabry-perot resonator cavity for a laser diode. Derive the laser diode rate equation? (NOV/DEC 2012)
6. Explain about the optical power launching?
7. Explain about the lencing scheme?
8. explain about the fiber amplifier?
9. What is the necessary of fiber to fiber connection. Explain the concept with neat diagram.
10. What do you understand by optical-wave-confinement & current confinement in laser diode/ explain with suitable structure. (NOV/DEC 2013)
11. Derive the SNR for optical fiber receiver?
12. Draw the injection laser diode structure & explain lasing in it? (MAY/JUNE 2013)
13. Explain the working of N hetro structure LED? (NOV/DEC 2013)
14. Define internal quantum efficiency of a LED. Deduce the expression for the same. (NOV/DEC 2013)

UNIT – 4
FIBER OPTIC RECEIVER AND MEASUREMENTS
PART – A

1. Define quantum limit. (Nov/Dec 2014) (May/June 2013)

It is defined as the minimum received optical power required for a specific bit error rate performance in a digital system.

2. What are the methods used to measure fiber refractive index profile?

Methods to measure fiber refractive index profile

- Interferometric method
- Near field scanning method
- Refracted near field method

3. Define quantum efficiency of a photo detector and write the expression.

Quantum efficiency M is defined as the ratio of no.of .electron hole pairs generated the number of incident photons

$$M = \frac{Ip/q}{p0/hv}$$

4. Mention the error source in fiber optical receiver. (Nov/Dec 2014)

Error sources in fiber optic receiver It can be either external can internal to the system

External noise: Atmospheric noise, equipment generated noise

Internal noise: Short noise, thermal noise

5. Why are semiconductor based photo detectors preferred to other types of photo detectors?

Semiconductor based photo detectors are preferred

- Because of its small size, Suitable material, High sensitivity, Fast response time

6. Distinguish modal noise and mode partition noise.

S.No	Model Noise	Mode Partition Noise
1.	Use single mode fiber to avoid this noise	It is the dominant noise in single mode fibers
2.	It arises when the light from a coherent laser is coupled into a multimode fiber	It is associated with intensity fluctuations in the longitudinal modes of a laser diode.

7. Why do we prefer silicon to make fiber optical receivers?

Silicon is preferred as

- They Generate Less Noise Than Germanium Based Photo Diodes,
- Silicon is available in abundant in nature.

8. What is meant by inter symbol interference (ISI)? (Nov/Dec 2013)

When a pulse is transmitted in a given time slot, most of the pulse energy will arrive in the corresponding time slot at the receiver. However, because of the pulse spreading induced by the fiber, some of the transmitted energy will progressively spread into neighboring time slots. The presence of this energy in adjacent time slots results in an interfering signal. Hence it is called Inter Symbol Interference.

9. Define quantum efficiency of optical detector?

It is defined as the fraction of incident photons which are absorbed by the photodetector and generate electrons which are collected at the detector terminals.

10. Define responsivity of optical detector?

It is defined as the ratio of output photocurrent to the incident optical power $\mathbf{R=\frac{Ip}{P0}}$

Where, Ip-output photo current; P_0-incidentoptical power.

11. Mention the benefits and drawbacks of avalanche photodiode. (May/June 2015)

- Carrier multiplication takes place in APD and as a result it detects multiple electrons at the output per incident photon. The avalanche process in APD has a sharp method which is sensitive to ambient temperature and may require dynamic control of a relatively high bias voltage.
- APD with minimum gain however provides about 15db more receiver sensitivity than that achieved with PIN photodiode. Where the applications demand high sensitivity silicon APD's are preferred choice.
- The disadvantage of APD is that it demands high biasing voltage and it is more noisy compared to a PIN diode. For long haul communications where received signsl is weak, APD is preferred over PIN diode.

12. List out the values of operating wavelengths and responsivities of si,Ge and InGaAs photodiodes.

- Si:operating wavelength=400-1100nm and
- Responsivity=0.4-0.5
- InGaAs: 1100-1700nm &0.75-0.95

13. What is meant by (1/f) noise corner frequency?

The (1/f) noise corner frequency fc is defined as the frequency at which (1/f) noise, which dominates the FET noise at low frequencies and has (1/f) power spectrum becomes equal to the high frequency channel noise given by T.

14. What do you mean by thermal noise?

Thermal noise is due to the random motion of electrons in a conductor. Thermal noise arising from the detector load resistor and from the amplifier electronics tend to dominate in applications with low signal to noise ratio.

15. Define responsivity of a photo detector.

It is defined as the ratio of output photo current to the incident optical power $\mathbf{R=\frac{Ip}{P0}=\eta q/hv}$

Where, R=Responsivity; Ip=Output photo current; Po=Incident optical power

16. Compare the performance of APD and PIN diode.

S.No	APD diode	PIN Diode
1.	The carrier multiplication yields newly created carriers which are also accelerated by high electric figh thus gaining enough energy to cause impact ionization which is known as avalanche effect	When an incident photon has energy greater than or equal to the band gap energy, it gives up its energy and exite an electron to conduction band. This process generates the photo carriers.

Analogous to the pin photo diode the performance of an APD is characterized by its responsivity. R_{APD}

$$\mathbf{R_{APD} = \eta q/h\upsilon = M = R_0 M}$$

17. GaAs has a bandgap energy of 1.43ev at 300k.Determine the wavelength above which an intrinsic photodetector fabricated from this material will cease to operate.

Solution : The long wavelength cutoff $Hc / Eg = 6.626*10^{-34}*2.298*10^{-8} / 1.43 *1.602 *10^{-19}$
$= 0.869\mu m$

18. What are the desired features of a photo detector?

- High quantum efficiency, Low rise time or fast response, Low dark current

19. What are the advantages of WDM?

Many different wavelengths can be sent along a fiber simultaneously in the 1300-1600nm spectrum

20. State the significance of maintaining the fiber outer diameter constant. (Nov/Dec 2014)

It is essential to maintain the fiber outer diameter constant. Any diameter variation may cause excessive radiation losses and make accurate fiber to fiber connection difficult.

21. What are the advantages of a trans-impedance amplifier? (Nov/Dec 2014)

1.Wide dynamic range 2. Less susceptible to pick up noise 3. Less sensitivity 4. Little or no equalization is required 5. It is very easily controllable and stable

22. List out the various error sources.

a)Quantum or shot noise b) Dark current noise c) Leakage current noise d) Thermal noise e) Amplifier noise f) Inter symbol interference

23. What is meant by excess noise factor?

The ratio of the actual noise generated in an avalanche photodiode to the noise that would exist if all carrier pairs were multiplied exactly by M is called the excess noise factor F and is defined by,

$$F = \langle m2\rangle/\langle m\rangle 2= \langle m2\rangle/M2$$

24. List the standard test methods.

a) Reference test methods (RTM). It measures a particular characteristic with high degree of accuracy and reproducibility. b) Alternative test methods (ATM). It measures with less accuracy but more suitable for practical use

25. What is meant by bit error rate?

To measure the rate of error occurrences in a digital data stream, a simple approach is to divide the number ‘Ne’ of errors occurring over a certain time interval ‘t’ by the number ‘Nt’ of pulses transmitted during this interval. This is called either the error rate or the bit-error rate.

PART-B

1. Draw the front end optical amplifiers and explain.
2. Considering the probability distributions for received logic 0 and 1 signal pulses,
3. Derive the expressions for BER and error function.
4. Write notes on the following (i)Fiber refractive index profile measurement (ii)Fiber cut off wavelength measurement.
5. Draw the schematics of pin photodiode and APD and explain.
6. Explain the fundamental receiver operation in optical communication.
7. An InGaAs pin photodiode has the following parameters at a wavelength of 1300 nm : I_D = 4 nA, R_L = 1000 ohms and the surface leakage current is negligible. The incident optical power is 300 nw (- 35 dB), and the receiver bandwidth is 20 MHz . Find the various noise terms of the receiver.
8. Discuss the performance of digital receiver by defining the probability of error.
9. Discuss the principle of operation of APD wiht neat circuit diagram. Also discuss the requirements of photo detector.
10. Discuss the fundamentals of receiver operations with neat block diagram.
11. What is known as quantum limit? A digital fiber optic link operating at 850 nm requires a maximum BER of 10*9. Find the minimum incidental optical power Po to achieve this BER at a data rate of 10 Mb/s for a simple binary level signaling scheme. (ry: 1), [1/r : B/2].
12. Discuss in detail digital receiver performance calculation and sensitivity calculation in detail.

UNIT-5
OPTICAL NETWORKS AND SYSTEM TRANSMISSION
PART – A

1. Distinguish fundamental and higher order solutions.

The pulses that do not change in shape are called fundamental soliton and that undergo periodic shape changes are called higher order soliton.

2. What is the purpose of rise time budget analysis?

Rise time budget is to ensure that the system is able to operate properly at the intended bit rate. Rise time bubge analysis is a method for determining the dispersion limitation of an optical fiber link. The concept of rise time is used to allocate the bandwidth among various components of the optical fiber links.

3. What is EDFA? (Nov/Dec 2014)

- It is optic fiber doped with erbium.
- Erbium has some interesting properties for optical communication photons at 1480 and 980nm wavelengths activate the electrons into metastable state. Electrons falling back emit light at 1550nm hence it is a low loss wavelength region for silicon optical fibers. It amplifies a signal by stimulated emission by means of electrons falling back to meta stable state at 1480nm.

4. What is the significance of rise time budget?

A rise time budget analysis is a convenient method for determining the dispersion limitation at an optical fiber link. This is particularly useful for digital system. In this approach, tsys is given as,

$$Tsys= (t^2 tx + t^2 rx + t^2 mod + t^2 mat)^{1/2}$$

5. Compare doped fiber amplifiers and conventional repeaters. (May/June 2011)

S.No	Doped Fiber Amplifiers	Conventional Repeaters
1.	These are needed periodically for amplifying and reshaping the signal in long distance links.	Conventional repeaters are also needed periodically for amplifying and reshaping the signal in long distance links.
2.	These are used as front and amplifier for and as LAN booster amplifier.	Repeaters are used to increase the signals strength for a particular distance.

6. Define modal noise and mode partition noise.

Modal noise: It arises when the light from a coherent laser is coupled into a multimode fiber operating at 400 Mbps and higher. It mainly occurs due to mechanical vibrations and fluctuations in the frequency of optical source.

Partition noise: The mode partition noise is associated with intensity fluctuations in the longitudinal modes of a laser diode. It becomes more pronounced for the higher bit rates.

7. What is chirping? (Nov/Dec 2011)

A laser which oscillates in a single longitudinal mode undercut operation may experience dynamic modulated. This line broadening is a frequency chirp associated with modulation induced changes in the carrier density.

8. What is the technique used for minimizing reflection noise?

- Prepare fiber end faces with a curved surface or an angle relative to the laser emitting facet. This directs reflected light away from the fiber axis, so it does not re-enter the wavelength (or) guide
- Use index –matching oil or gel at air glass interface.
- Use connectors in which end faces make physical contact.
- Use optical isolator within the laser transmitter.

9. What is mode partition noise? How can it be reduced? (May/June 2015)

Mode partition noise is associated with the intensity fluctuations in the longitudinal modes of a laser diode. The side modes are not sufficiently suppressed. This is dominant noise 1w single mode fibers. Mode partition noise becomes more pronounced for higher bit rates.

Reduction

- The errors due to mode partition noise can be reduced and sometimes eliminated by seeing the bias point of the laser above threshold.
- The effect is reduced by using a laser diode with a few longitudinal modes as possible. A single longitudinal mode laser diode would be preferred.

10. What are the main parameters used for characterizing the performance of optical amplifiers in a communication system?

- Provide high gain, Have a wide spectral bandwidth, Allow bi-direction operation, Add minimum noise from the amplifier, Have a low insertion loss, Good conversion efficiency

11. Define responsivity of a photodiode. (Nov/Dec 2011)

Responsitivity

It is the parameter that defines the photocurrent generated per unit optical power. It is related to quantum efficiency as, **R= Ip/Po=µq/hv**

12. What are solutions?

- Group velocity dispersion causes most pulses to broaben in time as they propagate through an optical fiber.
- However a pulse shape known as solitons takes into account the non-linear effects of silica to overcome the pulse broadening effect.

13. Define wavelength division multiplexing.

The technology of combining a number of wavelengths onto the same fiber is called wavelength division multiplexing.

14. Distinguish fundamental and higher order solutions.

- Solutions are very narrow, high intensity optical pulses that retain their shape through the interaction of balancing pulse dispersion with the non-linear properties of an optical fiber.
- The family of pulses that do not change in shape are called fundamental solitons and those that undergo periodic shape changes are called higher order solitons.

15. What are the three common topologies used for fiber optical network?

Three common topologies: Bus, Ring, Star

16. Calculate the number of independent signals that can be sent on a single fiber in the 1525-1565nm band. Take the spectral spacing as per ITU-T Recommendation G.692. (Nov/Dec 2012)

Mean frequency spacing as per ITU-T standard is 0.8nm.

1565-1525=40nm

No. of independent channels (at 0.8nm) =40/0.8 nm=50

17. What are the drawbacks of broadcast and select networks for wide area network applications?

- Draw backs of broadcast and select networks for wide area network application are.
- More wavelengths are needed as the number of nodes in the network grows.
- Without the widespread use of optical booster amplifiers, a large number of users spread over a wide area cannot reading be interconnected with a broadcast and select network.

18. What is WDM? (Nov/Dec 2014)

Since the light sources emit in a narrow wavelength band of less than 1 nm, many different independent optical channels can be used simultaneously in different segments of this wavelength range. The technology of combining a number of such independent information carrying wavelengths onto the same fiber is known as wavelength division multiplexing or WDM.

19. What are the most important non-linear effects of optical fiber communication?

Nonlinearity category	Single-channel	Multiple-channel
Index related	Self-phase modulation	Cross-phase modulation Four-wave mixing
Scattering related	Stimulated Brillouin scattering	Stimulated Raman Scattering

20. What do you mean by solitons? (Nov/Dec 2014)

Solitons are very narrow, high intensity optical pulses that retain their shape through the interaction of balancing pulse dispersion with nonlinear properties of an optical fiber. Thus, the soliton pulses travel through the optical fiber without any loss or dispersion.

21. Give the significance of solitons (May/June 2014)

Solitons may occur in proteins and DNA. Solitons are related to the low frequency collective motion in proteins and DNA. A recently developed model in neuroscience proposes that signals are conducted within neurons in the form of solitons.

22. List out the benefits of SONET over PDH networks (May/June 2014)

- Flexible synchronous structure, capability of powerful management, world standard digital format, optical interfaces, easy traffic cross connection capacity and add and drop facility, reduced networking cost due to the transversal compatibility, forward and backward compatibility

23. Define Link Power Budget.

The optical power budget in a fiber-optic communication link is the allocation of available optical power among various loss-producing mechanisms such as launch coupling loss, fiber attenuation, splice losses, and connector losses, in order to ensure that adequate signal strength is available at the receiver. In optical power budget attenuation is specified in decibels(dB) and optical power in dbms.

24. Define Rise time budget.

In the Rise time budget, we neglect the dispersion effect, which is the same as consider the bandwidth of the system to be large enough to be able to transmit the required bit rate. The dispersion reduces the available bandwidth which may limit not only the transmission rate, but also the sensitivity of the receiver and consequently the rise time budget due to inter symbol interference.

25. What are the drawbacks of broadcast and select networks for wide area network applications?

- More wavelengths are needed as the number of nodes in the network grows. Without the widespread use of optical booster amplifiers, a large number of users spread over a wide area cannot be readily be interconnected with a broadcast and select network

26. What is broadcast and select Network? (May/June 2013)

A broadcast-and-select network consists of a passive star coupler connecting the nodes in the network. Each node is equipped with one or more fixed-tuned or tunable optical transmitters and one or more fixed-tuned or tunable optical receivers.

PART-B

1. Discuss the concepts of Media Access Control protocols in Broadcast and select networks.
2. Describe the non-linear effects on network performance in detail.
3. Explain the basics of optical CDMA systems. (May/Jun 2013)
4. Explain various types of fiber splicing techniques and fiber connectors.
5. Explain the operational principles of WDM.
6. Explain the rise-time budget.
7. Discuss the operational principles of WDM.
8. Describe the key features of WDM .
9. Explain the rise-time budget of a fiber –optic point – to – point link.
10. Draw the point-to -point fiber optic link and discuss the system considerations.
11. Discuss the principle ,requirement and applications of WDM.
12. What are the system considerations in point to point links? Explain in detail.
13. Discuss in detail Fiber splicing and connectors. Explain the operation principles of WDM.
14. Explain the concept of Link Power Budget and Rise time Budget.
15. With suitable example , explain the conditions and constraints in the formulation and solution of routing and wavelength assignment problem in an optical wave.

Anna University Question Papers

Anna University
Question Paper code : 11347
B.E./B.Tech. Degree Examination, November/December 2012
Seventh Semester
Electronics and Communication Engineering
EC 2402/EC 72/10144 EC 702 - Optical Communication and Networking
(Regulation 2008)
(Common to PTEC 2402 - Optical Communication and Networking for B.E. (Part-Time) Sixth Semester Electronics and Communication Engineering - Regulation 2009)

Time: Three hours

Maximum : 100 marks

Answer ALL questions
Part A - (10 * 2 = 20 marks)

1. Calculate the cutoff wavelength of a single mode fiber with core radius of 4μm and = 0.003.
2. For a fiber with core refractive index of 1.54 and fractional refractive index difference of 0.01, calculate its numerical aperture.
3. What are the two reasons for chromatic dispersion?
4. What are the most important non-linear effects of optical fiber communication?
5. Compare and contrast between surface and edge emitting LEDs.
6. What is the significance of intrinsic layer in PIN diodes?
7. What is dark current?
8. List out the various error sources.
9. What were the problems associated with PDH networks?
10. Enumerate the various SONET/SDH layers.

Part B - (5 * 16 = 80 marks)

11. (a) (i) Starting from the Maxwell's equation, derive the expression for the wave equation of an electromagnetic wave propagating through optical fiber (8 marks)

11. (a) (ii) Derive the ray theory behind the optical fiber communication by total internal reflection. State the application of Snell's law in it. (8 marks)

Or

11. (b) (i) A Si fiber with silica core refractive index of 1.458, v = 75 and NA = 0.3 is to be operated at 820nm. What should be its core size and cladding refractive index? Calculate the total number of modes entering this fiber. (8 marks)

11. (b) (ii) Derive expression for the linearly polarized modes in optical fibers and obtain the equation for V number. (8 marks)

12. (a) (i) Describe the linear and non-linear scattering losses in optical fibers. (8 marks)

12. (a) (ii) An LED operating at 850nm has a spectral width of 45mm. What is the pulse spreading in ns/km due to material dispersion? What is the pulse spreading when a laser diode having a 2nm spectral width is used? (8 marks)

Or

12. (b) (i) Draw and explain the various fiber alignment and joint losses. (8 marks)

12. (b) (ii) Write notes on fiber splices and connectors. (8 marks)

13. (a) Draw and explain the structure of Fabry-Perot resonator cavity for a laser diode. Derive laser diode rate equations. (16 marks)

Or

13. (b) (i) Draw the structure and electric fields in the APD and explain its working

13. (b) (ii) What are the three factors that decides the response time of photodiodes? Explain them in detail with necessary sketches.

14. (a) (i) Draw the front end optical amplifiers and explain (8 marks)

14. (a) (ii) Considering the probability distributions for received logic 0 and 1 signal pulses, derive the expressions for BER and error function (8 marks)

Or

14. (b) Write notes on the following

Fiber refractive index profile measurement (8 marks)

(ii) Fiber cut off wavelength measurement (8 marks)

15. (a) discuss the concepts of Media Access Control protocols in Broadcast and select networks. (16 marks)

Or

15. (b) (i) Describe the non-linear effects on network performance in detail. (8 marks)

15. (b) (ii) Explain the basics of optical CDMA systems. (8 marks)

Reg. No. : [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

Question Paper Code : 31377

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

Seventh Semester

Electronics and Communication Engineering

EC 2402/EC 72/10144 EC 702 – OPTICAL COMMUNICATION AND NETWORKING

(Regulation 2008/2010)

(Common to PTEC 2402 – Optical Communication and Networking for B.E. (Part-Time) Sixth Semester – Electronics and Communication Engineering – (Regulation 2009))

Time : Three hours Maximum : 100 marks

Missing data may be suitably assumed.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. The refractive indexes of the core and cladding of a silica fiber are 1.48 and 1.46 respectively. Find the acceptance angle for the fiber.

2. Determine the normalized frequency at 820 nm for a step-index fiber having a 25 μm radius. The refractive indexes of the cladding and the core are 1.45 and 1.47 respectively. How many modes propagate in this fiber at 820 nm?

3. A continuous 12 kms-long optical fiber link has a loss of 1.5 dB/km. What is the minimum optical power that must be launched into the fiber to maintain an optical power level of 0.3 μW at the receiving end?

4. Define dispertion in multimode fibers. What is its effect?

5. Write two differences between a Laser diode and a LED.

6. For a photodiode define quantum efficiency-η and responsivity - R.

7. A digital fiber optic link operating at 1310 nm, requires a maximum BER of 10^{-8}. Calculate the required average photons per pulse.

8. The photo detector output in a cutback-attenuation set up is 3,3 V at the far end of the fiber. After cutting the fiber at the near end, 5m from the far end, photo detector output read was 3.92 V. What is the attenuation of the fiber in dB/Km?

9. Obtain the transmission bit rate of the basic SONET frame in Mbps.

10. Illustrate interchannel cross talk that occurs in a WDM system.

PART B — (5 × 16 = 80 marks)

11. (a) (i) With the help of a block diagram explain the different components of a optical fiber link. (12)

(ii) Compare the optical fiber link with a satellite link. (4)

Or

(b) (i) Explain the differences between meridional and skew rays. (4)

(ii) Bring out the differences between phase and Group velocities. (6)

(iii) Deduce an expression for NA of a fiber with the help of a neat figure showing all the details. (6)

12. (a) (i) Discuss the attenuation encountered in optical fiber communication due to :

(1) Bending

(2) Scattering

(3) Absorption. (12)

(ii) Calculate the maximum transmission distance for a fiber link with an attenuation of 0.2 dB/Km if the power launched in 1mw and the receiver sensitivity is 50 μW. Calculate the attenuation for an other link with same parameters and the distance of 26 Kms. (4)

Or

(b) (i) Clearly bringout the differences between intra and inter modal dispersion. (12)

(ii) Find the maximum bit rate for the fiber link of 5 Kms. The numerical aperture is 0.25 and the refractive index is 1.48. (4)

13. (a) (i) Explain the working of n hetero structure LED. (10)

(ii) Define Internal quantum efficiency of a LED. Deduce the expression for the same. (6)

Or

(b) (i) What do you understand by optical-wave-confinement and current confinement in LASER diode? Explain with suitable structures. (10)

(ii) Briefly explain the different noise sources of a photo detector. (6)

2 31377

14. (a) (i) Explain any two types of preamplifiers used in a receiver. (12)

(ii) Define the terms – 'Quantum limit' and 'Probability of Error' with respect to a receiver with typical values. (4)

Or

(b) (i) Explain the 'Insertion-Loss method' used for attenuation measurement. (8)

(ii) Explain the technique used in 'Frequency – Domain Intermodal Dispersion measurement'. (8)

15. (a) (i) What is a 'four-fiber BLSR' ring in a SONET? Explain the reconfiguration of the same during node or fiber failure. (8)

(ii) What is 'broadcast-and-select multihop network'? Explain. (8)

Or

(b) (i) Explain the following requirements for the design of an optically amplified WDM link :

(1) Link Band width

(2) Optical power requirements for a specific BER. (8)

(ii) Write a note on solitons. (8)

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Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 21377

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Seventh Semester

Electronics and Communication Engineering

EC 2402/EC 72 — OPTICAL COMMUNICATION AND NETWORKING

(Common to PTEC 2402 – Optical Communication and Networking for B.E. (Part-Time) Sixth Semester – Electronics and Communication Engineering – (Regulation 2009))

(Regulation 2008)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. For n_1 = 1.55 and n_2 = 1.52, calculate the critical angle and Numerical aperture.
2. What is a Linearly polarized mode?
3. What is Rayleigh scattering?
4. What is meant by mechanical splice?
5. Calculate the band gap energy for an LED to emit 850 nm.
6. Define : Detector response time.
7. What are the error sources of receiver?
8. What is known as quantum limit?
9. What is a broadcast and select network?
10. What is a soliton?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Derive the mode equations for a circular fibre using Maxwell's equations. (8)

(ii) Calculate the Numerical Apertures of a fibre having n_1 = 1.6 and n_2 = 1.49 and another fibre having n_1 = 1.458 and n_2 = 1.405. Which fibre has greater Acceptance angle? (8)

Or

(b) (i) Explain the ray theory of a fibre with a special mention about TIR, Acceptance angle and NA. (8)

(ii) Describe Single mode fibres and their mode – field diameter. What are the propagation modes in them? (8)

12. (a) (i) Derive expressions for material dispersion and waveguide dispersion and explain them. (8)

(ii) Describe the various types of fiber connectors and couplers. (8)

Or

(b) (i) Explain fiber alignment and joint losses. (6)

(ii) Describe various fiber splicing techniques with their diagrams. (10)

13. (a) (i) Draw the structures of SLED and ELED and explain their principle of operation. (8)

(ii) Draw the injection laser diode structure and explain lasing in it. (8)

Or

(b) (i) Draw the structures of PIN and APD photo detectors and explain their operations. (8)

(ii) Derive expressions for the SNR of both PIN and APD by incorporating all noise sources. (8)

14. (a) What are the various types of Preamplifiers available for optical networks? Explain any three of them with their circuit diagrams. (16)

Or

(b) Write detailed notes on the following :

(i) Fibre refractive index profile measurement (8)

(ii) Fibre cut off wavelength measurement (8)

15. (a) (i) Explain the SA/SA protocol and modified SA/SA protocol of Broadcast and select networks. (8)

(ii) What are the non – linear effects on network performance? Explain them briefly. (8)

Or

(b) (i) Explain the layered architecture of SONET/SDH with neat diagram. (8)

(ii) Write a detailed notes on optical CDMA and its applications. (8)

Reg. No. | | | | | | | | | | | | |

Question Paper Code : 51417

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2014.

Seventh Semester

Electronics and Communication Engineering

EC 2402/EC 72/10144 EC 702 — OPTICAL COMMUNICATION AND NETWORKING

(Regulation 2008/2010)

(Common to PTEC 2402 – Optical Communication and Networking for B.E. (Part –Time) Sixth Semester – Electronics and Communication Engineering– (Regulation 2009))

Time : Three hours Maximum : 100 marks

Missing data may be suitably assumed

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. A multimode fibre has core diameter of 50 μm and cladding refractive index of 1.45. If its modal dispersion is 10 ns/km, find its numerical aperture.

2. Distinguish meridional rays from skew rays.

3. Identify the causes of scattering loss.

4. A fibre has an attenuation of 1.5 dB/Km at 1300 nm. If 0.5 mW of optical power is initially launched into the fibre, what is the power level in microwatts after 9Km?

5. If the absorption coefficient of silicon is 0.05 micrometer^{-1} at 860 nm, find the penetration depth at which $p(x)/P_{in} = 0.368$.

6. Define the internal quantum efficiency of LED.

7. What are the receiver error sources?

8. Describe the term 'Quantum limit.

9. List out the benefits of SONET over PDH networks.

10. Give the significance of solitons.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Draw and explain ray theory transmission in an optical communication. (8)

(ii) With diagram, explain acceptance angle, numerical aperture and total internal reflection. (8)

Or

(b) With diagram, explain electromagnetic mode theory of optical propagation. (16)

12. (a) Explain the attenuation and losses in fibre. (16)

Or

(b) With diagram, explain intra and inter modal dispersion. (16)

13. (a) With diagram, explain surface and edge emitters of LED structures. (16)

Or

(b) Draw and compare the construction and characteristics of PIN and Avalanche photo diode. (16)

14. (a) With suitable diagram, explain optical receiver operation and its performance. (16)

Or

(b) Describe the dispersion and numerical aperture measurements of fibre. (16)

15. (a) Explain SONET layers and frame structure with diagram. (16)

Or

(b) With suitable example, explain the conditions and constraints in the formulation and solution of routing and wavelength assignment problem in an optimal way. (16)

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Question Paper Code: 21468

B.E.IB.Tech. DEGREE EXAMINATION, NOVEMBERIDECEMBER 2015

Seventh Semester

Electronics and Communication Engineering

EC *2402/EC 72/10144* EC 702 - OPTICAL COMMUNICATION AND NETWORKING

(Regulations *2008/2010)*

(Common to PTEC 2402 - Optical Communication and Networking for B.E. (Part-Time) Sixth Semester - Electronics and Communication Engineering- Regulations 2009)

Time: Three hours Maximum: 100 marks

Missing data may be suitably assumed.

Answer ALL questions.

PART A - (10 x 2 = 20 marks)

1. What is total internal reflection in a fiber?

2. Define phase and group velocity.

3. What do you mean by polarization dispersion in a fiber?

4. A fibre has an attenuation of 0.5 d:B/KIil at 1500 nm. If 0.5m W of optical power is initially launched into the fibre, what is the power level in after 25Km?

5. What is meant by hetero junction structure?

6. Define interna1 quantum efficiency of LED and Laser.

7. Draw and describe the operation of fiber optic receiver.

8. Mention few fiber diameter measurement techniques.

9. What is optical CDMA?

10. Distinguish SONET and SDH.

PART B - (5 x 16::: 80 marks)

11. (a) (i) With diagram, explain acceptance angle and Numerical Aperture of fibres. (8)

(ii) Classify fibers and explain them. (8)

Or

(b) Describe and derive the modes inplanar guide. (16)

12. (a) With necessary diagrams, explain the causes and types of fiber attenuation loss. (16)

Or

(b) (i) With diagram, derive the expression for intra modal dispersion. (10)

(ii) Describe about fiber connectors, splices and couplers. (6)

13. (a) Draw and compare LED and Injection Laser Diode structures. (16)

Or

(b) Discuss about optical detection noise. (16)

14. (a) Derive the probability of error of fiber optic receiver. (16)

Or

(b) Explain how. attenuation and dispersion measurements could be done

15. (a) Explain SONET layers and frame structure with diagram. (16)

(or)

(b) Discuss the performance improvement of WDM and EDFA systems. (16)

Question Paper Code : 80353

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Seventh Semester

Electronics and Communication Engineering

EC 6702 — OPTICAL COMMUNICATION AND NETWORKS

(Regulations 2013)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define numerical aperture.
2. What are the conditions for light to be propagation inside a fiber?
3. What are the causes of absorption?
4. What is polarization mode dispersion?
5. What are the mechanisms behind lasing action?
6. Define external quantum efficiency.
7. Define BER.
8. What is cut back method?
9. How do you ensure that the required system performance is met or not?
10. Name two popular architectures of SONET/SDH network.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Compare the structure and characteristics of step index and graded index fiber. (12)

(ii) A graded index fiber with a core with a parabolic refractive index profile ($\alpha = 2$) and diameter of $50\,\mu m$. The fiber has numerical aperture of 0.2. Estimate the number of the guided modes propagating in the fiber when the transmitted light has a wavelength $1\,\mu m$. (4)

Or

(b) (i) Consider a fiber with $25\,\mu m$ core radius, core index $n1 = 1.48$ and $\Delta = 0.01$. If $\lambda = 1320\,nm$, what value of V and how many modes propagate in the fiber. What percent of optical power flows in the cladding? If the core cladding difference is reduced to $\Delta = 0.003$, how many modes does the fiber support and what fraction of the optical power flows in the cladding? (8)

(ii) Explain the functional blocks of an optical communication link with neat block diagram. (8)

12. (a) Discuss about the design optimization of single mode fiber. (16)

Or

(b) What is waveguide dispersion? Derive an expression for time delay produced due to waveguide dispersion. (16)

13. (a) (i) A double heterojunction LED emitting at a peak wavelength of 1310 nm has radiative and non-radiative recombination time of 45 ns and 95 ns respectively The drive current is 35 mA. Determine internal quantum efficiency and internal power level. If the refractive index of the light source material is $n = 3.5$, find the power emitted from the device. (6)

(ii) What is fiber splicing? Discuss about fusion splicing and mechanical splicing. (10)

Or

(b) Explain the working principle of laser diode and derive its rate equation. (16)

14. (a) Explain the different methods employed in measuring the attenuation in optical fiber with neat block diagram. (16)

Or

(b) What are the performance measures of a digital receiver? Derive an expression for bit error rate of a digital receiver. (16)

15. (a) (i) Draw the generic configuration of SONET and explain the functions of add drop multiplexer in SONET. (8)

(ii) A 90 Mb/s NRZ data transmission system that sends two DS3 channels uses a GaAlAs laser diode that has a spectral width of 1 nm. The rise time of the laser transmitter output is 2 ns. The transmission distance is 7 km over a graded index fiber that has 800 MHz.km bandwidth-distance product. If the receiver bandwidth is 90 MHz and mode mixing factor $q = 0.7$, what is the system rise time? What is the rise time if there is no mode mixing? (use 0.07 ns/(nm-km)). (8)

Or

(b) Discuss in detail about the effect of noise on system performance.

EC6703 EMBEDDED AND REAL TIME SYSTEMS

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UNIT I INTRODUCTION TO EMBEDDED COMPUTING AND ARM PROCESSORS 9

Complex systems and micro processors– Embedded system design process –Design example: Model train controller- Instruction sets preliminaries - ARM Processor – CPU: programming input and output- supervisor mode, exceptions and traps – Co-processors- Memory system mechanisms – CPU performance- CPU power consumption

UNIT II EMBEDDED COMPUTING PLATFORM DESIGN 9

The CPU Bus-Memory devices and systems–Designing with computing platforms – consumer electronics architecture – platform-level performance analysis - Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.

UNIT III PROCESSES AND OPERATING SYSTEMS 9

Introduction – Multiple tasks and multiple processes – Multirate systems- Pre-emptive real-time operating systems- Priority based scheduling- Interprocess communication mechanisms – Evaluating operating system performance- power optimization strategies for processes – Example Real time operating systems-POSIX-Windows CE

UNIT IV SYSTEM DESIGN TECHNIQUES AND NETWORKS 9

Requirement Analysis – Specifications-System analysis and architecture design – Quality Assurance techniques- Distributed embedded systems – MPSoCs and shared memory multiprocessors

UNIT V CASE STUDY 9

Data compressor - Alarm Clock - Audio player - Software modem-Digital still camera - Telephone answering machine-Engine control unit – Video accelerator

TOTAL PERIODS: 45

TEXT BOOKS:

T1. Marilyn Wolf, “Computers as Components - Principles of Embedded Computing System Design”, Third Edition “Morgan Kaufmann Publisher (An imprint from Elsevier), 2012

REFERENCES:

R1. Jonathan W.Valvano, “Embedded Microcomputer Systems Real Time Interfacing”, Third Edition Cengage Learning, 2012.

R2. David. E. Simon, “An Embedded Software Primer”, 1st Edition, Fifth Impression, Addison-Wesley Professional, 2007

R3. Raymond J.A. Buhr, Donald L.Bailey, “An Introduction to Real-Time Systems- From Design to Networking with C/C++”, Prentice Hall, 1999

R4. C.M. Krishna, Kang G. Shin, “Real-Time Systems”, International Editions, Mc Graw Hill 1997

R5. K.V.K.K.Prasad, “Embedded Real-Time Systems: Concepts, Design & Programming”, Dream Tech Press, 2005

R6. Sriram V Iyer, Pankaj Gupta, “Embedded Real Time Systems Programming”, Tata Mc Graw Hill, 2004.

UNIT-1
INTRODUCTION TO EMBEDDED COMPUTING AND ARM PROCESSORS

PART-A

1**. Define a System.**

A System is defined as a way of doing one or more tasks according to a program.

2. What is an embedded system?

An embedded system employs a combination of hardware & software (a "computational engine") to perform a specific function; is part of a larger system that may not be a "computer"; works in a reactive and time-constrained environment

3. What are the advantages of embedded system?

Advantages:

Customization yields lower area, power, cost, etc.

4. What are the disadvantages of embedded system? Disadvantages:

Higher HW/software development overhead design, compilers, debuggers, etc., may result in delayed time to market!

5. What are the applications of an embedded system?

Embedded Systems: Applications:

- Consumer electronics, e.g., cameras, camcorders, etc.,
- Consumer products, e.g., washers, microwave ovens, etc.,
- Automobiles, e.g.,anti-lock braking, engine control, etc.,
- Industrial process controllers & avionics/defense applications
- Computer/Communication products, e.g., printers, FAX machines, etc.,
- Emerging multimedia applications & consumer electronics

6. What are the complicating factors in embedded design?

Complicating factors in the design of embedded systems

- Many of the subtasks in design are intertwined.
- Allocation depends on the partitioning, and scheduling presumes a certain allocation.
- Predicting the time for implementing the modules in hardware or software is not very easy, particularly for tasks that have not been performed before.

7. What are the real-time requirements of an embedded system?

Hard-real time systems: where there is a high penalty for missing a deadline e.g., control systems for aircraft/space probes/nuclear reactors; refresh rates for video, or DRAM. Soft realtime systems: where there is a steadily increasing penalty if a deadline is missed.

e.g., laser printer: rated by pages-per-minute, but can take differing times to print a page (depending on the \"complexity\" of the page) without harming the machine or the customer.

8. What are the functional requirements of embedded system?

- Data Collection
- Sensor requirements
- Signal conditioning
- Alarm monitoring
- Direct Digital Control
- Actuators

- Man-Machine Interaction
    1. Informs the operator of the current state of the controlled object
    2. Assists the operator in controlling the system.

9. What are the main components of an embedded system?

Three main components of embedded systems:
The Hardware
Application Software
RTOS

10. Define embedded microcontroller.

An embedded microcontroller is particularly suited for embedded applications to perform dedicated task or operation.

Example: 68HC11xx, 8051, PIC, 16F877, etc.,

11. Explain digital signal processing in embedded system continued digitization of signals increasing the role of DSP in ES.

- Signals are represented digitally as sequence of "samples"
- ADC's are moving closer to signals

12. What are the various classifications of embedded systems?

Small scale embedded systems, Medium scale embedded systems, and Sophisticated embedded systems.

13. What are the two essential units of a processor on an embedded system and what does the execution unit of a processor in an embedded system do?

Program flow control unit (CU) and Execution unit (EU)

The execution unit implements data transfer and data conversion. It includes ALU and circuits that execute instruction for jump, interrupt, etc.,

14. Give examples for general purpose processor.

Microprocessor, Microcontroller, Embedded processor, Digital Signal Processor, Media Processor

15. Define microprocessor.

A microprocessor fetches and processes the set of general-purpose instructions such as data transfer, ALU operations, stack operations, I/O operations and other program control operations.

16. When is Application Specific System processors (ASSPs) used in an embedded system?

An ASSP is dedicated to real-time video processing applications such as video conferencing, video compression and decompression systems. It is used as an additional processing unit for running application specific tasks in the place of processing using embedded software.

17. Define ROM image.

ROM image in a system memory consists of:

Boot-up program, stack address pointer, program counter address pointer, application tasks, ISRs, input data, RTOS and vector addresses. Bytes at each address must be defined to create ROM image.

18. Define device driver.

A device driver is software for controlling, reading, sending a byte of stream of bytes from/to the device.

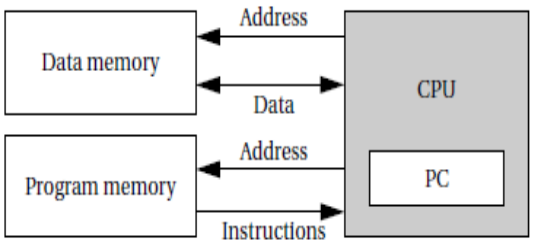
19. Give some examples for small scale embedded systems.

68HC05, PIC 16F8x, 8051, etc.,

20. Give some examples for medium scale embedded systems

8051, 80251, 80x86, 80196, 68HC11xx

21. Draw Harvard Architecture Diagram



22. Give the reactivity in embedded system.

Closed systems

- Execution indeterminacy confined to one source
- Causal relations are easily established.

Open systems

- Indeterminacy from multiple sources, not controllable or observable by the programmer not possible to infer causal relations

23. Explain distributed systems.

- Consist of components that may necessarily be physically distributed.
- Consist of communicating processes on multiple processors and/or dedicated hardware connected by Communication links.
  - Motivational
  - Economical
  - Multiple processors to handle multiple time-critical tasks physically distributed
  - Devices under control may be physically distributed.

24. What are the temporal requirements?

Tasks may have deadlines: Minimal latency jitter, Minimal error detection latency, Timing requirements due to tight software control loops, Human interface requirements.

25. Give the classification of embedded system.

Multi-dimensional classifications

Hard versus software systems

- Fail-safe versus fail-operational systems
- Guaranteed-response versus best-effort
- Resource-adequate versus resource-inadequate
- Event-triggered versus time-triggered.

26. The Main Components of Embedded System

- Micro Processor, Digital Signal Processor
- Converters (A-D or D-A)
- Actuators
- Memory (On-Chip or off-Chip memory)

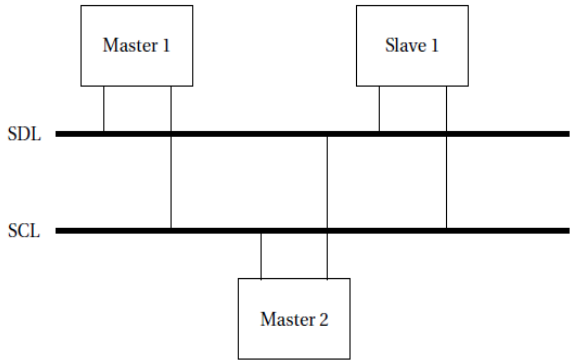
27. What are the various embedded system requirements?

- R1 Functional requirements
- R2 Temporal requirements
- R3 Dependability requirements

28. Give some examples for sophisticated embedded systems

ARM7, Power PC, Intel 80960, etc.,

29. Draw Structure of I^2c Bus System



30. What are the factors which governs the performance of CPU? (APRIL/MAY 2015)

(i) Pipelining, (ii) Catching

31. Enumerate various issues in real time computing. (Nov/Dec 2013)

Embedded system designers have a very clear performance goal in mind –their program must meet its deadline. The heart of embedded computing is real time computing.

We need tools to help us analyze the real-time performance of embedded systems. We also need to adopt programming disciplines and styles that make it possible to analyze these programs.

32. Write short notes on ARM processor. (Nov/Dec 2013)

ARM is actually a family of RISC architectures that have been developed over many years. ARM instructions are written one per line, starting after the first column. Comments begin with a semicolon and continue to the end of the line. A label, which gives a name to a memory location, comes at the beginning of the line, starting in the first column.

Example: LDR r0,[r8] ; a comment
Label Add r4, r0, r1

The ARM processor can be configured at power-up to address the bytes in a word in either little-endian mode (or) big-endian mode.

33. What are the Instruction set features useful for embedded programming? (May/June2013)

Complex instruction set computers (CISC), these machines provided a variety of instructions that may perform very complex tasks, such as string searching. RISC-reduced instructions set computers these machines provide somewhat fewer and simpler instructions. The instructions were also chosen so that they could be efficiently executed in pipelined processors.

34. Differentiate top-down and bottom-up design. (APRIL/MAY 2014)

Top –down design method is the easiest designing method for embedded system learners when compared to bottom-up design. In general, the less experience we have follow top-down systems, the more we will have rely on bottom-up design information to help us refine the system.

35. List the functions of ARM Processor in supervisor mode. (APRIL/MAY 2014) (APRIL 2016)

The ARM instruction that puts the CPU in supervisor mode is called SWI. SWI causes the CPU to go into supervisor mode and sets the PC TO 0*08. In supervisor mode CPSR are all set to 1 indicate that the CPU is in supervisor mode. The old value of the CPSR just before the SWI is stored in a register called the Saved programmed status register (SPSR).

PART-B

1. Write short notes on
   (a) CPU performance (4 Marks) (NOV/DEC 2013)
   (b) Supervising mode
   (c) Instruction set preliminaries (6 Marks) (NOV/DEC 2013)
2. Explain embedded system design process with suitable diagrams. (NOV/DEC 2013) (APRIL 2016)
3. What are the parameters to be considered while designing an embedded system design process? Explain. (16 Marks) (APR/MAY 2015)
4. Explain ARM processor operations and types with instruction sets. (May/June2013) (APRIL 2016)
5. Explain about the model train controller with neat sketch. (APR/MAY 2015)
6. With neat sketch about the organization of ARM processor and co-processor. (NOV/DEC 2012) (April/May 2014)
7. Explain about Embedded system with suitable example
8. Explain in detail about instruction preliminaries and CPU performance.
9. Discuss in detail about coprocessor (12Marks) (NOV/DEC 2013)
10. Discuss about formalism for system design. (8 Marks) (APR/MAY 2015)
11. Describe the various stages involved in model train controller. (NOV/DEC 2012) (May/June2013)
12. Explain in detail the memory system mechanism and CPU performance in a Coprocessor system (APRIL 2016)

UNIT- 2
EMBEDDED COMPUTING PLATFORM DESIGN
PART-A

1. Give the summary of I/O devices used in embedded system

Program, data and stack memories occupy the same memory space. The total addressable memory size is 64 KB. Program memory - program can be located anywhere in memory. Jump, branch and call instructions use 16-bit addresses, i.e. they can be used to jump/branch anywhere within 64 KB. All jump/branch instructions use absolute addressing. Data memory - the processor always uses 16-bit addresses so that data can be placed anywhere. Stack memory is limited only by the size of memory. Stack grows downward. First 64 bytes in a zero-memory page should be reserved for vectors used by RST instructions.

- I/O ports
- 256 Input ports
- 256 Output ports Registers
- Accumulator or A register is an 8-bit register used for arithmetic, logic, I/O and load/store operations.

2. Define bus.

Buses: The exchange of information.

Information is transferred between units of the microcomputer by collections of conductors called buses. There will be one conductor for each bit of information to be passed, e.g., 16 lines for a 16-bit address bus. There will be address, control, and data buses

3. What are the classifications of I/O devices?

- Synchronous serial input and output
- Asynchronous serial UART input and output
- Parallel one bit input and output
- Parallel port input and output

4. Give some examples for serial input I/O devices.

Audio input, video input, dial tone, transceiver input, scanner, serial IO bus input, etc., Give the steps for accomplishing input output data transfer Accomplishing input/output data transfer

There are three main methods used to perform/control input/output data transfers. They are,

- Software programming (scanning or polling)
- interrupt controlled
- Direct memory access (DMA)

5. What do you meant by bus arbitration?

Bus Arbitration: Most processors use special control lines for bus arbitration, ie, controlling the use of the address and data bus,

- An input which the DMAC uses to request the bus
- An output(s) indicating the bus status
- An output indicating acceptance of the DMAC\'s bus request

6. What are the two characteristics of synchronous communication?

- Bytes/frames maintain constant phase difference and should not be sent at random time intervals. No handshaking signals are provided during the communication.
- Clock pulse is required to transmit a byte or frame serially. Clock rate information is transmitted by the transmitter.

7. What do you mean by asynchronous communication?

The most basic way of sharing data is by copying the data in question to each server. This will only work if the data is changed infrequently and always by someone with administrative access to all the servers in the cluster.

8. What are the three ways of communication for a device?

- Separate clock pulse along with data bits
- Data bits modulated with clock information
- Embedded clock information with data bits before transmitting

9. Expand a) SPI b) SCI

SPI - SERIAL PERIPHERAL INTERFACE
SCI - SERIAL COMMUNICATION INTERFACE

10. What are the forms of timer?

- Hardware interrupt timer
- Software timer
- User software controlled hardware timer
- RTOS controlled hardware timer
- UP/DOWN count action timer
- One-shot timer (No reload after overflow and finished states)

11. Define RTC

RTC Stands for Real Time Systems. Once the system starts, do not stop/reset and the count value cannot be reloaded.

12. What is I^2C?

Inter- Integrated Circuit (2-wire/line protocol) which offers synchronous communication. Standard speed: 100Kbps and High speed: 400 Kbps

13. What is USB? Where is it used?

USB - Universal Serial Bus and operating speed up to 12 Mbps in fast mode and 1.5Mbps in low-speed mode.

14. What are the features of the USB protocol?

A device can be attached, configured and used, reset, reconfigured and used, detached and reattached, share the bandwidth with other devices.

15. Mention some I/O standard interfaces.

- HSTL - High Speed Transceiver Logic (Used in high speed operations)
- SSTL - Stub Series Terminated Logic (Used when the buses are needed to isolate from the large no. of stubs)

16. What are the Testing Strategies used in the Program Validation (APRIL 2016)

- Black-box methods generate tests without looking at the internal structure of the program.
- Clear-box (also known as white-box) methods generate tests based on the program structure.

17. Define Debugging and Complier

Debugging is a process of removing errors during run time and execution time of program.
Complier is a translator which converts high level language into assembly level language which later converted into binary codes.

18. What is Component Interfacing?

Some I/O devices are designed to interface directly to a particular bus, forming glue-less interfaces. But glue logic is required when a device is connected to a bus for which it is not designed.
It is a process of interfacing glue logic between a system bus and the device for the device which is not made for a particular type of system bus.

19. Write the classification of Memory Devices

- Primary Memory:
  1. Read Only Memory (ROM)
  2. Random Access Memory (RAM)
- Secondary Memory:
  1. Floppy disk
  2. Hard disk
  3. Pen drive
- Extendable Memory:
  1. L1 cache
  2. L2 cache

20. Write any four I/O devices

- Printer, Scanner, Monitor, Keyboard

21. What is CSMA/CD?

- The Ethernet arbitration scheme is known as Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
- A node that has a message waits for the bus to become silent and then starts transmitting. It simultaneously listens, and if it hears another transmission that interferes with its transmission, it stops transmitting and waits to retransmit.
- The main aim of CSMA/CD technique is to avoid congestion and collision during transmission.

22. What are the uses of test Bench Code Program in debugging?

The test bench generates inputs to simulate the actions of the input devices; it may also take the output values and compare them against expected values, providing valuable early debugging help.

23. Name any two techniques used to optimize execution time of a program. (NOV/DEC 2012)

1. Compiler
2. Scheduling

24. What does a linker do? (NOV/DEC 2012)

A linker allows a program to be stitched together out of several smaller pieces. The linker operates on the object files created by the assembler and modifies the assembled code to make the necessary links between files.

25. What are CPU Buses? (NOV/DEC 2013)

The bus is the mechanism by which the CPU communicates with memory and devices. One of the major roles of the bus is to provide an interface to memory. A bus is at a minimum, a collection wires, but the bus also defines a protocol by which the CPU, memory, and devices communicate.

26. List out the various compilation techniques. (NOV/DEC 2013)

1. Machine independent optimization
2. Instruction-level optimizations and code generation.

27. What are different CPU buses? State the function of each one. (MAY/JUNE 2013)

1. DMA Bus-it is a bus operation that allows reads and writes not controlled by the CPU.DMA transfer is controlled by a DMA controller, which requests control of the bus from the CPU. After gaining control, the DMA controller performs read and write operations directly between devices and memory.
2. High-speed buses may provide wider data connections.
3. A high-speed bus usually requires more expensive circuits and connectors. The cost of low speed devices can be held down by using a lower speed, lower-cost bus.
4. AMBA BUS (ARM BUS) supports CPUs, memories and peripherals integrated in a system-on-silicon.it includes two buses AHB (AMBA high performance) and APB (AMBA peripherals)

28. State the principle of basic compilation technique. (MAY/JUNE 2013)

The high-level language program is parsed to break it into statements and expressions. In addition, symbol table is generated, which includes all the named objects in the program,

29. What is the bus protocol especially, the four-cycle handshake? (April/May 2014)

- The basic building block of most bus protocols is the four-cycle handshake. The handshake ensures that when two devices want to communicate, one is ready to transmit and other is ready to receive.
- The handshake uses a pair of wires dedicated to the handshake: **enq** (enquiry) and **ack** (acknowledge)

30. What is a data flow graph? (April/May 2014)

A data flow graph is a model of a program with no conditionals. In a high level programming language, a code segment with no conditionals with only one entry and exit point is known as basic block.

31. What is memory map input-output interface? (April/May 2015)

Some I/O devices are designed to interface directly to a particular bus, forming glueless interfaces. But glue logic is required when a device is connected to a bus for which it is not designed.

32. What is need for Bus Arbitration? (April/May 2015)

A process by which the current bus master accesses the bus and then leaves the control of bus and passes it to another bus –requesting processor unit.

PART-B

1. Write short notes on
   (a) Basic compilation techniques with process diagram (8 Marks) (APR/MAY 2015)
   (b) Program validation and testing (8 Marks) (MAY/JUNE 2013)
2. Write short notes on Components interfacing. (8 Marks) (APR/MAY 2014)
3. How are memory and I/O devices interfaced with a processor? (NOV/DEC2012)
4. Explain about how assembler helps in the development of program design? (NOV/DEC2012)
5. With a suitable example, how debugging is carried out using debuggers and compilers. (NOV/DEC2012)
6. How is a program tested for its validity? Explain. (6 Marks) (NOV/DEC2012)
7. Explain briefly about debugging and compilation process. (16 Marks) (APR/MAY 2014)
8. Describe about memory devices with suitable examples. (16 Marks) (NOV/DEC2013)
9. What do you mean by Model of programs? Explain. (8 Marks) (APR/MAY 2015)
10. Explain about assembly and linking with examples. (16 Marks) (NOV/DEC2013)
11. Explain the debugging techniques used in embedded system. (8 Marks) (MAY/JUNE 2013)
12. Describe the System Bus configuration and explain the bus protocol. (8 Marks) (MAY/JUNE 2013)
13. Describe the basic types of memory components commonly used in embedded systems. (8 Marks) (APRIL 2016).
14. Explain the challenges and techniques used for embedded system debugging (8 Marks) (APRIL 2016)
15. Discuss in detail the program level embedded system performance analysis and explain the optimization of program level energy, power and program size. (8 Marks) (APRIL 2016)

UNIT- 3
PROCESS AND OPERATING SYSTEMS
PART - A

1. Mention the elements of C program.

1. Files:
   - Header files, Source files, Configuration files, Preprocessor directives
2. Functions:
   - Macro function, Main function, Interrupt service routines or device drivers
3. Others:
   - Data types, Data structures, Modifiers, Statements, Loops and pointers

2. What is Context Switching? (NOV/DEC 2012) (NOV/DEC 2013) (APRIL/MAY 2014) (APRIL/MAY 2015)

- It is the computing process of storing and restoring state (context) of CPU so that execution can be resumed from the same point at a later time.
- It is an essential feature of Multi-tasking Operating System.

3. Write any two Advantages of Multi-processor OS

- Since Multi-processor OS is a logical extension of Multi-programming OS many processors are present in the system in which each different processor carry out different function.
- It has the additional property that every memory can be read as fast as every other memory word called uniform memory access multiprocessors.

4. Define process. (NOV/DEC 2013)

A process is a program that performs a specific function.

5. Define (TCB)

The TCB stands for Task Control Block which holds the control of all the tasks within the block. It has separate stack and program counter for each task.

6. What is a thread?

A thread otherwise called a lightweight process (LWP) is a basic unit of CPU utilization, it comprises of a thread id, a program counter, a register set and a stack. It shares with other threads belonging to the same process its code section, data section, and operating system resources such as open files and signals.

7. What are the benefits of multithreaded programming?

The benefits of multithreaded programming can be broken down into four major categories:

- Responsiveness
- Resource sharing
- Economy
- Utilization of multiprocessor architectures

8. Define RTOS.

A real-time operating system (RTOS) is an operating system that has been developed for real-time applications. It is typically used for embedded applications, such as mobile telephones, industrial robots, or scientific research equipment.

9. Define CPU scheduling.

CPU scheduling is the process of switching the CPU among various processes. CPU scheduling is the basis of multi-programmed operating systems. By switching the CPU among processes, the operating system can make the computer more productive.

10. Define Synchronization.

Message passing can be either blocking or non-blocking. Blocking is considered to be synchronous and non-blocking is considered to be asynchronous.

11. Define Inter process communication.

Inter-process communication (IPC) is a set of techniques for the exchange of data among multiple threads in one or more processes. Processes may be running on one or more computers connected by a network. IPC techniques are divided into methods for message passing, synchronization, shared memory, and remote procedure calls (RPC). The method of IPC used may vary based on the bandwidth and latency of communication between the threads, and the type of data being communicated.

12. Define Semaphore.

A semaphore 'S' is a synchronization tool which is an integer value that, apart from initialization, is accessed only through two standard atomic operations; wait and signal. Semaphores can be used to deal with the n-process critical section problem. It can be also used to solve various synchronization problems.

The classic definition of 'wait'

```
wait (S){
        While   (S<=0);
                S--;
         }
```

The classic definition of 'signal' signal (S){

```
         S++;
         }
```

13.What is a semaphore?

Semaphores -- software, blocking, OS assistance solution to the mutual exclusion problem basically a non-negative integer variable that saves the number of wakeup signals sent so they are not lost if the process is not sleeping another interpretation we will see is that the semaphore value represents the number of resources available

14.Give the semaphore related functions.

A semaphore enforces mutual exclusion and controls access to the process critical sections. Only one process at a time can call the function fn.

SR Program: A Semaphore Prevents the Race Condition.

SR Program: A Semaphore Prevents Another Race Condition.

15.When the error will occur when we use the semaphore?

- When the process interchanges the order in which the wait and signal operations on the semaphore mutex.
- When a process replaces a signal (mutex) with wait (mutex).
- When a process omits the wait (mutex), or the signal (mutex), or both.

16.What is priority inheritance?

Priority inheritance is a method for eliminating priority inversion problems. Using this programming method, a process scheduling algorithm will increase the priority of a process to the maximum priority of any process waiting for any resource on which the process has a resource lock.

17.Define Mailbox and Pipe.

Mailboxes are software-engineering components used for interprocess communication, or for inter-thread communication within the same process. A mailbox is a combination of a semaphore and a message queue (or pipe).

18.Define Socket.

A socket is an endpoint for communications between tasks; data is sent from one socket to another.

19.Define Remote Procedure Call.

Remote Procedure Calls (RPC) is a facility that allows a process on one machine to call a procedure that is executed by another process on either the same machine or a remote machine. Internally, RPC uses sockets as the underlying communication mechanism.

20.Define thread cancellation & target thread.

The thread cancellation is the task of terminating a thread before it has completed. A thread that is to be cancelled is often referred to as the target thread. For example, if multiple threads are concurrently searching through a database and one thread returns the result, the remaining threads might be cancelled.

21.What is preemptive and non-preemptive scheduling?

- Under non-preemptive scheduling once the CPU has been allocated to a process, the process keeps the CPU until it releases the CPU either by terminating or switching to the waiting state.
- Preemptive scheduling can preempt a process which is utilizing the CPU in between its execution and give the CPU to another process.

22. What is a Dispatcher?

The dispatcher is the module that gives control of the CPU to the process selected by the short-term scheduler. This function involves:

- Switching context
- Switching to user mode
- Jumping to the proper location in the user program to restart that program.

23.What are the various scheduling criteria for CPU scheduling?

The various scheduling criteria are

- CPU utilization, Throughput, Turnaround time, waiting time, Response time

24.Define throughput?

Throughput in CPU scheduling is the number of processes that are completed per unit time. For long processes, this rate may be one process per hour; for short transactions, throughput might be 10 processes per second.

25.What is turnaround time?

Turnaround time is the interval from the time of submission to the time of completion of a process. It is the sum of the periods spent waiting to get into memory, waiting in the ready queue, executing on the CPU, and doing I/O.

26.Define race condition.

When several process access and manipulate same data concurrently, then the outcome of the execution depends on particular order in which the access takes place is called race condition. To avoid race condition, only one process at a time can manipulate the shared variable.

27.What is critical section problem?

Consider a system consists of 'n'processes. Each process has segment of code called a critical section, in which the process may be changing common variables, updating a table, writing a file. When one process is executing in its critical section, no other process can allowed executing in its critical section.

28. What are the requirements that a solution to the critical section problem must satisfy?

The three requirements are

- Mutual exclusion
- Progress
- Bounded waiting

29.Define deadlock.

A process requests resources; if the resources are not available at that time, the process enters a wait state. Waiting processes may never again change state, because the resources they have requested are held by other waiting processes. This situation is called a deadlock.

30. What are conditions under which a deadlock situation may arise?

A deadlock situation can arise if the following four conditions hold simultaneously in a system:

- Mutual exclusion
- Hold and wait
- No pre-emption
- Circular wait

31.What does a scheduler do in an operating system environment? (NOV/DEC 2012)

CPU scheduling is the process of switching the CPU among various processes. CPU scheduling is the basis of multi-programmed operating systems. By switching the CPU among processes, the operating system can make the computer more productive.

32.List the various scheduling policies. (MAY/JUNE2013)

- CPU utilization
- Throughput
- Turnaround time
- Waiting time
- Response time

33.What are the power optimization strategies used for processes? (MAY/JUNE2013)(APRIL 2016)

The RTOS and system architecture can use static and dynamic power management mechanisms to help manage the systems power consumption. A power management policy is a strategy for determining when to perform certain power management operations.

34.What are major inter process communication mechanisms? (APRIL/MAY 2014)

- Shared memory communication
- Message passing
- Signals

PART-B

1. Explain the concepts of multiprogramming, multiprocessing and time sharing operating systems
2. Assume the following workload in a system. All jobs arrive at time 0ms in the order given

JOB	BURSTTIME(or) PROCESS TIME in ms	PRIORITY
A	8	2
B	4	1
C	5	4
D	2	2
E	1	3

   (i) Draw a Gantt chart illustrating the execution of these job using FCFS, R (quantum=4ms), Priority and SJF CPU scheduling
   (ii) Calculate the average waiting time and average turnaround time for each of the above
3. (a) (i). Explain the process state diagram
   (ii). How to evaluate the operating system performance
   (iii) Write short notes on Co-operative scheduling. (4 Marks) (APR/MAY2015)
4. Write a detailed note on interprocess communication mechanisms. (16 Marks) (NOV/DEC2013) (APR/MAY2015)
5. Discuss any two scheduling policies used in multiprocess environment. (16 Marks) (NOV/DEC2012) (APRIL 2016)
6. Discuss about multiple process and interprocess communication mechanisms. (16 Marks (NOV/DEC2012) (APRIL 2016)
7. Explain the principle of priority based context switching mechanism. Discuss about the various priority based scheduling algorithms. (16 Marks) (MAY/JUNE2013)
8. Explain power Management and optimization strategies for processes. (16 Marks) (APR/MAY2014)
9. Explain Multiprocessor and operating systems in detail.
10. Discuss in detail about power optimization strategies for CPU operation. (16 Marks) APR/
11. Discuss in detail about multitasks and multi processes. (16 Marks) (NOV/DEC2013) (APRIL 2016)
12. Explain the services of operating system in handling multiprocess scheduling and communication. (16 Marks) (APR/MAY2014)

UNIT – 4
SYSTEM DESIGN TECHNIQUES AND NETWORKS
PART-A

1. Define Speed up

It is defined as the efficiency of a system how much faster is the system with accelerator termed as speed up.

2. What are the factors for the bus transactions in the accelerators?

- Time required to flush any registers or cache values of main memory
- Time required for transfer of control between CPU and accelerator

3. What are the different components of distributed Embedded Systems?

- Sensors/Actuators, 16 bit CPU, DSP, ASIC, Microcontrollers

4. What are the seven layers of OSI MODEL?

- Physical, Data link, Network, Transport, Session, Presentation, Application

5. What is meant by OSI MODEL?

To provide high level of services with many of details of transmission from other components of system, international standards of networks and ISO developed 7 layers model called open source interconnection model.

6. What is fixed priority arbitration?

FPA is a scheme which gives priority to competing device in the same way. If a high priority and a low priority both have long data transmission ready to same time, low priority is disable until high priority proceeds.

7. What are the advantages of distributed embedded systems?

- Used to help diagnose problems in another part
- Isolating the error to one part of the system

8. Define distributed system

Building of embedded system with several PE s taking over a network is more complex to perform the same task but it is used to communicate physically separated and carry the data to a distant such a system is called as distributed system

9. Summarize the goals of design process

Manufacturing cost, Performance, Power consumption, Time to market, Design cost, Quality

10. Define design flow

A design flow is a sequence of steps to be followed during design. Some of the steps can be performed by tools, such as compilers or CAD systems, others steps can be performed by hand.

(i)Waterfall model of software development, (ii) The spiral model of software design

11. What are the different types of interconnect networks?

- I^2C bus for microcontroller based system, CAN for automotive electronics, Ethernet and variations of standard Ethernet

12.What is requirement and types of requirements for system design?

Requirements are informal descriptions of what the customer wants, the goal of creating a requirements document is effective communication between the customers and the designers.

(i) Functional requirements, (ii) Nonfunctional requirements

13. Define quality assurance

The quality of a product or service can be judged by how well it satisfies its intended function. The quality assurance process is vital for the delivery of satisfactory system. The international standards organization (ISO) has created a set of quality standards known as ISO 9000.

14. What are the applications of internet protocol?

- Laser printer, Web pages, To read email, To know information about the computer, Remote monitoring, CC TV and so on

15. What are merits of distributed embedded architecture? (Nov/Dec 2012) (April/May 2014)

An important merit of a distributed system with several CPUs is that one part of the system can be used to help diagnose problems in another part.

16. What do you mean by hardware accelerator? (Nov/Dec 2013) (APRIL 2016)

One important category of PE for embedded multiprocessor is the accelerator. An accelerator is attached to CPU buses to quickly execute certain key functions. Accelerators can provide large performance increases for applications with computational kernels that spend a great deal of time in a small section of code. Accelerators can also provide critical speedups for low-latency I/O functions.

17. State the advantages of network based design. (Nov/Dec 2013)

- Low cost
- Lower priority communications can be handled separately without interfacing with high priority communications on the primary network.

18. What is CMM?

CMM is a one way of measuring the quality of an organizations software development process, it was developed by Carnegie Mellon university software engineering institute. It provides a model for judging an organization.

19. State the important requirements to develop Network based embedded systems. (May/June 2013)

Single hop networks, Multihop networks, Scheduling and allocation of communication are important additional design tasks required for many distributed networks.

20. List the OSI layers from lowest to highest level of abstraction. (April/May 2014)

1. Physical layer, 2. Data link, 3. Network, 4. Transport, 5. Session, 6. Presentation, 7. Application

21. State the needs of accelerators. (April/May 2015) (May/June 2013)

An accelerator is attached to CPU buses to quickly execute certain key functions. Accelerators can also provide critical speedups for low-latency I/O functions.

22. What do you mean by network based design? (April/May 2015) (APRIL 2016)

If there is more than one network, we must allocate communications to the networks. we may establish multiple networks so that Lower priority communications can be handled separately without interfacing with high priority communications on the primary network.

PART – B

1. Discuss about various networks used for embedded system with an example. (NOV/DEC2013) (APRIL 2016)
2. Explain about distributed embedded architectures with an example. (NOV/DEC2012/2013)
3. Explain about MPSoCs and shared memory multiprocessors.
4. Explain the Accelerated system design. List its advantages. (MAY/JUNE2013)
5. Explain how requirements specifications system design architecture are integrated in the embedded system design.
6. Write a note on Accelerators and Network Based System Design. (NOV/DEC2012)
7. Explain in detail about accelerator and its system design. (MAY/JUNE2013)
8. Explain any one type of network used for embedded system design. (MAY/JUNE2013)
9. Explain Networks for embedded systems and Internet enabled embedded system. (APRIL 2014) (APRIL 2016)
10. Discuss about various quality assurance techniques.
11. Explain the operation and advantages of CPU Accelerated systems. (APRIL 2016)

UNIT- 5
CASE STUDY
PART-A

1. Define data compressor.

Data compressor techniques are available to meet the specific needs of most of applications. It falls into two main categories, lossy and lossless compression.

2. Define software modem.

Soft modem or software modem is a modem with minimal hardware capacities, designed to use a host computers resources to perform most of the tasks performed by dedicated hardware in a traditional modem.

3. What is a PDA? (APRIL/MAY 2014)

PDA (personal digital assistant) is a portable computing machine. Like notebook PC, PDA can run a wide variety of applications.

4. What are the subsystems of PDA?

(i) Process/memory, (ii) User interface, (iii) Connectivity, (iv) Power management unit

5. What is a STB? (APRIL/MAY 2014)

STB (Set Top Box) is an integral part of TV viewed in many parts of the world. It is very complex embedded system consisting of 30+ hardware blocks and similar number of software drivers.

6. List out some STB blocks.

(i) RAM
(ii) Satellite
(iii) RF modulator
(iv) Power supply
(v) Smart card
(vi) Flash

7. What is SOC?

SOC (System on a Chip) or SOC (System on Chip) is an integrated circuit (IC) that integrates all components of a computer or other electronic system into a single chip.

8. List out the applications of software modem.

(i) Mode emulation
(ii) Remote wake up
(iii) Device monitor

9. List out the examples of hardware co-systems.

TV, ATM machines, Automobiles, Aircrafts, Satellites, Consumer electronics, Network routers, Thermostats.

10. List the major components in the PDA systems. (May/June 2013)

Memory, Display, Power management unit.

11. What are FOSS Tools? (Nov/ Dec 2013) (May/June 2013)

Free and open source software is computer software that can be classified as both free software and open-source software that is anyone is freely licensed to use, copy, study and change the software in any time, and the source code is openly shared so that people are encouraged to voluntarily improve the design of the software.

12. Write short notes on Hardware and Software Co-design. (Nov/ Dec 2013) (APRIL 2016)

Embedded computing is unique because it is on hardware and software Co-design problem the hardware and software must be designed together to make sure that the implementation not only but also meets performance, cost and reliability goals.

13. Why are most designers use FOSS tools in embedded system development? (Nov/ Dec 2012)

Free and open source software is computer software that can be classified as both free software and open-source software that is anyone is freely licensed to use, copy, study and change the software in any time, and the source code is openly shared so that people are encouraged to voluntarily improve the design of the software. So most of the design engineers use FOSS tools.

14.What is audio player and perceptual coding?

Audio players are often called MP3 players after the popular audio data format. although a number of audio compression formats have been developed and are in regular use. Audio compression is a lossy process that relies on perceptual coding. The coder eliminates certain features of the audio stream so that the result can be encoded in fewer bits.

15. Give any two advantages of Data Compressor. (April/May 2015)

- Less disk space
- Faster writing and reading
- Faster file transfer
- Variable dynamic range
- Byte order independent

16. List the major steps involved in compression process for JPEG

- Color space conversion
- Color down sampling
- Block -based discrete cosine transform(DCT)
- Quantization
- Entropy coding

17.How to measure the performance of digital camera.

- Determine the exposure and focus
- Capture image
- Develop the image
- Compress the image
- Generate and store the image as a file.

18.What is luminance and chrominance?

The image is divided into pixels, a pixel's brightness is often referred to as its luminance, a color pixels' brightness in a particular color is known as chrominance.

19.What is engine control unit?

This unit controls the operation of a fuel injected engine based on several measurements taken from the running engine.

20. Define block motion estimation.

MPEG uses motion to encode one frame in terms of another, rather than send each frame separately, as in motion JPEG, some frames are sent as modified forms of other frames using a technique known as block motion estimation.

PART-B

1. Describe how PDA and Data compressor are designed (NOV/DEC 2012)
2. Discuss about digital still camera.
3. Discuss about Data compressor and system-on-silicon in detail with suitable diagrams. (MAY/JUNE 2013) (NOV/DEC 2013)
4. Explain software modem with neat sketch. (NOV/DEC 2013)
5. Explain embedded hardware and software co-design of the PDA. (APRIL/MAY 2014) (APRIL 2016)
6. With neat block diagram, explain the video accelerator.
7. With neat sketches, explain the entire design of Data compressor based on Huffman coding principle. Also illustrate the Huffman coding with numerical example.
8. Explain Data compressor and Software Modem in detail. (APRIL/MAY 2014)
9. Explain embedded hardware and software co-design INVOLVED IN Software Modem in detail, (APRIL 2016)
10. Explain alarm clock-case study
11. Explain telephone answering machine with suitable diagrams.

Anna University Question Papers

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 51382

B.E./B.Tech. DEGREE EXAMINATION, APRIL 2014.

Eighth Semester

Electronics and Communication Engineering

EC 2042/EC 801 — EMBEDDED AND REAL TIME SYSTEMS

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate top-down and bottom-up design.
2. List the functions of ARM processor in supervisor mode.
3. What is the bus protocols especially, the four-cycle handshake?
4. What is a data flow graph?
5. What are the major inter process communication mechanisms?
6. Define context switching.
7. List the OSI layers from lowest to highest level of abstraction
8. What is a distributed embedded architecture?
9. What is a PDA?
10. What is a set —top box?

PART B — (5 × 16 = 80 marks)

11. (a) Explain in detail the operation of ARM processor and coprocessor. (16)

Or

(b) (i) With a simple system namely, a model train controller, how will you use the UML to model systems? (8)

(ii) Explain the operation of the BL instruction, including the state of ARM registers before and after its operation. (4)

(iii) How do you return from an ARM procedure? (4)

12. (a) (i) Explain the component interfacing. (8)

(ii) Explain the memory devices. (8)

Or

(b) (i) Describe the basic compilation techniques. (8)

(ii) Explain the debugging process. (8)

13. (a) Explain the services of operating system in handling multiprocess scheduling and communication. (16)

Or

(b) Discuss the power management and optimization for processes. (16)

14. (a) Discuss about Accelerator based Embedded system and network based Embedded systems. (16)

Or

(b) Explain networks for embedded systems and Internet-enabled embedded system. (16)

15. (a) Write short notes on the following : (8 + 8)

(i) Data compressor

(ii) Software modem.

Or

(b) (i) Explain the FOSS tools for embedded system development. (8)

(ii) Explain Embedded Hardware and software co-design. (8)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 11310

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2012.

Eighth Semester

Electronics and Communication Engineering

EC 2042/EC 801 — EMBEDDED AND REAL TIME SYSTEMS

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is function of exceptions?

2. How is ARM processor different from other processors?

3. Name any two techniques used to optimize execution time of a program.

4. What does a linker do?

5. What is context switching?

6. What does a scheduler do in an operating system environment?

7. What are the merits of embedded distributed architecture?

8. What is the role played by the accelerator in the design of embedded system?

9. Differentiate between Hardware and Software Co-Design.

10. Why are most designers use Foss tools in embedded system development?

PART B — (5 × 16 = 80 marks)

11. (a) Describe the various stages involved in the design of train controller.

Or

(b) Write in detail about the organisation of ARM processor and co-processor.

12. (a) (i) How are memory and I/O devices interfaced with a processor? (10)

(ii) Explain about how assembler helps in the development of program design. (6)

Or

(b) (i) With a suitable example explain how debugging is carried out using Debuggers and compilers. (10)

(ii) How is a program tested for its validity? Explain. (6)

13. (a) Discuss about multiple process and interprocess communication mechanisms.

Or

(b) Describe any two scheduling policies used in multiprocess environment.

14. (a) Write a note on Accelerators and Network Based System Design.

Or

(b) Discuss about Internet enabled systems and architecture of distributed embedded systems.

15. (a) Describe how PDA and Data compressor are designed.

Or

(b) Discuss about software MODEM and System – on – silicon.

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Reg. No. : [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

Question Paper Code : 21340

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Eighth Semester

Electronics and Communication Engineering

EC 2042/EC 801 — EMBEDDED AND REAL TIME SYSTEMS

(Regulation 2008)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the Instruction set features useful for embedded programming?
2. What are the parameters used to evaluate the CPU performance?
3. What are the different CPU buses? State the function of each one.
4. State the principle of basic complication technique.
5. List the process scheduling policies.
6. What are the power optimization strategies used for processes?
7. What is the use of attaching accelerator to CPU?
8. State the important requirements to develop Network based embedded systems.
9. List the major components in the Personal Digital Assistants System.
10. What are FOSS Tools?

PART B — (5 × 16 = 80 marks)

11. (a) Explain in detail the design steps of Modern Train controller with suitable diagrams. (16)

Or

(b) (i) Describe the structural and Behavioral descriptions of methods used for designing an embedded system. (8)

(ii) Explain the ARM process or features and modes of operations. (8)

12. (a) (i) Describe the system bus configuration and explain the bus protocol. (8)

(ii) Explain the debugging techniques used in embedded system. (8)

Or

(b) (i) Discuss in detail the fundamental model used for program development. (8)

(ii) Describe the techniques used for Program Validation and Testing. (8)

13. (a) Explain the principle of priority based context switching mechanism. Discuss about the various priority based scheduling algorithms. (16)

Or

(b) Explain in detail how shared memory and message passing mechanisms are used for Inter process communication. (16)

14. (a) (i) Explain the Accelerated system design. List its advantages. (8)

(ii) Explain any one type of network used for embedded system design. (8)

Or

(b) Explain how Internet can be used by embedded computing systems. (16)

15. (a) Explain the Hardware and Software design for Set-Top-Box. (16)

Or

(b) Discuss about the design of Data compressor and System-on-Silicon. (16)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 31340

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

Eighth Semester

Electronics and Communication Engineering

EC 2042/EC 801 – EMBEDDED AND REAL TIME SYSTEMS

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Enumerate various issues in real time computing.
2. Write short notes on ARM processor.
3. What are CPU buses?
4. List out the various compilation techniques.
5. Define : Processes.
6. What is context switching?
7. What do you mean by hardware accelerator?
8. State the advantages of network based design.
9. Write short notes H/W and S/W Co-design.
10. What are FOSS tools for Embedded Systems?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Explain about the Embedded system design process with suitable diagrams. (10)

(ii) What are instruction set preliminaries. (6)

Or

(b) (i) Discuss in detail about coprocessor. (12)

(ii) What do you mean by CPU performance? (4)

12. (a) Describe about Memory devices with suitable examples. (16)

Or

(b) Discuss in detail about assembly and linking with examples. (16)

13. (a) Discuss in detail about multi tasks and multi processes. (16)

Or

(b) Explain about inter process communication mechanism with neat sketch. (16)

14. (a) Discuss in detail about distributed embedded architecture with neat sketches. (16)

Or

(b) Explain in detail about networks for embedded systems with an example. (16)

15. (a) Discuss about data compressor in detail with suitable diagrams. (16)

Or

(b) Explain about Software modem with neat sketch. (16)

Question Paper Code : 71425

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Eighth Semester

Electronics and Communication Engineering

EC 2042/EC 801 — EMBEDDED AND REAL TIME SYSTEMS

(Regulation 2008)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Give two features that differ a general purpose Microcontroller from an embedded processor.

2. What are the factors which governs the performance of a CPU?

3. What is 'memory map' input-output interface?

4. What is need for Bus Arbitration?

5. How is a Real Time operating systems uniquely different than a general purpose OS?

6. What is Context Switching ?

7. State the needs of accelerators.

8. What do you mean by network based design?

9. What is hardware and software co-design?

10. Give any two advantages of Data Compressor.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Explain the Model Train Controller with neat sketch. (8)

(ii) Discuss about formalism for system design. (8)

Or

(b) What are the parameters to be considered while designing an Embedded System design process? Explain. (16)

12. (a) (i) Describe need for ICE, JTAG for embedded system development. (12)

(ii) What is advantage of vectored addressing of stack? (4)

Or

(b) (i) What do you mean by Model of programs? Explain. (8)

(ii) Describe about basic compilation techniques. (8)

13. (a) (i) Describe in detail about the Inter Process Communication mechanisms. (12)

(ii) Write short notes on Co-operative scheduling. (4)

Or

(b) Discuss in detail about power optimization strategies for CPU operation. (16)

14. (a) Explain about distributed embedded architecture with suitable examples. (16)

Or

(b) Describe about Internet enabled systems in detail. (16)

15. (a) (i) Justify through two features on how system on chip design is useful? (4)

(ii) Enumerate some of the FOSS tools for embedded system development and explain. (12)

Or

(b) Write short notes on :

(i) PDAs (8)

(ii) Set-Top Box. (8)

Question Paper Code : 52578

B.E/B.Tech. DEGREE EXAMINATION, APRIL 2016

Eighth Semester

Electronics and Communication Engineering

EC2042 / EC 801 – EMBEDDED AND REAL TIME SYSTEMS

(Regulations 2008)

Time : Three Hours **Maximum : 100 Marks**

Answer ALL questions.

PART – A (10 × 2 = 20 Marks)

1. Why embedded computing is more suitable for real time systems ?
2. List the major functions of CPU in Supervisor mode.
3. Show the structure of a typical CPU bus which supports Read/Write.
4. How the program validation can be done ?
5. Define the process states : Waiting, Ready, Executing.
6. What are the strategies used for the power optimization in Multi processing ?
7. Justify that an Accelerator is not a Coprocessor.
8. Why do we build network based embedded systems ?
9. What is the need for Hardware and Software codesign for a Data compressor ?
10. What are POSS tools ?

PART – B (5 × 16 = 80 Marks)

11. (a) (i) Write in detail about the steps in Embedded system design process. (8)

(ii) Explain the operation of ARM processor. (8)

OR

(b) Explain in detail the memory system mechanism and CPU performance in a Coprocessor system. **(16)**

12. (a) (i) Describe the basic types of memory components commonly used in embedded systems. **(8)**

(ii) Explain the challenges and techniques used for embedded system debugging. **(8)**

OR

(b) Discuss in detail the program level embedded system performance analysis and explain the optimization of program-level energy, power and program size. **(16)**

13. (a) (i) Explain how the multiple tasks and multiple processes are handled in embedded computing systems. **(8)**

(ii) Explain the various process scheduling policies. **(8)**

OR

(b) Explain in detail how the interprocess communication is provided by Operating System using shared memory and message passing mechanisms. **(16)**

14. (a) (i) Explain the operation and advantages of CPU Accelerated Systems. **(8)**

(ii) Explain the features and applications of Internet enabled embedded systems. **(8)**

OR

(b) Discuss in detail about the several interconnected networks used especially for distributed embedded computing. **(16)**

15. (a) Explain in detail about the hardware and software design of the Personal digital assistants. **(16)**

OR

(b) Explain the hardware and software design involved in Software Modem in detail. **(16)**

Reg. No. :

Question Paper Code : 80354

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Seventh Semester

Electronics and Communication Engineering

EC 6703 — EMBEDDED AND REAL TIME SYSTEMS

(Common to Biomedical Engineering and Computer Science and Engineering)

(Regulations 2013)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Enumerate some embedded computers that are exists from origin of the embedded systems.

2. In what way Interrupts differ from Exceptions?

3. Compare Static and Dynamic RAM.

4. What is Data Flow Graph and Control/Data Flow Graph (CDFG)?

5. Define tasks and processes.

6. Write about scheduling states present in the embedded system design.

7. What do you mean by quality and quality assurance related to embedded systems?

8. Give examples of internet enabled system.

9. Specify the MPEG layer 1 data frame format set for the audio player application.

10. What are the classes in data compressor?

PART B — (5 × 16 = 80 marks)

11. (a) (i) How CPU performance is affected? Explain them with example instructions. (8)

(ii) Analyze the requirements for designing a GPS moving map in embedded system design process. (8)

Or

(b) (i) How are the conceptual specifications and detailed specifications written in UML language to design the Model train controller. (8)

(ii) How memory management is done for an embedded system processor in order to manage multiple programs in a single physical memory? (8)

12. (a) (i) Explain in detail the testing process involved in developing an embedded system. (8)

(ii) Describe how embedded system is useful in competing with computing platform. (8)

Or

(b) (i) Explain the various debugging techniques in the development of embedded system. (8)

(ii) Discuss in detail the optimization of energy and power of an embedded system. (8)

13. (a) (i) Describe why automobile engines require a multi-rate control. (8)

(ii) Explain the example real time operating system called windows CE in detail. (8)

Or

(b) (i) Explain in detail rate monotonic scheduling with an example. (8)

(ii) Discuss in detail multitasking and multiprocessing. (8)

14. (a) Briefly discuss about the design methodologies for an embedded computing system. (16)

Or

(b) (i) Discuss in detail about the network based embedded system design. (8)

(ii) Write notes on internet enabled systems. (8)

15. (a) Explain the hardware and software design of software modem and telephone answering machine. (16)

Or

(b) Write in detail about the embedded concepts in the design of data compressor and video accelerator. (16)

EC6004 SATELLITE COMMUNICATION L T P C
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UNIT I SATELLITE ORBITS 9

Kepler's Laws, Newton's law, orbital parameters, orbital perturbations, station keeping, geo stationary and non Geo-stationary orbits – Look Angle Determination- Limits of visibility –eclipse-Sub satellite point –Sun transit outage-Launching Procedures - launch vehicles and propulsion.

UNIT II SPACE SEGMENT AND SATELLITE LINK DESIGN 9

Spacecraft Technology- Structure, Primary power, Attitude and Orbit control, Thermal control and Propulsion, communication Payload and supporting subsystems, Telemetry, Tracking and command. Satellite uplink and downlink Analysis and Design, link budget, E/N calculation-performance impairments-system noise, inter modulation and interference, Propagation Characteristics and Frequency considerations- System reliability and design lifetime

UNIT III EARTH SEGMENT 9

Introduction – Receive – Only home TV systems – Outdoor unit – Indoor unit for analog (FM) TV – Master antenna TV system – Community antenna TV system – Transmit – Receive earth stations – Problems – Equivalent isotropic radiated power – Transmission losses – Free-space transmission – Feeder losses – Antenna misalignment losses – Fixed atmospheric and ionospheric losses – Link power budget equation – System noise – Antenna noise – Amplifier noise temperature – Amplifiers in cascade – Noise factor – Noise temperature of absorptive networks – Overall system noise temperature – Carrierto- Noise ratio – Uplink – Saturation flux density – Input back off – The earth station - HPA – Downlink – Output back off – Satellite TWTA output – Effects of rain – Uplink rain– Fade margin – Downlink rain – Fade margin – Combined uplink and downlink C/N ratio – Inter modulation noise.

UNIT IV SATELLITE ACCESS 9

Modulation and Multiplexing: Voice, Data, Video, Analog – digital transmission system, Digital video Brocast, multiple access: FDMA, TDMA, CDMA, Assignment Methods, Spread Spectrum communication, compression – encryption

UNIT V SATELLITE APPLICATIONS 9

INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, Satellite Navigational System. Direct Broadcast satellites (DBS)- Direct to home Broadcast (DTH), Digital audio broadcast (DAB)- Worldspace services, Business TV(BTV), GRAMSAT, Specialized services – E –mail, Video conferencing, Internet

TOTAL PERIODS: 45

TEXT BOOKS:

T1. Dennis Roddy, "Satellite Communication", 4th Edition, Mc Graw Hill International, 2006.

REFERENCES:

R1. Wilbur L.Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, "Satellite Communication Systems Engineering", Prentice Hall/Pearson, 2007

R2. N.Agarwal, "Design of Geosynchronous Space Craft", Prentice Hall, 1986

R3. Bruce R. Elbert, "The Satellite Communication Applications", Hand Book, Artech House Bostan London, 1997

R4. Tri T. Ha, "Digital Satellite Communication", II nd edition, 1990.

R5. Emanuel Fthenakis, "Manual of Satellite Communications", Mc Graw Hill Book Co., 1984

R6. Robert G. Winch, "Telecommunication Trans Mission Systems", Mc Graw-Hill Book Co., 1983

R7. Brian Ackroyd, "World Satellite Communication and earth station Design", BSP professional Books, 1990

R8. G.B.Bleazard, "Introducing Satellite communications", NCC Publication, 1985.

R9. M.Richharia, "Satellite Communication Systems-Design Principles", Macmillan 2003

UNIT-I
SATELLITE ORBITS
PART A

1. State Kepler's third Law. (Nov/Dec2015)

- Kepler's third law states that the square of the periodic time of orbit is proportional to the cube of the mean distance between the two bodies.
- The mean distance is equal to the semi major axis a. For the artificial satellites orbiting the earth, Kepler's third law can be written in the form a3 = μ / n2
- Where n is the mean motion of the satellite in radians per second and μ is the earth's geocentric gravitational constant.

2. Define Apogee and Perigee. (April / May 2015)

- **Apogee :** The point on the elliptical orbit, which is the farthest from the center of the earth. Apogee distance ha = a(1+e)
- **Perigee :It is the** point on the orbit that is nearest to earth. The perigee distance for a elliptical orbit is given by hp = a(1-e);

Where e – eccentricity of the orbit. A – semi major Axis.

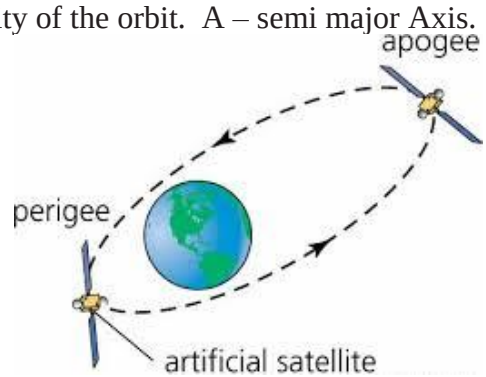

Figure : Apogee and Perigee

3. Write the equation for total energy of a satellite for a two body system. (Nov/Dec2015)

$$E_{tot} = \frac{1}{2}m_1\dot{\mathbf{x}}_1^2 + \frac{1}{2}m_2\dot{\mathbf{x}}_2^2 + U(\mathbf{r}) = \frac{1}{2}(m_1+m_2)\dot{\mathbf{R}}^2 + \frac{1}{2}\mu\dot{\mathbf{r}}^2 + U(\mathbf{r})$$

Where $\mathbf{m}_1$ and $\mathbf{m}_2$ are their masses and **r** their distance

4. List out the frequency bands used for satellite services. (April / May 2015)

Frequency range,	(GHz) Band designation
0.1–0.3	VHF
0.3–1.0	UHF
1.0–2.0	L
2.0–4.0	S
4.0–8.0	C
8.0–12.0	X
12.0–18.0	Ku
18.0–27.0	K
27.0–40.0	Ka

5. What are the features of Polar orbiting satellite. (May /June 2014)

- Polar orbiting satellites are satellites which orbit the earth in such a way to cover the north and south Polar Regions.
- They are used for environmental monitoring and search and rescue services.
- Since the orbit is lower than the Geostationary satellites, the data resolution is higher.
- They provide global coverage for climatic studies.

6. Define right ascension of ascension node. (May /June 2014)

- To define completely the position of the orbit in space, the position of the ascending node is specified.
- However, because the earth spins, while the orbital plane remains stationary, the longitude of the ascending node is not fixed, and it cannot be used as an absolute reference.
- However, for an absolute measurement, a fixed reference in space is required. The reference chosen is the first point of Aries, otherwise known as the vernal, or spring, equinox.
- The vernal equinox occurs when the sun crosses the equator going from south to north, and an imaginary line drawn from this equatorial crossing through the center of the sun points to the first point of Aries.

7. Calculate the radius of a circular orbit for which the period is 1 day.(Nov/Dec 2014)

Given : 1 day.

$$\omega = \frac{2\pi}{1\ day} = 7.272\ 10^{-5}\ rad/\sec$$

Using $\mu - 3.986005 \times 10^{14}\ m^3/s^2$

$$\therefore a = \left(\frac{\mu}{\omega^2}\right)^{1/3} = 42241\ldots\ km$$

8. What is prograde orbit? (Nov/Dec 2014)

- An orbit in which the satellite moves in the same direction as the earth's rotation.
- The prograde orbit is also known as a direct orbit.
- The inclination of a prograde orbit always lies between 0°and 90°.
- Most satellites are launched in a prograde orbit because the earth's rotational velocity provides part of the orbital velocity.

9. How is the world divided to facilitate frequency planning for satellite services? (May/June 2013)

The world is divided in to three regions

- Region1: Europe, Africa,(formerly the Soviet Union)and Mongolia
- Region 2: North and South America and Greenland
- Region3: Asia, Australia, and the south- west Pacific

10. What are Julian Dates? (May/June 2013)

- Calendar times are expressed in UT, and although the time interval between any two events may be measured as the difference in their calendar times, the calendar time notation is not suited to computations where the timing of many events has to be computed.
- What is required is a reference time to which all events can be related in decimal days. Such a reference time is provided by the Julian zero time reference, which is 12 noononJanuary1intheyear4713 B.C.
- The important point is that ordinary calendar time are easily converted to Julian dates, measured on a continuous timescale of Julian days.

11. Define orbital Parameters.

In order to mention the position of the Earth orbiting satellites some parameters are used and these are termed as orbital parameters. They are

- Semi Major Axis, Eccentricity, Mean Anomaly, Inclination, Argument of Perigee & Right Ascension of Ascending Node

12. What are the Orbital Perturbations?

The Keplerian orbit is ideal; it assumes that the earth is a uniform spherical mass resulting from the satellite motion balancing the gravitational pull of the earth. But in practical Some disturbance and forces are changes the orbital positions.

- They are the gravitational forces of the sun and the moon and atmospheric drag.
- The gravitational pulls of sun and moon have negligible effect on low-orbiting satellites, but they do affect satellites in the geostationary orbit.
- Atmospheric drag, on the other hand, has negligible effect on geostationary satellites but does affect low- orbiting earth satellites below about 1000 km.

13. How to represent the geocentric-equatorial coordinate system?

- The geocentric-equatorial coordinate system is an inertial system of axes, the-reference line being fixed by the fixed stars.
- The reference line is the line of Aries. This is a very slow rotation.
- With the origin lying at the center of the earth, as would be used for close in terrestrial satellites, a geocentric system is obtained.
- Two geocentric coordinate systems are called equatorial or elliptic depending on whether the plane of the elliptic is used as respective reference plane.

14. What is sub satellite point?

- The sub satellite point is the location on the surface of the earth that lies directly between the satellite and the centre of the earth.

Figure shows the meridian plane which cuts the sub satellite point.

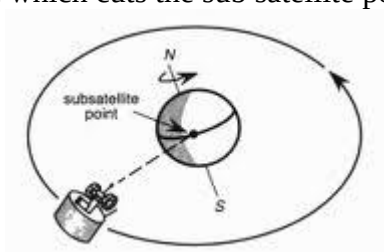

Figure : Sub Satellite Point

15. Define sidereal Day.

- The sidereal day is defined as one complete rotation of the earth relative to the fixed stars.
- One sidereal day has 24 sidereal hours,1 sidereal hour has 60 sidereal minutes and 1 sidereal minutes has 60 sidereal seconds. Generally, a sidereal day has 23h, 56 min.

16. Write the advantages of Geo Stationary orbit.

Advantages of Geo Stationary orbit are

- Tracking equipment avoided
- Earth stations at constant distance and remain at line of sight
- Larger coverage area

- Global coverage with less no. of satellites.
- Same quality of service at all places
- No Doppler shift, Cost effective.

18. How the satellites are affected due to Atmospheric drag?

- For near-earth satellites, below about 1000 km, the effects of atmospheric drag are significant.
- Because the drag is greatest at the perigee, the drag acts to reduce the velocity at this point, with the result that the satellite does not reach the same apogee height on successive revolutions.
- The result is that the semi major axis and the eccentricity are both reduced. Drag does not noticeably change the other orbital parameters, including perigee height.

19. What are the basic concepts determining the look angles and its ranges?

The coordinates to which the earth station antenna must be pointed to communicate with a satellite are called look angles, the following concepts determines the look angle.

- Orbital elements.
- Various measures of time.
- The peri-focal coordinate system, which is based on the orbital plane.
- The geocentric-equatorial coordinate system, which is based on the earth's equatorial plane.
- The topo centric- horizon coordinate system, which is based on the observer's horizon plane.

20. What are Look angles? Define Them.

- The coordinates to which the earth station antenna must be pointed to communicate with a satellite are called look angles.
- These are most commonly specified as Azimuth and Elevation angles.
  Azimuth Angle:It is defined as horizontal pointing angle of an earth station antenna.
  Elevation Angle:It is the vertical angle formed between direction of travel of an EM wave radiated from and earth station antenna pointing directly towards a satellite and the horizontal plane.

21. Write the advantages and disadvantages of Satellite Communication.

A Satellite is a physical object that revolves around some celestial body. A satellite which is used for communication purpose is called communication satellites. The advantages and disadvantages are as follows

Advantages:

- Wide Area of Coverage.
- Point to Multipoint Links whereas many terrestrial links are point to point.
- Mobile Communication can be established.
- Economical when long distance is involved.
- For Geo Stationary Satellite Doppler shift is negligible.

Disadvantages:

- Propagation delay is very high.
- Impedance mismatch + Propagation delay produces echo in telephone systems.
- Echo Suppressors or Echo chancellors are to be added so that complexity Increases.
- Propagation Delay reduces the efficiency of the data transmission over satellite communication

22. State Kepler's first and third law.

Kepler's I law:

It states that the path followed by the satellite around the primary will be an ellipse. An ellipse has two focal points F1, & F2. The center of mass of the two body system, termed the barycenter is always centered on one of the foci. The eccentricity, e is,

$$e = \frac{\sqrt{a^2 - b^2}}{a}$$

Kepler's III Law:

It states that the square of the periodic time of orbit is proportional to the cube of the mean distance between the two bodies,

$a^3 = \mu/n^2$

where, n= mean motion of the satellite in rad/sec.

μ = earth's geocentric gravitational constant.

With n in radians per second, the orbital period in second is given by, $P = 2\pi/n$

23. **What is the limit of visibility?**

The east and west limits on the geostationary are of a satellite which are visible from any given station are known as limits of visibility.

PART B

1. (a)Describe the effect of orbit perturbations due to the effect of a non-spherical earth and atmospheric drag.(8) (APRIL /MAY 2015)
   (b)Explain what is meant by apogee height and perigee height. A satellite has an apogee of 39,342 km and a perigee of 613Km. Determine the semi major axis and the eccentricity of its orbit(Earth radius = 6371 km).(8) (APRIL /MAY 2015)
2. (a)Describe the method of finding the position vector R of the Earth relative to the IJK frame. (8) (APRIL /MAY 2015)
   (b)Explain the launching procedure for putting the GEO satellites in the orbit. (8) (Nov/Dec2015)
3. hat are the orbital parameters? Derive the expression for orbital equation of the satellite starting from Newton's law.(16) (Nov/Dec2015)
4. (a)Explain about frequency allocations for satellite services.(8)(MAY /JUNE 2014)
   (b)Explain about U.S.Domsats. (8)(MAY /JUNE 2014)
5. Explain in detail about orbital elements and orbital perturbations with suitable example. (16)(MAY /JUNE 2014)
6. (a)Explain the three Kepler's law with relevant diagrams (6) (NOV/DEC 2014)
   (b)For a particular satellite the eccentricity is 9.5981 x 10^{-3} and the mean anomaly is 204.9779*.The mean motion is 14.2171404 rev/day. The semimajor axis is 7194.9Km calculate the true anomaly and the magnitude of the radius vector 5s after epoch. (6) (NOV/DEC 2014)
   (c)Write a brief note on Julian dates. (4) (NOV/DEC 2014)
7. (a) Explain the orbital perturbations in detail. (8) (NOV/DEC 2014)
   (b)Explain the geometry for determining the sub satellite point with a diagram. (8) (NOV/DEC 2014)
8. (a)Describe the method of finding the position vector R of the Earth relative to the IJK frame. (08) (May/June 2013)
   (b)Calculate the magnitude of the position vector in the PQW frame for the orbit with Ω = 300°, ω=60°,i=65°, rp = -6500 km and rq=4000Km. Calculate also the position vector in the IJK frame and its magnitude. Confirm the magnitude. Confirm the magnitude of r vector unchanged in both frames.(8) (May/June 2013)(April/May 2015)
9. Explain in detail about geocentric-equatorial coordinate system which is based on the earth's equatorial plane. (16)
10. Explain in detail about topocentric-horizon coordinate system which is based on the observer's horizon plane. (16)
11. What is meant by polar orbiting and explain in details. (16)
12. State Kepler's three laws of planetary motion. Illustrate in each case their relevance to artificial satellites orbiting the earth. (16)
13. What are look angles? Explain how look angles are determined using sub satellite pints? Derive the necessary expression for look angles. (16)
14. Give a detailed note on launching vehicles and the procedures employed for launching spacecraft in GEO orbits. (16)

UNIT – 2
SPACE SEGMENT AND SATELLITE LINK DESIGN
PART A

1. Define azimuth angle. (April / May 2015)

The coordinates to which the earth station antenna must be pointed to communicate with a satellite are called look angles.

- Azimuth angle is defined as the horizontal pointing angle of an antenna.
- It is the angle between true (geographic) south or north and the point on the horizon directly below the sun.

2. What is a propellant? (April / May 2015)

- Propellant is the chemical mixture burned to produce thrust in rockets and consists of a fuel and an oxidizer.
- A fuel is a substance that burns when combined with oxygen producing gas for propulsion. An oxidizer is an agent that releases oxygen for combination with a fuel.
- The ratio of oxidizer to fuel is called the mixture ratio. Propellants are classified according to their state - liquid, solid, or hybrid.

3. What is meant by station keeping? (Nov/Dec2015)

- It is the process of maintenance of satellite's attitude against different factors that can cause drift with time.
- Satellites need to have their orbits adjusted from time to time because the satellite initially placed in the correct orbit, natural forces induce a progressive drift.
- There are two types of station keeping
    1. East – West station keeping : this is the correction along the axis.
    2. North – South Station Keeping : this is to correct the change in inclination.

4. What are geostationary satellites? (Nov/Dec2015)

- A geostationary orbit is one in which a satellite orbits the earth at exactly the same speed as the earth turns and at the same latitude, specifically zero, the latitude of the equator.
- A satellite orbiting in a geostationary orbit appears to be hovering in the same spot in the sky, and is directly over the same patch of ground at all times.
- A Geo Stationary satellite is one which has a visible period of 23 h, 56 min, 4s, or 86,164s.
- The reciprocal of this is 1.00273896 rev/day.

5. Define Roll, Pitch and Yaw. (May /June 2014)

- The three axes which define a satellite's attitude are its roll, pitch, and yaw (RPY) axes All three axes pass through the center of gravity of the satellite.
- For an equatorial orbit, movement of the satellite about the roll axis moves the antenna footprint north and south; movement about the pitch axis moves the footprint east and west; and movement about the yaw axis rotates the antenna footprint.

6. Define input back-off. (May /June 2014)

- In order to reduce the inter modulation distortion, the operating point of the TWT must be shifted closer to the linear portion of the curve, the reduction in input power being referred to as i/p backoff.
- The saturation flux density for single carrier operation is known input backoff will be specified for multiple carrier operation, referred to the single carrier saturation level.
- The earth station EIRP will have to be reduced by the specified backoff (Bo), resulting in an uplink value of $[EIRP]_o = [EIRP_s]_u - [B_o]_i$

7. Write down the parameters which are necessary for determining the look angles for the geostationary orbit. (Nov/Dec 2014)

- The coordinates to which the earth station antenna must be pointed to communicate with a satellite are called look angles.
- The following parameters λE, ϕE, ϕss are necessary to determine the look angles.
- The earth-station latitude, denoted here by λE
- The earth-station longitude, denoted here by ϕE
- The longitude of the sub satellite point, ϕss.

8. Define sun transit outage. (Nov/Dec 2014)

- The event which must be allowed for during the equinoxes is the transit of the satellite between earth and sun, such that the sun comes within the beam width of the earth-station antenna.
- When this happens, the sun appears as an extremely noisy source which completely blanks out the signal from the satellite.
- This effect is termed sun transit outage, and it lasts for short periods—each day for about 6 days around the equinoxes.

9. Distinguish between Geosynchronous and Geostationary orbits. (May/June 2013)

- Geosynchronous - An orbit around Earth whose orbital period is equal to a sidereal day (23 hours, 56 minutes), irrespective of its inclination.
  Ex: A person on a point on Earth, will see a satellite in this orbit in the same place in the sky at the same time of the day, every day.
- Geostationary - A geosynchronous orbit around Earth at 35,786 km above the equator, so that it remains stationary as seen from Earth.
  Ex: A person on any point on Earth, will see a satellite in this orbit stationary w.r.t his position, just like a star in the sky.

10. What are the needs for station keeping? (May/June 2013)

- Station-keeping maneuvers must be carried out to maintain the satellite within set limits of its nominal geostationary position.
- There are a number of perturbing forces that cause an orbit to depart from the ideal keplerian orbit.
- For the geostationary case, the most important of these are the gravitational fields of the moon and the sun, and the non-spherical shape of the earth, and also solar radiation pressure and reaction of the satellite itself to motor movement within the satellite.

11. What is meant by payload?

- The payload refers to the equipment used to provide the service for which the satellite has been launched.
- The payload comprises of a repeater and antenna subsystem and performs the primary function of communication
- The repeater have two types 1.Transparent repeater 2. Regenerative Repeater.

12. What is the temperature control in the satellite?

- The need for temperature control is to maintain a constant temperature inside the satellites. Because, the important consideration is that the satellites equipment should operate as nearly as possible in a stable temperature environment.
- Thermal blankets and shields may be used to provide insulation.
- Radiation mirrors are often used to remove heat from communication payload.
- These mirror drum surrounded the communication equipment shelves in each case and provide good radiation paths.

13. Write notes on transponder.

- A transponder is the series of interconnected units which forms a single communications channel between the receive and transmit antennas in a communications satellite
- It is a single communication channel which is formed by a series of interconnected units.
- A typical transponder bandwidth is 36 MHz, and allowing for a 4-MHz guard band between transponders, 12 such transponders can be accommodated in the 500-MHz bandwidth.

14. Write short notes on attitude control system.

- The attitude of a satellite refers to its orientation in space.
- Usually, the attitude-control process takes place aboard the satellite, but it is also possible for control signals to be transmitted from earth, based on attitude data obtained from the satellite.
- It is the system that achieves & maintains the required attitudes.
- The main functions of attitude control system include maintaining accurate satellite position throughout the life span of the system.

15. Define angle of Tilt.

- The angle a rocket makes with the vertical as it curves along its trajectory. The angle at which the dish is tilted relative to the polar mount until the bore sight is pointing at a satellite position due south of the earth station is known as angle of tilt. This is also referred as declination.

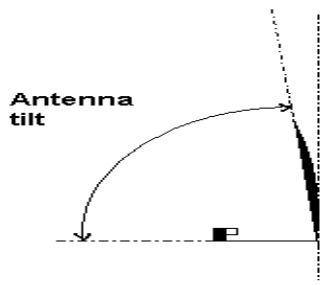

Fig: Tilt Angle

16. Define Momentum Bias.

- Spin stabilization may be achieved with cylindrical satellites.
- The satellite is constructed so that it is mechanically balanced about one particular axis and is then set spinning around this axis. For geostationary satellites, the spin axis is adjusted to be parallel to the N-S axis of the earth. In these dual-spin spacecraft, spin stabilization is obtained using spinning flywheels, which are termed as momentum wheels. The average momentum of these wheels is known as momentum bias.

17. Define output backoff.

- An input backoff is employed, a corresponding output backoff must be allowed for the satellite EIRP.
- When the operating point of the Travelling wave tube amplifier (TWTA) is shifted closer to the linear portion in order to reduce intermodulation distortion.
- The corresponding drop in the output power in decibels is known as the output backoff.

18. Write the equations of Link-Power Budget.

- The power output of the link is power at the receiver.
- The major source of loss in any ground satellite link is the free space spreading loss.

[PR] = [EIRP] + [GR] – [LOSSES]

[LOSSES]=[FSL]+[RFL]+[AML]+[AA]+[PL]

Where, FSL=Free Space Spreading Loss(dB) RFL=Receiver Feeder Loss(dB)

AML=Antenna Misalignment Loss(sB); AA= Atmospheric Absorption(dB)

PL= Polarization mismatch Law(dB)

19. What is system noise?

- Noise temperature is very important concept in receivers. By using this, thermal noise which is generated by active and passive devices in the receiver can be calculated.
- The noise power is given by, Pn=KTnB
  Where, Pn=Noise power , K=Boltzman's constant
  Tn=Noise temperature of source(in Kelvin) B=Bandwidth in Hz

20. Define noise factor.

- An alternative way of representing amplifier noise is by means of its noise factor F.
- For defining it, the source is taken at room temperature, denoted by T_0.
- The input noise from such a source is KT0 and the output noise from the amplifier is $N_{0,out} = FGKT_0$
  Where G -is the available power gain of the amplifier, F - is the noise factor

PART B

1. Explain about advanced Trios-N spacecraft and Morelos with a neat sketch. (16)(MAY /JUNE 2014) (APRIL/MAY 2015)
2. Explain in detail about antenna look angles and the polar mount antenna.(16) (MAY /JUNE 2014)(APRIL/MAY 2015)
3. Explain the procedure used to control the altitude control of satellite with necessary diagrams.(16) (NOV/DEC 2015)
4. (a) Determine the angle of tilt required for a polar mount used with an earth station at latitude 49° north. Assume a spherical earth of radius 6371 km, and ignore earth station altitude.(06) (NOV/DEC 2014)
   (b)Explain what is meant by satellite attitude, and briefly describe the attitude control with a relevant diagram.(10) (NOV/DEC 2014)
5. (a)Describe with a diagram, satellite eclipse and satellite sun transit around spring and autumn equinoxes.(10) (NOV/DEC 2014)
   (b)What is thermal control? Why it is necessary in a satellite? (6) (NOV/DEC 2014)
6. (a)An earth station is located at latitude 12°S and longitude 52° W. Calculate the antenna look angles for a satellite at 70°W.(8) (May/June 2013)
   (b)Show and explain the Earth eclipse of satellite . How this can be overcome by the satellites? (8)(May/June 2013)
7. Explain attitude control of satellites. With neat diagrams explain the spinning satellite stabilization and momentum wheel stabilization.(16) (May/June 2013)
8. (a)Explain transponders with necessary diagrams.(8)
   (b)Explain antenna subsystems with necessary diagrams.(8)
9. Explain what is meant by satellite attitude, and briefly describe two forms of attitude control. (16)
10. Draw the block diagram of TT&C and explain each and individual blocks. (16)
11. From the calculation of system noise temperature prove that C/N ratio is directly proportional to G/T ratio.(16)
12. List and explain the factors governing the design of satellite links. (16)
13. How is the performance of a satellite impaired due to external factors? Also suggest suitable methods to overcome the same. (16)
14. In detail, explain the various sub-modules and their functions of a Telemetry , Tracking and Command (TT & C) subsystem. Draw required diagrams. (16)
15. (a) With a neat sketch, explain the various modules of Attitude and orbit control(AOCS) subsystem. (16)
    (b)Derive the analytical expression for uplink CNR. (16)

UNIT – 3
EARTH SEGMENT
PART A

1. What are the effects of rain over space link? (Nov/Dec2015)

- In Ku band, rainfall is the most significant cause of signal fading.
- Rainfall results in attenuation of radio waves by scattering and by absorption of energy from the wave.
- Rain attenuation increases with increasing frequency and is worse in the Ku band compared with the C band.
- The rain attenuation for horizontal polarization is considerably greater than for vertical polarization.

2. Define fade margin. (Nov/Dec2015)

- The amount by which a received signal level may be reduced without causing system performance to fall below a specified threshold value.
- It is mainly used to describe a communication system such as satellite, for example a system like global star operates at 25-35 dB Fade margin.
- A design allowance that provides for sufficient system gain or sensitivity to accommodate expected fading, for the purpose of ensuring that the required quality of service is maintained.
- The amount by which a received signal level may be reduced without causing system performance to fall below a specified threshold value.

3. State the basic problems in satellite digital transmission. (April / May 2015)

The following are the basic problems occurs in satellite digital transmission,

- No coverage of polar region, Long time delay, Echo, Eclipse due to the earth and the sun, Sun Transit outage

4. What are Receiver Feeder losses? (May /June 2014)

- Losses at the connection of receiving antenna occurs at couplers, filters and waveguides. This is called receiver feeder loss (RFL). These Losses are added to free space loss (FSL) Similar losses occur at transmitting antenna.
- Transmitter feeder losses are not accounted EIRP.

5. What is the reason for placed LNA at the end of the feeder cable? (May /June 2014)

- A Low-noise amplifier (LNA) is an electronic amplifier that amplifies a very low-power signal without significantly degrading its signal-to-noise ratio.
- An amplifier increases the power of both the signal and the noise present at its input
- The receiving horn feeds into a low-noise converter (LNC) or possibly a combination unit consisting of a low-noise amplifier (LNA) followed by a converter.
- Low noise amplifier(LNA) is placed at the end of the feeder cable so that the noise in the cable is reduced by the gain of the LNA.

6. Expand TVRO and TT & C. (May /June 2014)

- **TVRO** : The earth segment of a satellite communications system consists of the transmit and receive earth stations. The simplest of these are the home TV receive-only (TVRO) systems.
- TVRO systems relied on feeds being transmitted unencrypted and using open-standards, which heavily contrasts to DBS systems in the region.

- **TT&C -** Tracking, Telemetry, and Command : Throughout the launch and acquisition phases, a network of ground stations, spread across the earth, is required to perform the tracking, telemetry, and command (TT&C) functions.

7. A satellite downlink at 12GHz operates with a transmit powerof 60Wand an antenna gain of 48.2 dB. Calculate the ERP in dBW. (May /June 2014)

Given : Downlink frequency = 12 Ghz
Transmit Power =60Watts
Antenna Gain =48.2 dB

Calculation:

EIRP = 10 log 6 + 48.2 = 56 dBW

8. What are the basic requirements of an earth station antenna?

- The basic requirements of an earth station antenna are listed below.
- The antenna must have a low noise temperature. The ohmic losses of antenna must also be maximum.
- The antenna must be rotated or steered easily so that a tracking system can be employed to point the antenna beam accurately.
- The antenna radiation must have a low side lobe level to reduce interference from unwanted signals and also to minimize interference into other satellites and terrestrial systems. The antenna must have a high directive gain.

9. What is outdoor unit?

- An outdoor unit consists of a receiving antenna feeding directly into a low-noise amplifier/converter combination.
- A parabolic reflector is generally used, with the receiving horn mounted at the focus.
- A common design is to have the focus directly in front of the reflector, but for better interference rejection an offset feed may be used.
- Comparing the gain of a 3-m dish at 4 GHz with a 1-m dish at 12 GHz, the ratio D/l equals 40 in each case, so the gains will be about equal.

10. What is [C/N0] ratio for uplink?

- The free-space and other losses are calculated for the uplink frequency.
- The resulting carrier-to-noise density is that which appears at the detector of the satellite receiver.

[C/N0]U=[EIRP]U+[G/T]U-[LOSSES]U-[K].
Uplink Satellite E/S Losses at Uplink frequencies

11. Define output backoff.

- An input backoff is employed, a corresponding output backoff must be allowed for the satellite EIRP.
- When the operating point of the Travelling wave tube amplifier (TWTA) is shifted closer to the linear portion in order to reduce intermodulation distortion.
- The corresponding drop in the output power in decibels is known as the output backoff.

12. What is earth station of a satellite communications system?

- The earth segment of a satellite communications system consists of the transmit and receive earth stations.
- The simplest of these are the home TV receive-only (TVRO) systems, and the most complex are the terminal stations used for international communications networks.

- Also included in the earth segment are those stations which are on ships at sea, and commercial and military land and aeronautical mobile stations.

13. What is LNB?

- The appropriate receiving device at the antenna is called a low-noise block converter (LNB), which contains a low-noise amplifier and a block down converter.
- On the transmit side, there would need to be an up converter and high power amplifier; if the transmit power required is less than about 10W, then it is possible to obtain both functions within what is called a block-upconverter (BUC).(or)
- The receiving horn feeds into a low-noise converter (LNC) or possibly a combination unit consisting of a low-noise amplifier (LNA) followed by a converter.
- The combination is referred to as an LNB, for low-noise block.

14. Define Equivalent Isotropic Radiated Power.

- A key parameter in link-budget calculations is the equivalent isotropic radiated power(EIRP).
- The maximum flux density at distance r from the transmitting antenna of gin G is ψM=
- An isotropic radiator with an input power equal to GPs would produce same flux density.

Hence EIRP = GPs

[EIRP]=[Ps]+[G] Dbw

15. Define Antenna misalignment losses

- When a satellite link is established, the ideal situation is to have the earth station and satellite antennas aligned for maximum gain.
- There are two possible sources of off-axis loss, one at the satellite and one at the earth station.
- The off-axis loss at the satellite is taken into account by designing the link for operation on the actual satellite antenna contour.
- The off-axis loss at the earth station is referred to as the antenna pointing loss.

16. Write down the Link-Power Budget Equation

- The [EIRP] can be considered as the input power to a transmission link.
- The major source of loss in any ground-satellite link is the free-space spreading loss [FSL], the basic link-power budget equation taking into account this loss only.
- The losses for clear-sky conditions are
  [LOSSES]=[FSL]+[RFL]+[AML]+[AA]+[PL]
- The power at the receiver may be calculated as
  [PR]=[EIRP]-[LOSSES]+[GR], where the last quantity is the receiver antenna gain.

17. What is [C/N0] ratio for downlink?

- The free-space and other losses are calculated for the downlink frequency.
- The resulting carrier-to-noise density is that which appears at the detector of the earth station receiver.

[C/N0]D=[EIRP]D+[G/T]D-[LOSSES]D-[K]-[B].

Down Link Satellite E/S Losses at downlink frequencies

18. What do you meant by rain attenuation?

- Rain attenuation makes no sense to determine the attenuation caused by rainfall because they will be very punctual events,
- Since rain only causes severe attenuation in situations of heavy rain.
- Thus, even though one satellite transmission may be strongly affected due to rain,

- its orbit period of nearly 90 minutes minimizes that loss because the same ground station will have several other opportunities to receive VORSat's signals.
- For GEO satellites it becomes mandatory to perform these calculations, once the satellite's position in relation to the GS is permanent.

19. What are the advantages of large antenna system?

The advantages are

- Large antennas are capable of carrying large volume of traffic is its operation can be with wideband carriers.
- Large antenna produce narrow beams and large antenna can be easily equipped with automatic tracking system.
- It is possible to achieve the highest possible aperture efficiency and lowest possible noise temperature so that G/T is maximized in large antenna.
- Gain of the large antenna is high since effective aperture area is high and so aperture efficiency is also high.

20. List the corrections added to received power for additional losses.

- Corrections must be added to P_R for additional losses due to Antenna efficiency – power is lost in the antenna feed structure, also connections to the receiver.
- Atmospheric absorption due to water and oxygen molecules
- Polarization mismatches of Tx & Rx antennas. Antenna misalignments –ie . bore sights of Tx and Rx antennas not aligned.

21. Examine why noise temperature is a useful concept in communication receivers?

Noise temperature is a measure of the noise entering a receiver through antenna. Noise temperature provides a way of determining how much thermal noise is generated by active and passive devices in the receiving system.

Generally, at the receiver side, the noise temperature should be maintained as low as possible. Front-end amplifier is immersed in liquid helium to maintain its physical temperature around 4°K. it is practical in large earth stations.

22. Write the features of MATV.

A master antenna TV MATV system includes,

- Provide reception of direct broadcast system (DBS) TV/FM channels to a small group of users.
- Single outdoor unit is needed, but feeds number of indoor units.
- Each receiver has access to all the independent channels of other users.

PART B

1. (a)A satellite TV signal occupies the full transponder bandwidth of 86MHz, and it must provide a C/N ratio of 62dB at the destination earth station. Given that the total transmission losses are 600dB and the destination earth station G/T ration is 81dB/K. calculate the satellite EIRP required.(8) (MAY /JUNE 2014) (Nov/Dec2015)
   (b)Explain about Master Antenna TV system in detail.(8) (MAY /JUNE 2014) (Nov/Dec2015)
2. With the aid of block schematic, describe the functioning of the receive only home TV systems. (8)(Nov/Dec2015)
3. (a)Explain briefly CATV system. (8) (NOV/DEC 2014)
   (b)Discuss about antenna misalignment losses and feeder losses(8) (NOV/DEC 2014)
4. (a)Derive the link - Power budget equation. (8) (NOV/DEC 2014)
   (b)An LNA is connected to a receiver which has a noise figure of 12 dB. The gain of the LNA is 40dB, and its noise temperature is 120K. Calculate the overall noise temperature referred to the LNA input. (4) (NOV/DEC 2014)
   (c)A satellite is operated at an EIRP of 56dBW with an output BO of 6dB. The transmitter feeder losses amount to 2dB, and the antenna gain is 50dB. Calculate the power output of the TWTA required for full saturated EIRP. (4) (NOV/DEC 2014)
5. (a)Draw the detailed block diagram of a transmit receive earth station and explain. (8)(May/June 2013)
   (b)Describe and compare MATV and CATV systems.(8) (May/June 2013)
6. (a)Derive expression for the link power budget of a satellite system.(8)(May/June 2013)
   (b)What is saturation flux density? If the power received by a 1.8 m parabolic antenna at 14 GHz is 250pW, then calculate the saturation flux density. (8)(May/June 2013)
7. (a)With the aid of a block schematic, briefly describe the functioning of the receive only home TV systems. (8)(MAY /JUNE 2014)
   (b)An antenna has noise temperature of 100 K and is matched into a receiver which has a noise temperature of 400K. Calculate the noise power density and the noise power for a bandwidth of 80MHz.(8) (MAY /JUNE 2014)(Nov / Dec 2015)
8. Draw the block diagram and explain the receive only home TV system.(16) (APRIL /MAY 2015)
9. Explain the following. (APRIL /MAY 2015)
   (I) EIRP. (8)
   (II)Transmission Losses.(8)
10. With a neat diagram, explain the procedure for measuring critical satellite parameters like C/N0 and G/T. Emphasize on the significance of these parameters. (16)
11. In detail explain the block diagram representation of a typical digital earth station(Transmitter and receiver).Give the block diagram.(16)
12. With a neat sketch, Explain the power budget for a link considering backoff and rain fade margin.
13. How does the system noise temperature affect the performance? Derive the expression for overall system noise temperature at the receiving earth station.
14. With a neat diagram how measurements on G/T and C/N0 are made (16)
15. Give a detailed note on
    (a) TVRO
    (b) MATV Earth station antennas. (16)

UNIT – 4
SATELLITE ACCESS
PART A

1. **List the advantages of CDMA especially where VAST type terminals are involved. (May/June 2013) April/May 2015**

The advantages of CDMA are

- Efficient practical utilization of fixed frequency spectrum.
- Flexible allocation of resources.
- Many users of CDMA use the same frequency, TDD or FDD may be used
- Multipath fading may be substantially reduced because of large signal bandwidth
- No absolute limit on the number of users, Easy addition of more users.
- Impossible for hackers to decipher the code sent
- No sense of handoff when changing cells
- CDMA is compatible with other cellular technologies; this allows for nationwide roaming.

The combination of digital and spread-spectrum modes supports several times as many signals per unit bandwidth as analog modes.

2. **Write about demand assigned TDMA satellite access. (Nov /Dec 2015)**

- Resource is allocated as needed in response to changing traffic conditions.
- Suitable for bursty or varying traffic conditions.
- More number of earth stations can access the satellite.
- Efficient resource utilization.
- The burst length may be kept constant and the number of bursts per frame used by the given station is varied when the demand is varied.

3. **What is meant by thin route service? (May/June 2013) (April/May 2015)**

- Traffic can be broadly classified as heavy route, medium route, and thin route.
- In a thin-route circuit, a transponder channel (36 MHz) may be occupied by a number of single carriers, each associated with its own voice circuit.
- This mode of operation is known as single carrier per channel (SCPC).

4. **Define CDMA. (May /June 2014)**

- In this method, each signal is associated with a particular code that is used to spread the signal in frequency & or time.
- Spread spectrum multiple access
- Pulse address multiple access

5. **Define the term preamble and post amble. (May /June 2014) (Nov /Dec 2015)**

- Preamble is the initial position of a traffic burst which carries information similar to that carried in
- Certain time slots at the beginning of each burst are used to carry timing & synchronizing information.
- These time slots collectively are referred to as preamble.

6. **What is a single access?**

- A single access means, single modulated carries occupies the whole of the available bandwidth of a transponder.
- Single access operation is used only on heavy traffic routers.
- Example : Telesat Canada - in this satellite each transponder channel being capable of carrying 960 one way voice circuits on an FDM/FM carrier and so it provides heavy route message facilities.

7. What are the disadvantages of FDMA.

The following are the advantages of FDMA

- Sensitive to fading
- Stabilization is difficult.
- Sensitive to random frequency modulation.
- Sensitive to inter modulation distortion.

8. What is meant by multiple access?

- A transponder to be loaded by a number of carriers, which may originate from a number of earth stations geographically separate and each earth station may transmit one or more of the carriers.
- This is called as multiple access.
- There are different multiple access techniques they are

  FDMA : Frequency Division Multiple Access
  TDMA: Time Division Multiple Access
  CDMA: Code Division Multiple Access

9. What is CBR?

- An un modulated carrier wave is provided during the first part of the carrier and bit-timing recover (CBR) time slot.
- It is used as a synchronizing signal for local oscillator in the detector circuit.
- In the remaining part of CBR time slot, the carrier is modulated by a known phase change sequence.

10. What is BCW?

- The copy of burst code word (BCW) is stored in all the earth stations. Incoming bits in the burst are compared with the BCW.
- The receiver detects the group of received bits matched with BCW. Then, accurate time reference for the burst position in frame is provided.

11. What is amplitude modulation?

- The modulated signal may be expressed as,

  am(t)={kas(t)+1}Ac sin(ωct+ 1)
- For special case where the modulating signal in sine wave with angular frequency cos and letting k=m,above equation becomes
  am(t)=(msinω st+1)Ac sin ωct where, m=modulation index.

12. What is meant by space division multiple access?

- The satellite as a whole to be accessed by earth stations widely separated geographically but transmitting on the same frequency i.e. known as frequency reuse.
- This method of access known as space division multiple access.

13. What is burst code word and burst position acquisition?

- Burst code: It is a binary word, a copy of which is stored at each earth station.
  Burst position acquisition:
- A station just entering, or reentering after a long delay to acquire its correct slot position is known as burst position acquisition.

14. Define guard time.

- It is necessary to prevent the bursts from overlapping.

- The guard time will vary from burst to burst depending on the accuracy with which the various bursts can be positioned within each frame.

15. What are the limitations of FDMA-satellite access?

- If the traffic in the downlink is much heavier than that in the uplink, then FDMA is relatively inefficient.
- So, bandwidth of the uplink channel is not fully used.
- Compared with TDMA, FDMA has less flexibility in reassigning channels.
- Carrier frequency assignments are hardware controlled.

16. What is meant by decoding quenching?

- In certain phase detection systems the phase detector must be allowed time to recover from one burst before the next burst is received by it.
- This is known as decoding quenching.

17. What is meant by digital speech interpolation?

- The point is that for a significant fraction of the time the channel is available for other transmissions,& advantages is taken of this in a form of demand assignment known as digital speech interpolation.

<u>Types</u>

  - Digital time assignment speech interpolation
  - Speech predictive encoded communications

18. Write short notes on open-loop timing control.

- It is a method of transmit timing. In this method, according to burst time plan, a station transmits at a fixed interval.
- Necessary guard time is allowed to absorb the variations in propagation delay.

19. What is meant by burst position acquisition & burst position synchronization?

- Burst position acquisition & burst position synchronization means when a station just entering, or reentering after a long delay to acquire its correct slot position.

20. Point out the pre-assigned TDMA satellite access.

Example for preassigned TDMA is CSC for the SPADE network. CSC can accommodate upto 49 earth stations in the network and 1 reference station. All bursts are of equal length. Each burst contains 128 bots. The bit rate is 128 Kb/s.

21. How does the spread spectrum system differ from conventional communicational communication systems?

The spread spectrum system undergo double modulation.

1. First modulation – carrier and message signal.
2. Second modulation – the resultant signal and PN code sequence, which spreads the spectrum over the available bandwidth.

PART B

1. (a)Discuss satellite links and TCP.(8) (APRIL /MAY 2015)
   (b)Explain direct sequence spread spectrum.(8) (APRIL /MAY 2015)
2. (a)With neat diagrams, explain the TDMA burst and frame structure of satellite system.(12) (APRIL /MAY 2015)
   (b)Compare FDMA, TDMA, and CDMA. (4) (APRIL /MAY 2015)
3. (a)What is a SPADE system? Explain its channeling scheme and operation. (May/June 2013)(8) (Nov/Dec2015)
   (b)Explain pre assigned TDMA and Demand assigned TDMA in detail. (May/June 2013)(8) (Nov/Dec2015)
4. (a)Describe the conventional approach and group signal processing of on-board signal processing for FDMA/TDM operation.(8) (May/June 2013) (Nov/Dec2015)
   (b)Describe how signal acquisition and tracking are achieved in a DS/SS system. (8)(May/June 2013) (Nov/Dec2015)
5. (a)Explain the principle behind spectrum spreading and dispreading and how this is used to minimize interference in a CDMA system. Also determine the throughput efficiency of the system. (10) (MAY /JUNE 2014)
   (b)Write short notes on satellite links and TCP.(6) (MAY /JUNE 2014)
6. Describe briefly about on board signal processing for FDMA/TDMA operation.(16) (MAY /JUNE2014)
7. Explain clearly the pre assigned FDMA with suitable diagrams and show how it differs from demand assigned FDMA. (16) (NOV/DEC 2014)
8. Draw the frame and burst format of TDMA and explain the need for a reference burst in a TDMA system.(16) (NOV/DEC 2014)
9. With a neat block diagram, explain the functioning of a SPADE System.(16)
10. Describe the ways in which demand assignment may be carried out in FDMA. (16)
11. Explain the following 1. pre assigned Traffic. 2. Encryption. (16)
12. For digital video broadcast what type of multiple access is best suited. Justify your answer. (16)
13. With a neat block diagram explain the working of a FDMA based satellite network. Analyse its merits and demerits.
14. In detail explain the format structure of TDMA frame. Comment on the significance of each field
15. Explain the concept of compression in satellite links.

UNIT – 5
SATELLITE APPLICATIONS
PART A

1. **List the types of maps. (May/June 2013)**
   Types of map:
   - Topographic map - a reference tool, showing the outlines of selected natural and man-made features of the Earth it acts as a frame for other information.
   - Topography" refers to the shape of the surface, represented by contours and/or shading, but topographic maps also show roads and other prominent features.
   - Thematic map - a tool to communicate geographical concepts such as the distribution of population densities, climate, movement of goods, land use etc.

2. **How many satellites are in the space for providing GPS data? (May/June 2013)**
   There are 4 satellites are needed to cover entire earth.

3. **What are the components of GIS? (May /June 2014) (Nov/Dec 2014) (April / May 2015)**
   The three components of a Geographical Information System are
   - Computer hardware, Software Modules, Organizational context.

4. **What are the services of GPS? (May /June 2014)**
   Some important services of Global Positioning System (GPS) are
   - Aircraft tracking
   - Map making
   - Surveying
   - Search and rescue.
   - Missile and projectile guidance.

5. **Write the main components of GPS.**
   - The Control segments, The Space segments, The User segments

6. **What is map?**
   - A map is defined as the representation of the features of the earth drawn to scale.
   - It is the traditional method of storing, analyzing and presenting spatial data.
   - The map is also known as the ‘spatial language’.

7. **Write about Gramsat?**
   - The Gramsat Programme (GP) is an initiative to provide communication networks at the state level connecting the state capital to districts and blocks.
   - The networks provide Computer Connectivity, Data Broadcasting and TV Broadcasting facilities having applications like e-Governance, National Resource Information System (NRIS), Development Information, Tele-conferencing, Disaster Management, Tele-medicine and Distance Education.

8. **Define DTH.**
   - DTH stands for Direct-To-Home television.
   - DTH is defined as the reception of satellite programmes with a personal dish in an individual home.

9. What are the components of DTH.

- A DTH network consists of a broadcasting centre,
- Satellites,
- Encoders,
- Multiplexers,
- Modulators and DTH receivers.

10. Write down some applications of GPS.

Some important applications of Global Positioning System (GPS) are

- Aircraft tracking
- Map making
- Surveying
- Search and rescue.
- Missile and projectile guidance.

11. What do you meant by video conferencing?

- A videoconference is a live connection between people in separate locations for the purpose of communication, usually involving audio and often text as well as video.
- At its simplest, videoconferencing provides transmission of static images and text between two locations. At its most sophisticated, it provides transmission of full-motion video images and high-quality audio between multiple locations.

12. What do you mean by DBS.

- Direct broadcast satellite (DBS) refers to satellite television (TV) systems in which the subscribers, or end users, receive signals directly from geostationary satellites.
- Signals are broadcast in digital format at microwave frequencies. DBS is the descendant of direct-to-home (DTH) satellite services.

13. What do you meant by DAB.

- Digital audio broadcasting (DAB), also known as digital radio and high-definition radio, is audio broadcasting in which analog audio is converted into a digital signal and transmitted on an assigned channel in the AM or (more usually) FM frequency range.
- DAB is said to offer compact disc (CD)- quality audio on the FM (frequency modulation) broadcast band and to offer FM-quality audio on the AM (amplitude modulation) broadcast band.

14. Define LEO ?

- LEO means Low Earth Orbit it is relatively low in altitude;
- The altitude range is between 200 and 1200 km above the Earth's surface.

15. Give the Applications of LEO?

- Communications satellites - some communications satellites including the Iridium phone system use LEO.
- Earth monitoring satellites – it use LEO as they are able to see the surface of the Earth more clearly as they are not so far away. They are also able to traverse the surface of the Earth.
- The International Space Station : It is in an LEO that varies between 320 km (199 miles) and 400 km (249 miles) above the Earth's surface. It can often be seen from the Earth's surface with the naked eye.

16. Define MEO.

- A medium earth orbit (MEO) satellite is one with an orbit within the range from a few hundred miles to a few thousand miles above the earth's surface.
- Satellites of this type orbit higher than low earth orbit (LEO) satellites, but lower than geostationary satellites.

17. Compare LEO,MEO and GEO

Parameter	LEO	MEO	GEO
Satellite Height	500-1500 km	5000-12000	35,800 km
Orbital Period	10-40minutes	2-8 hours	24 hours
Number of	40-80	8-20	3
Satellite Life	Short	Long	Long
Number of	High	Low	Least(none)
Cost	Cheap	Very Expensive	Expensive
Propagation Loss	Least	High	Highest

18. What are the INSAT services?

The INSAT provides 3 main services

- Long distance communication
- TV and Radio broadcasting.
- Metrology.

19. What are the services and features of GSM?

The GSM services are classified into 2.

- Tele services.
- Data services.

Features of GSM:

- Subscriber Identity Module (SIM)
- On the air privacy.

20. Define Satellite Navigational System.

- Satellite Navigation are SATNAV system is a system of satellite that provides autonomous geospatial positioning with global coverage.
- It allows electronic receivers to determine the latitude, longitude and attitude position within a few meters using timing signals transmitted from a line of sight by radio from the satellite.

21. What do you infer about GRAMSAT?

ISRO has come up with the concept of dedicated GRAMSAT satellites, keeping in mind the urgent need to eradicate illiteracy in the rural belt which is necessary for the all round development of the nation.

This GRAMSAT satellite is carrying six to eight high powered C-band transponders, which together with video compression techniques can disseminate regional and cultural specific audio-visual programmes of relevance in each of the regional languages through rebroadcast mode on an ordinary TV set.

22. Outline the three regions to collect the frequency for satellite services.

- Region 1: It covers Europe, Africa and Mangolia
- Region 2: It covers North & south America and Greenland
- Region 3: It covers Asia, Australia and South west pacific

PART B

1. List the characteristics of digital satellite image and explain how image enhancement is carried out. (16) (APRIL /MAY 2015)
2. Explain the types of maps used in GIS based urban applications. (16)(APRIL /MAY 2015)
3. Explain the data input hardware of GIS. (16)(Nov/Dec2015)
4. Explain the following satellite applications (16)(Nov/Dec2015)
   (a)Global positioning system. (6) (b) Satellite navigation system. (10)
5. Explain in detail about Integration of GIS, remote sensing and urban application. (16)(MAY /JUNE 2014)
6. (a)Explain in detail about elements of interpretation and Interpretation keys characteristics of digital satellite image. (10) (MAY /JUNE 2014)
   (b)With short notes on Resource information system. (6) (MAY /JUNE 2014)
7. (a)Discuss about the key characteristics of digital satellite image. (8) (NOV/DEC 2014)
   (b)Write short notes on types of maps. (8) (NOV/DEC 2014)
8. (a)Explain what is meant by remote sensing and also the need of integration of GIS and remote sensing.(12) (NOV/DEC 2014)
   (b)State the advantages of GPS. (4) (NOV/DEC 2014)
9. (a)Describe the visual interpretation of satellite images. What are the elements of interpretation? Explain it. (8) (May/June 2013)
   (b)Explain the various image enhancement schemes. (8) (May/June 2013)
10. (a)Explain the significance of integrating GIS and remote sensing. What are their application? (8) (May/June 2013)
    (b)Write a detailed note on GPS and its application in GIS. (8) (May/June 2013)
11. Explain with neat diagram about DTH system (16)
12. Write short notes on (16)
    (a) Gramsat
    (b) E mail Service
13. Write short notes on the specialized services offered by satellites for video conferencing e-mail and internet. (16)
14. In detail explain the various mobile satellite services and their impact on society. (16)
15. In detail Explain about INMARSAT, LEO, MEO. (16)

Anna University Question Papers

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 21293

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2012.

Eighth Semester

Electronics and Communication Engineering

080290077 – SATELLITE COMMUNICATION

(Regulation 2008)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Mention the various types of satellite orbits.
2. Define the term 'azimuth'.
3. Mention the various mechanisms through which attitude control is attained.
4. What are transponders?
5. List out the types of modulation schemes employed in satellite communication.
6. Define the term 'beam switching'.
7. Give the significance of EIRP.
8. Define the term 'antenna gain'.
9. What are satellite phones?
10. What is meant by DAB? Give its significance.

PART B — (5 × 16 = 80 marks)

11. (a) (i) What are orbital elements? How are they helpful in locating satellites in orbital planes? (10)

(ii) Explain the launching procedure of geo-stationary satellites using launch vehicles. Give diagrams. (6)

Or

(b) State and derive the expressions for the look angles. Give necessary diagrams. (16)

12. (a) Explain how attitude control is established through various satellite stabilization techniques. (16)

Or

(b) Deduce the expression for overall carrier to noise ratio starting from received power flux. Indicate the power margin assigned to accommodate various losses excluding atmospheric losses. (16)

13. (a) With a neat block diagram, explain the working of a FDMA based satellite network. Analyse its merits and demerits. (16)

Or

(b) (i) In detail, explain the format structure of TDMA frame. Comment on the significance of each field. (10)

(ii) Explain satellite switched TDMA. (6)

14. (a) Give a detailed note on

(i) TVRO (5)

(ii) MATV (5)

(iii) Earth station antennas. (6)

Or

(b) With neat diagrams, explain how measurements on $\frac{G}{T}$ and $\frac{C}{N_0}$ are made. (16)

15. (a) In detail, explain the various mobile satellite services and their impact on society. (16)

Or

(b) Give a detailed note on

(i) DBS and DTH (8)

(ii) GRAMSAT and Business TV. (8)

Reg. No. : [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

Question Paper Code : 21343

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Eighth Semester

Electronics and Communication Engineering

EC 2045/EC 810 -- SATELLITE COMMUNICATION

(Regulation 2008)

(Common to PTEC 2045 — Satellite Communication for B.E. (Part-Time) Seventh Semester - Electronics and Communication Engineering — Regulation 2009)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Given the geostationary orbital radius 'r', the Earth's radius 'R' and speed of light 'C' how will you compute the time taken for a signal to pass from Earth to the Satellite and back again?

2. Enlist the traditional orbital Keplerian elements

3. How is the attitude of a satellite controlled through active control?

4. Why the operation near the saturation point of a TWTA is to be avoided when multiple carriers are being amplified simultaneously?

5. When VSAT-type terminals involved CDMA offers several advantages for satellite networking. What are they?

6. Point out the function of (a) the burst code word and (b) the carrier and bit-timing recovery channel in a TDMA burst.

7. Give the reason for deploying a demodulator/remodulator unit in our home television set when we want to function in a satellite TV/FM receiving system.

8. What is known as polarization interleaving with reference to the Down link frequency?

9. When the available bandwidth is 500 MHZ, how many transponder each of bandwidth 24 MHZ can be accomodated.

10. What is meant by conjestion and slowstart with reference to Internet traffic.

PART B — (5 × 16 = 80 marks)

11. (a) (i) A satellite is orbiting the equatorial plane with a period from perigee to perigee of 10h. Given that the eccentricity is 0.002 and the earth's equatorial radius is 6378.1414 km how will you calculate the semi major axis.

(ii) Summarise how you will determine the look angles for the geostationary orbit? What are known as sun-synchronous orbits.

Or

(b) (i) How will you determine the sub satellite point?

(ii) Write a brief note on launch vehicles and propulsion.

12. (a) How do the TT and C subsystem perform aboard the spacecraft? Also explain the working of a transponder unit.

Or

(b) How is the performance of a satellite impaired due to external factors? Also suggest suitable methods to overcome the same.

13. (a) (i) Describe the ways in which demand assignment may be carried out in FDMA.

(ii) What is known as pre-assigned traffic?

Or

(b) (i) Calculate the probability of false detection, when N = 10 and d = 4.

(ii) For digital video broadcast what type of multiple access is best suited. Justify your answer.

14. (a) Show how MATV is used to provide reception of DDS to a small group of users. When this group is large what type of antenna should be used? Explain.

Or

(b) Analyse the functioning of Transmit — Receive Earth stations. With a block diagram explain how the redundant earth station functions.

15. (a) Enumerate how GSM and GPS deploying Satellites have improved the mobility of the customers.

Or

(b) Write short notes on the specialized services offered by satellites for video conferencing e-mail and internet.

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Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 51385

B.E./B.Tech. DEGREE EXAMINATION, APRIL 2014.

Eighth Semester

Electronics and Communication Engineering

EC 2045/EC 810/10144 ECE 52 — SATELLITE COMMUNICATION

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define geostationary orbit.

2. What do you mean by apogee?

3. Why is noise temperature a useful concept in communication receivers?

4. Write the objectives with which the downlink of any satellite communication system must be designed.

5. Define multiplexing.

6. Write the two basic problems in satellite digital transmission.

7. For a given satellite and signal transmission, what are the earth station parameters affecting the C/N ratio?

8. Why is the cassegrain antenna popular for large earth stations?

9. Write the four kinds of communications that the network structure of MSAT can accommodate.

10. Write the two areas of satellite communications which are gaining major thrust from leading satellite industries and organisations in recent years.

PART B — (5 × 16 = 80 marks)

11. (a) Explain how Kepler's and Newton's laws are used to describe the orbit. (16)

Or

(b) Explain the following :

(i) Orbital perturbations. (8)

(ii) Launching vehicles. (8)

12. (a) From the calculation of system noise temperature prove that C/N ratio is directly proportional to G/T ratio. (16)

Or

(b) (i) List and explain the factors governing the design of satellite links. (10)

(ii) What are the factors contributing to noise in an earth station receiving channel? (6)

13. (a) Briefly discuss about analog voice transmission. (16)

Or

(b) Compare the salient features of FDMA, TDMA and CDMA. (16)

14. (a) Briefly explain about the test equipments for earth stations. (16)

Or

(b) (i) Briefly discuss on TVRO systems. (8)

(ii) Describe how the gain of large antennas can be optimized. (8)

15. (a) Explain the types of INTELSAT satellites with respect to basic space craft characteristics and vehicle type. (16)

Or

(b) (i) Explain the block diagram of an outdoor unit for a DBS home receiver. (8)

(ii) With a block schematic explain about DTH system. (8)

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Reg. No. : [ ]

Question Paper Code : 91387

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2014.

Eighth Semester

Electronics and Communication Engineering

EC 2045/EC 810/10144 ECE 52 — SATELLITE COMMUNICATION

(Regulation 2008/2010)

(Common to PTEC 2045 – Satellite Communication for B.E. (Part-Time) Seventh Semester – ECE – Regulation 2009)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Find the viewing angle of a geostationary satellite orbiting at 42200 km from an earth station making an elevation angle of 25°

2. What is ascending node and descending node?

3. What is split body stabilization?

4. What is frequency planning

5. What are the advantages of TDMA over FDMA?

6. Define multiplexing.

7. Define antenna gain

8. A satellite downlink at 10GHZ operates with a transmit power of 5w and an antenna gain of 48.2dB.Calculate the EIRP in dBw.

9. List the differences between LEO and MEO satellites.

10. What is GRAMSAT?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Describe the steps involved in launching a satellite. (8)

(ii) What are the different types of satellite orbits? Discuss their merits and demerits. (8)

Or

(b) (i) Define look angle and explain look angle determination in detail. (8)

(ii) If a satellite is at a height of 36000 km and orbiting in equatorial plane, comment whether the satellite will be under eclipse on equinox days and find the duration of the eclipse. (8)

12. (a) (i) Explain how altitude and orbit control is achieved from an earth station. (8)

(ii) Derive the satellite link design equation. (8)

Or

(b) (i) Why T, T and C are necessary for a satellite system? Explain in detail. (8)

(ii) Briefly explain the sources of noise in satellite communication. What is the importance of noise temperature in link design? (8)

13. (a) (i) Explain FDMA in detail and also enumerate the interference in FDMA. (8)

(ii) Explain direct sequence spread spectrum communication in detail. (8)

Or

(b) (i) Explain what is meant by back off and why is it necessary in multiple access systems. (6)

(ii) Explain digital video broadcasting in detail. (10)

14. (a) (i) Draw the block diagram and explain the TVRO system. (8)

(ii) Explain in detail the test equipment measurement on G/T, C/No. (8)

Or

(b) (i) Explain earth station transmitter and receiver with necessary block diagram. (10)

(ii) Explain CATV in detail with a neat diagram. (6)

15. (a) (i) Explain direct broadcast satellite in detail. (8)

(ii) Explain GPS in detail with necessary diagrams. (8)

Or

(b) Write notes on

(i) INTELSAT

(ii) E-mail

(iii) BTV

(iv) DTH.

Reg. No. : [ ]

[Question Paper Code : 71428]

B.E./B.Tech DEGREE EXAMINATION, APRIL/MAY 2015.

Eighth Semester

Electronics and Communication Engineering

EC 2045/EC 810/10144 ECE 52 – SATELLITE COMMUNICATION

(Regulation 2008/2010)

(Common to PTEC 2045 – Satellite Communication for B.E. (Part-time)

Seventh Semester – ECE – Regulation 2009)

Time : Three hours Maximum : 100 marks

Answer All questions.

PART - A (10 X 2 = 20 marks)

1. State Kepler's Second Law

2. Differentiate ascending node from descending node.

3. Why thermal control is necessary?

4. Which parameters decide the system reliability?

5. Define single access and multiple access.

6. What is the need of reference burst in TDMA?

7. What is the difference between DBS TV and conventional TV?

8. A satellite downlink at 12 GHz operates with a transmit power of 6 W and an antenna gain of 48.2 dB. Calculate the EIRP in dBW.

9. Name the services provided by GSM.

10. What are the features of LEO?

PART B — (5 × 16 = 80 marks)

11. (a) (i) A satellite is orbiting in the equatorial plane with a period from perigee to perigee of 12 h. Given that the eccentricity is 0.002. Calculate the semi major axis. The earth's equatorial radius is 6378.1414km.

(ii) Explain the orbital perturbations in detail.

Or

(b) (i) Determine the limits of visibility for an earth station situated at mean sea level, at latitude 48.42° north, and longitude 89.26 degrees west. Assume a minimum angle of elevation of 5°. (6)

(ii) Discuss about launching procedures. (10)

12. (a) (i) Explain TT and C system in detail. (8)

(ii) Derive the downlink C/N ratio for the satellite. (8)

or

(b) (i) Explain how intermodulation noise originates in a satellite link and describe how it is reduced? (8)

(ii) Derive link — power budget equation. (8)

13. (a) (i) Explain what is meant by FDMA, and show how this differs from FDM. (6)

(ii) Briefly describe the ways in which demand assignment may be carried out in FDMA network. (10)

Or

(b) Explain the principle behind spectrum spreading and dispreading and how this is used to minimize interference in a CDMA system. (16)

14. (a) Describe and compare the MATV and the CATV systems. (16)

Or

(b) (i) Explain any one test equipment for the measurement on C/N_0. (8)

(ii) Draw the basic block of earth segment and explain

15. (a) (i) Explain the operation of VSAT system in detail. (8)

(ii) Describe the GPS functioning with a block diagram. (8)

Or

(b) (i) Explain how DTH operation is carried out with a neat diagram. (10)

(ii) Write a brief note on video conferencing. (6)

Question Paper Code:80315

B.E/B.TECH. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016

SEVENTH SEMESTER

ELECTRONICS AND COMMUNICATION ENGINEERING

EC 6004-SATELLITE COMMUNICATION

(REGULATION 2013)

Time: Three hours **Maximum: 100 marks**

Answer ALL Questions

PART A- (10 x 2 = 20 marks)

1. State Kepler's first and third law.
2. What is the limit of visibility?
3. Examine why noise temperature is a useful concept in communication receivers?
4. Formulate uplink and downlink equation of a satellite access.
5. Write the features of MATV.
6. A Satellite downlink at 12 GHz operates with a transmit power of 6W and an antenna gain of 48.2Db. Calculate the EIRP in dbw.
7. Point out the pre-assigned TDMA satellite access.
8. How does the spread spectrum system differ from conventional communicational communication systems?
9. What do you infer about GRAMSAT?
10. Outline the three regions to collect the frequency for satellite services.

PART B-(16 x 5= 80 marks)

11. (a). (i). Illustrate the orbital parameters used for positioning a satellite. (8)
(ii). Estimate the suitable equations for look angles and the range for geostationary satellite. (8)
(Or)
(b). (i). Categorize the frequency allocations and draw the frequency spectrum for satellite services.(12)
(ii). Illustrate the effects of non-spherical earth. (4)

12. (a). (i). Justify the reasons behind why the transponders are connected in the communication channel with neat diagrams. (4)
(ii). Analyze the wideband receiver and input de-multiplexer with appropriate diagrams. (12)
(Or)
(b). Examine how the attitude and orbit control system (AOCS) is achieved through spin stabilization systems? Give necessary diagrams. (16)

13. (a). (i) Point out the calculation of link power budget equation. (4)
(ii) List the various types of system noise. Explain in detail. (12)
(Or)

(b). (i) Derive the expression of output back off satellite TWTA output for the downlink communication. (8)

(ii) Calculate the carrier to noise ratio for the combined uplink and downlink communication. (8)

14. (a). (i) Explain FDMA in detail and also enumerate the interference in detail. (8)

(ii) Explain direct sequence spread spectrum communication in detail. (8)

(Or)

(b). (i) Identify the band limited and power limited TWT amplifier operation. (10)

(ii) Explain the operation of digital TASI in TDMA operation. (6)

15. (a). Elaborate the main features and services offered by mobile satellite systems. (16)

(Or)

(b). Discuss the services of the following system with its usage.

(i) INTELSAT (4)

(ii) Email (4)

(iii) BTV (4)

(iv) DTH (4)

IT6005 DIGITAL IMAGE PROCESSING L T P C

3 0 0 3

UNIT I DIGITAL IMAGE FUNDAMENTALS 9

Introduction – Origin – Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels - color models.

UNIT II IMAGE ENHANCEMENT 9

Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering – Frequency Domain: Introduction to Fourier Transform – Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters

UNIT III IMAGE RESTORATION AND SEGMENTATION 9

Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering Segmentation: Detection of Discontinuities–Edge Linking and Boundary detection – Region based segmentation-Morphological processing- erosion and dilation

UNIT IV WAVELETS AND IMAGE COMPRESSION 9

Wavelets – Subband coding - Multiresolution expansions - Compression: Fundamentals – Image Compression models – Error Free Compression – Variable Length Coding – Bit-Plane Coding – Lossless Predictive Coding – Lossy Compression – Lossy Predictive Coding – Compression Standards.

UNIT V IMAGE REPRESENTATION AND RECOGNITION 9

Boundary representation – Chain Code – Polygonal approximation, signature, boundary segments – Boundary description – Shape number – Fourier Descriptor, moments- Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching

TOTAL PERIODS: 45

TEXT BOOKS:

T1. Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, Third Edition, Pearson Education, 2010.

REFERENCES:

R1. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, “Digital Image Processing Using MATLAB”, Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.

R2. Anil Jain K. “Fundamentals of Digital Image Processing”, PHI Learning Pvt. Ltd., 2011

R3. Willliam K Pratt, “Digital Image Processing”, John Willey, 2002

R4. Malay K. Pakhira, “Digital Image Processing and Pattern Recognition”, First Edition, PHI Learning Pvt. Ltd., 2011

R5. http://eeweb.poly.edu/~onur/lectures/lectures.html

R6. http://www.caen.uiowa.edu/~dip/LECTURE/lecture.html

UNIT - I
DIGITAL IMAGE FUNDAMENTALS
PART A

1. Define simultaneous contrast and mach band effect? (April/May 2015)

MACH BAND EFFECT: visual system tends to undershoot or overshoot around the boundary of regions of different intensities. The intensity of the stripes is constant, actually it perceive a brightness pattern that is strongly scalloped, especially near the boundaries. These seemingly scalloped bands are called *Mach bands* .This phenomenon, is called mach band effect.

SIMULTANEOUS CONTRAST: It is related to the fact that a region's perceived brightness does not depend simply on its intensity.

2. Define brightness and contrast? (April/May 2015)

Brightness represents the perceived luminance. it is a subjective descriptor that is practically impossible to measure and it is one of the factors in describing color sensation.

Contrast : $\frac{\Delta f}{f}$ ≈d(log f)≈Δc this equation says equal increment in the log of the luminacw should be perceived to be equally different, the change in contrast ,c=$a_1 + a_2 \log f$ where $a_1 and\ a_2$ are constants is called contrast.

3. State mach band effect?(Nov/Dec 2016, Nov/Dec 2015, May/June 2014)

Machband effect means the intensity of the stripes is constant. Therefore it preserves the brightness pattern near the boundaries, these bands are called as machband effect.

4. Compare RGB and HSI color image model?(Nov/Dec 2014)

HIS color model used to describe by its hue, saturation and intensity, it is well suited for human interpretation .RGB color model appear in its primary spectral components of red, green and blue.

5. Define Hue and Saturation?(May/June 2014)

Hue is a color attribute that describes a pure color where saturation gives a measure of the degree to which a pure color is diluted by white light.

6. How do you relate contrast and brightness?(Nov/Dec 2012)

Brightness represents the perceived luminance. it is a subjective descriptor that is practically impossible to measure and it is one of the factors in describing color sensation.

Contrast: $\frac{\Delta f}{f}$ ≈d(log f)≈Δc this equation says equal increment in the log of the luminacw should be perceived to be equally different, the change in contrast ,c=$a_1 + a_2 \log f$ where $a_1 and\ a_2$ are constants is called contrast

7. Define optical illusion and mach band.(May/June 2013)

Optical illusion is in which the eye fills in non existing information or wrongly perceives geometrical properties of objects

Mach band is not simple function of intensity which is based on visual system tends to overshoot or undershoot around the boundary of region of different intensities. These scalloped band are called mach band.

8. List the hardware oriented color models?

- RGB model, CMY model, YIQ model, HSI model

9. Mention the difference a monochrome and a grayscale image.(Nov/Dec 2013)

Monochrome Image	Grayscale Image
Any one of the color ie black or white	Combination of black and white
Values are 0 and 1	Values are 0 to 255 –gray scale intensity

10. Define Image?

An image may be defined as two dimensional light intensity function f(x, y) ,Where x and y denote spatial co-ordinate and the amplitude or value of f at any point (x, y) is called intensity or grayscale or brightness of the image at that point.

11. What is meant by pixel?

A digital image is composed of a finite number of elements each of which has a particular location or value. These elements are referred to as pixels or image elements or picture elements or pels elements.

12. Define Digital image?

When x, y and the amplitude values of f all are finite discrete quantities, we call the image digital image

13. What is recognition and Interpretation?

Recognition means is a process that assigns a label to an object based on the information provided by its descriptors. Interpretation means assigning meaning to a recognized object

14. What are the types of light receptors?

The two types of light receptors are

- Cones
- Rods

15. Differentiate photopic and scotopic vision?

Photopic vision Scotopic vision

The human being can resolve the fine details with these cones because each one is connected to its own nerve end.This are also known as bright light vision. Several rods are connected to one nerve end. So it gives the overall picture of the image. This is also known as thin light vision.

16. How cones and rods are distributed in retina?

In each eye, cones are in the range 6-7 million and rods are in the range 75-150 million

17. Define subjective brightness and brightness adaptation?

Subjective brightness means intensity as preserved by the human visual system. Brightness adaptation means the human visual system can operate only from scotopic to glare limit. It cannot operate over the range simultaneously. It accomplishes this large variation by changes in its overall intensity.

18. What is simultaneous contrast?

The region reserved brightness not depend on its intensity but also on its background. All centre square have same intensity. However they appear to the eye to become darker as the background becomes lighter.

19. What is meant by illumination and reflectance?

- Illumination is the amount of source light incident on the scene. It is represented as i(x, y).
- Reflectance is the amount of light reflected by the object in the scene. It is represented by r(x,y).

19. Define sampling and quantization

- Sampling means digitizing the co-ordinate value (x, y).
- Quantization means digitizing the amplitude value.

20. Find the number of bits required to store a 256 X 256 image with 32 gray levels?

Gray levels = 25 = 5 bits

257 * 256 * 5 = 327680 bits.

21. Write the expression to find the number of bits to store a digital image?

The number of bits required to store a digital image is b=M X N X k

When M=N, this equation becomes b=N^2k

22. Define checker board effect?(Nov/Dec 2016)

There is an interesting phenomenon known as the checkerboard effect. This effect is observed by leaving unchanged the number of grey levels and varying the spatial resolution while keeping the display area unchanged. The checkerboard effect is caused by pixel replication, that is, lower resolution images were duplicated in order to fill the display area.

PART B

1. Write note on RGB model(8)(Nov/Dec 2011)
2. Explain any four basic relationships between pixels(8)(Nov/Dec 2012)
3. What is a frame buffer? Discuss the categories of digital storage for image processing applications.(8)(Nov/Dec 2012) (Nov/Dec 2014)
4. Describe in detail about the elements of digital image processing systems.(8)(Nov/Dec 2012) (May/June2014)(Nov/Dec 2015)
5. Explain the basic concepts of sampling and quantization with neat sketch.(8)(May/June 2013)
6. Explain about the sampling(4)((May/June2014)
7. What is visual perception model and explain. How this is analogues to a DIP system.(8)(Nov/Dec 2014)
8. When do you prefer non-uniform sampling and quantization? Justify.(8)(Nov/Dec 2014)
9. Describe how the image is digitized by sampling and quantization (8)(April/May2015)
10. What are the elements of an image processing system and describe its working? How this is used for weather forecasting applications? (8)
11. Explain the principle of sampling and quantization. discuss the effect of increasing the: (i) sampling frequency (ii) quantization levels, on image
12. How an RGB model is represented using HIS format? Describe the transformation. (8)
13. Discuss HIS color model in detail. (8) (Nov/Dec 2015)
14. Describe in detail image sensing and acquisition. (16)
15. Explain with example a)Neighbors of pixel b)Connectivity (Nov/Dec 2016, April/May 2009)
16. Explain with block diagram, fundamental steps in digital image processing. (April/May 2010)
17. What are different operations used in DIP? Describe each with example. (April/May 2010)
18. With necessary diagrams explain how an anlog image is converted into digital image.(Nov/Dec 2016)
19. What is meant by image sensing? Explain in detail the construction and operation of various image acquisition devices (Nov/Dec 2016)
20. what is a color model? What is its type? Explain RGB and HIS models with necessary diagrams. (Nov/Dec 2016)

UNIT - 2
IMAGE ENHANCEMENT
PART A

1. What do you infer from multimodal histogram?(May/June 2012)

A multimodal distribution is a probability distribution with more than one peak, or "mode."

- A distribution with two peaks or more is multimodal
- A bimodal distribution is also multimodal, as there are multiple peaks.

2. What are the types of image enhancement available?(Nov/Dec 2012)

- Spatial domain method
- Frequency domain method

3. What is histogram equalization? (Nov/Dec 2015)

It is defined as, the goal is to obtain a uniform histogram for the output image. It is different from continuous and discrete functions.

4. What is a bit plane? (Nov/Dec 2016, Nov/Dec 2013)

Instead of highlighting gray level ranges, highlighting the contribution made to total image appearance by specific bits might be desired. Suppose that each pixel in an image is represented by 8 bits. Imagine that the image is composed of eight 1-bit planes, ranging from bit plane 0 for LSB to bit plane-7 for MSB.

5. Define spatial averaging. (May/June 2014)

Spatial averaging each pixel in an image is replaced by a weighted average of its neighborhood pixel.

6. Specify the objective of image enhancement technique.

The objective of enhancement technique is to process an image so that the result is more suitable than the original image for a particular application.

7. What is contrast stretching?

Contrast stretching reduces an image of higher contrast than the original by darkening the levels below m and brightening the levels above m in the image.

8. What is meant by masking?

Mask is the small 2-D array in which the values of mask co-efficient determine the nature of process. The enhancement technique based on this type of approach is referred to as mask processing.

9. Define histogram.

The histogram of a digital image with gray levels in the range [0, L-1] is a discrete function h(rk)=nk. rk-kth gray level nk-number of pixels in the image having gray level rk.

10. Write the steps involved in frequency domain filtering. x+y

1. Multiply the input image by (-1) to center the transform.
2. Compute F(u,v), the DFT of the image from (1).
3. Multiply F(u,v) by a filter function H(u,v).
4. Compute the inverse DFT of the result in (3).
5. Obtain the real part of the result in (4). x+y
6. Multiply the result in (5) by (-1)

11. **Explain spatial filtering?**

Spatial filtering is the process of moving the filter mask from point to point in an image. For linear spatial filter, the response is given by a sum of products of the filter coefficients, and the corresponding image pixels in the area spanned by the filter mask.

12. **Name the different types of derivative filters?**

1. Perwitt operators
2. Roberts cross gradient operators
3. Sobel operators

13. **What do you mean by Point processing?**

Image enhancement at any Point in an image depends only on the gray level at that point is often referred to as Point processing

14. **What is grey level slicing?**

Highlighting a specific range of grey levels in an image often is desired. Applications include enhancing features such as masses of water in satellite imagery and enhancing flaws in x-ray images.

15. **What is the purpose of image averaging?**

An important application of image averaging is in the field of astronomy, where imaging with very low light levels is routine, causing sensor noise frequently to render single images virtually useless for analysis.

16. Define Laplacian.

The Laplacian of the two dimensional image f(x,y) is defined as

$$\nabla^2 f(x,y) = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

17. **Define image subtraction.**

The difference between 2 images f(x,y) and h(x,y) expressed as, g(x,y)=f(x,y)-h(x,y) is obtained by computing the difference between all pairs of corresponding pixels from f and h

18. What is histogram specification?

The method used to generate a processed image that has a specified histogram is called histogram matching or histogram specification.

19. What is sharpening spatial filtering?

It is used to highlight fine detail in an image. It is used in electronic printing and medical imaging and in military.

20. What is use of smoothing spatial filter?

It is used for blurring and for noised reduction. Blurring is removed of small details from an image.

21. what is unsharp masking? (Nov/Dec 2016)

The Unsharp Mask filter sharpens edges of the elements without increasing noise or blemishThe "unsharp" of the name derives from the fact that the technique uses a blurred, or "unsharp", negative image to create a mask of the original image.

PART B

1. Write the salient features of image histogram. What do you infer?(8)(Nov/Dec 2014)
2. How do you perform directional smoothing, in image? Why it is required?(8) (Nov/Dec 2014).
3. Briefly discuss about the histogram equalization and specification techniques.(16)(May/June 2014) (Nov/Dec 2016)
4. Illustrate the steps in histogram equalization of the image.(16)(Nov/Dec2013)(Nov/Dec 2016)

$$\begin{bmatrix} 4 & 4 & 4 & 4 & 4 \\ 3 & 4 & 5 & 4 & 3 \\ 3 & 5 & 5 & 5 & 3 \\ 3 & 4 & 5 & 4 & 3 \\ 4 & 4 & 4 & 4 & 4 \end{bmatrix}$$

5. Describe histogram equalization. Obtain histogram equalization for the following image segment of size 5×5?Write the inference on image segment before and after equalization.(16)(May/June2013)

$$\begin{bmatrix} 20 & 20 & 20 & 18 & 16 \\ 15 & 15 & 16 & 18 & 15 \\ 15 & 15 & 19 & 15 & 17 \\ 16 & 17 & 19 & 18 & 16 \\ 20 & 18 & 17 & 20 & 15 \end{bmatrix}$$

6. What is histogram equalization? Discuss in detail about the procedure involved in histogram matching.(16)(Nov/Dec 2012)
7. Write in detail about histogram processing.(10)(Nov/Dec2011)
8. Describe histogram equalization. Obtain histogram equalization for the following 8 bit image segment of size 5×5?Write the inference on image segment before and after equalization.(16)(April/May2015)

$$\begin{bmatrix} 200 & 200 & 200 & 180 & 240 \\ 180 & 180 & 180 & 180 & 190 \\ 190 & 190 & 190 & 190 & 180 \\ 190 & 200 & 220 & 220 & 240 \\ 230 & 180 & 190 & 210 & 230 \end{bmatrix}$$

9. Explain histogram specification techniques in detail with equations.(8)(Nov/Dec 2015)
10. How first and second derivative enhance the image? Explain which is more enhance?(Nov/Dec 2009)
11. Explain in detail the method for smoothening the image is frequency domain.(Nov/Dec 2016)
12. Explain gradient operators for image enhancement.(Nov/Dec 2016)

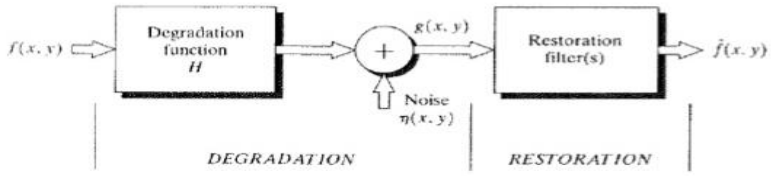
UNIT - 3
IMAGE RESTORATION AND SEGMENTATION
PART – A

1. What is meant by Image Restoration?

Restoration is the process of removal or minimization or recovering of known degradation or distorted in an image.

2. How a degradation process is modeled? (Nov/Dec 2016,NOV/DEC 2011,MAY/JUNE 2013, APR/MAY 2015)

The degradation process is modeled as a degradation function that together with an additive noise term operates on an input image F(x,y).



3. Define Gray-level interpolation?

Gray-level interpolation deals with the assignment of gray levels to pixels in the spatially transformed image

4. What is meant by Noise probability density function?

The spatial noise descriptor is the statistical behavior of gray level values in the noise component of the model.

5. Why the restoration is called as unconstrained restoration? (MAY/JUNE 2014, MAY/JUNE 2014)

In the absence of any knowledge about the noise _n‘, a meaningful criterion function is to seek an f^ such that H f^ approximates of in a least square sense by assuming the noise term is as small as possible. Where H = system operator. f^ = estimated input image. g = degraded image.

6. Which is the most frequent method to overcome the difficulty to formulate the spatial relocation of pixels?

The point is the most frequent method, which are subsets of pixels whose location in the input (distorted) and output (corrected) imaged is known precisely.

7. What are the three methods of estimating the degradation function?

(i). Observation
(ii). Experimentation
(iii). Mathematical modeling.

8. What are the types of noise models?

Guassian noise. Rayleigh noise. Erlang noise. Exponential noise. Uniform noise. Impulse noise.

9. Give the relation for rayleigh noise?

Rayleigh noise:

The PDF is P(Z)= 2(z-a)e-(z—a)2/b/b for Z>=a 0 for Z<a

mean μ=a+ b/4 standard deviation _2=b(4-_)/4

10.Give the relation for Gamma noise?

Gamma noise:

The PDF is P(Z)=ab zb-1 ae-az/(b-1) for Z>=0 0 for Z<0 mean μ=b/a,
standard deviation _2=b/a2

11.Give the relation for Exponential noise?

Exponential noise

The PDF is P(Z)= ae-az Z>=0
Z<0 mean μ=1/a
standard deviation _2=1/a2

12.Give the relation for Uniform noise? (APR/MAY 2015)

Uniform noise:

The PDF is P(Z)=1/(b-a) if a<=Z<=b 0 otherwise mean μ=a+b/2
standard deviation _2=(b-a)2/12

13.Give the relation for Impulse noise?

Impulse noise:

The PDF is P(Z) =Pa for z=a Pb for z=b 0 Otherwise

14. What is inverse filtering? (MAY/JUNE 2014)

The simplest approach to restoration is direct inverse filtering, an estimate F^(u,v) of the transform of the original image simply by dividing the transform of the degraded image G^(u,v) by the degradation function.

F^ (u,v) = G^(u,v)/H(u,v)

15. What is pseudo inverse filter?

It is the stabilized version of the inverse filter.For a linear shift invariant system with frequency response H(u,v) the pseudo inverse filter is defined as H-(u,v)=1/(H(u,v) H=/00 H=0

16. What is meant by least mean square filter?

The limitation of inverse and pseudo inverse filter is very sensitive noise. The wiener filtering is a method of restoring images in the presence of blurr as well as noise.

17. Write the properties of Singular value Decomposition(SVD)?

- The SVD transform varies drastically from image to image.
- The SVD transform gives best energy packing efficiency for any given image.
- The SVD transform is useful in the design of filters finding least square, minimum solution of linear equation and finding rank of large matrices.

18. What is meant by blind image restoration?

An information about the degradation must be extracted from the observed image either explicitly or implicitly. This task is called as blind image restoration.

19. What are the two approaches for blind image restoration?

- Direct measurement.
- Indirect estimation.

20. What is meant by Direct measurement?

In direct measurement the blur impulse response and noise levels are first estimated from an observed image where this parameter are utilized in the restoration.

21. What is segmentation?

Segmentation subdivides on image in to its constitute regions or objects. The level to which the subdivides is carried depends on the problem being solved .That is segmentation should when the objects of interest in application have been isolated.

22. Write the applications of segmentation. (NOV/DEC 2013)

- Detection of isolated points.
- Detection of lines and edges in an image.

23.What are the three types of discontinuity in digital image?

Points, lines and edges.

24.How the derivatives are obtained in edge detection during formulation?

The first derivative at any point in an image is obtained by using the magnitude of the gradient at that point. Similarly the second derivatives are obtained by using the laplacian.

25.Write about linking edge points.

The approach for linking edge points is to analyze the characteristics of pixels in a small neighborhood (3x3 or 5x5) about every point (x,y)in an image that has undergone edge detection. All points that are similar are linked, forming a boundary of pixels that share some common properties.

26.What are the two properties used for establishing similarity of edge pixels?

a. The strength of the response of the gradient operator used to produce the edge pixel.
b. The direction of the gradient.

27.What is edge?

An edge isa set of connected pixels that lie on the boundary between two regions edges are more closely modeled as having a ramplike profile. The slope of the ramp is inversely proportional to the degree of blurring in the edge.

28.Give the properties of the second derivative around an edge? (APR/MAY 2015)

- The sign of the second derivative can be used to determine whether an edge pixel lies on the dark or light side of an edge.
- It produces two values for every edge in an image.
- An imaginary straightline joining the extreme positive and negative values of the second derivative
- would cross zero near the midpoint of the edge.

29.Define Gradient Operator?

First order derivatives of a digital image are based on various approximation of the 2-D gradient. The gradient of an image f(x,y) at location(x,y) is defined as the vector

Magnitude of the vector is _f=mag(_f)=[Gx2+ Gy2]1/2 _(x,y)=tan-1(Gy/Gx) _(x,y) is the direction angle of vector _f

30.What is meant by object point and background point?

To execute the objects from the background is to select a threshold T that separate these modes. Then any point (x,y) for which f(x,y)>T is called an object point. Otherwise the point is called background point.

31.What is global, Local and dynamic or adaptive threshold?

When Threshold T depends only on f(x,y) then the threshold is called global . If T depends both on f(x,y) and p(x,y) is called local. If T depends on the spatial coordinates x and y the threshold is called dynamic or adaptive where f(x,y) is the original image.

32.What is the principle of growing based image segmentation? (NOV/DEC2011,MAY/JUNE 2014)

Region growing is a procedure that groups pixels or subregions in to layer regions based on predefined criteria. The basic approach is to start with a set of seed points and from there grow regions by appending to each seed these neighbouring pixels that have properties similar to the seed.

33.Specify the steps involved in splitting and merging? (MAY/JUNE 2013, MAY/JUNE 2014)

Split into 4 disjoint quadrants any region Ri for which P(Ri)=FALSE. Merge any adjacent regions Rj and Rk for which P(RjURk)=TRUE. Stop when no further merging or splitting is positive.

34.What is meant by markers?

An approach used to control over segmentation is based on markers. marker is a connected component belonging to an image. We have internal markers, associated with objects of interest and external markers associated with background.

35.What are the 2 principles steps involved in marker selection? (NOV/DEC 2012)

The two steps are

a. Preprocessing
b. Definition of a set of criteria that markers must satisfy.

36.State the conditions to be met by the partitions in region based segmentation. (NOV/DEC 2011)

a. $P(R_i)$=TRUE for i=1,2,…n=Deals with the properties that must be satisfied by the pixels in a segmented region
b. $P(R_iUR_j)$=FALSE for i=j=The pixels in two adjacent regions should not have the same identity level.

37.Why geometric transformation are called so? (MAY/JUNE 2012, APR/MAY 2015))

Geometric transformation are used to restore the images that have already undergone geometric distortions. They recover the original image by modifying the spatial relationships between pixels in an image.

38.What is meant by wiener filter? (NOV/DEC 2012)

Wiener filtering is a method of restoring images in the presence of blur as well as noise.The aim is to approximate the original images that the mean square error between the original and approximated image is minimized.

39.Mention the drawbacks of inverse filtering. (NOV/DEC 2013)

Highly sensitive to noise and removal of blur caused by uniform linear motion.

40. What is mean by Lagrange multiplier? (NOV/DEC 2014)

Lagrange multiplier is used to minimize the noise as well as to achieve the equality constraint.

$$W(f)=|Qf|^2+\lambda(|(g-Hf)|^2-|n|^2)$$

41.What do you understand by Mexican hat function? (Nov/Dec 2016)

The 2D forms by just spinning the 1D form about the vertical axis yielding isotropic functions which have the same 1D Gaussian cross section in any cut through the origin. The second derivative form is well known as a sombrero or Mexican hat.

PART B

1. What is image segmentation. Explain in detail.
2. Explain Edge Detection in details?
3. Define Thresholding and explain the various methods of thresholding in detail?
4. Discuss about region based image segmentation techniques. Compare threshold region based techniques.
5. Define and explain the various representation approaches?
6. Explain Boundary descriptors.
7. Explain regional descriptors
8. Explain the two techniques of region representation.
9. Explain the segmentation techniques that are based on finding the regions directly.
10. How is line detected? Explain through the operators.
11. Explain the algebra approach in image restoration.
12. What is the use of wiener filter in image restoration. Explain.
13. What is meant by Inverse filtering? Explain.
14. Explain singular value decomposition and specify its properties.
15. Explain image degradation model /restoration process in detail.
16. What the two approaches for blind image restoration? Explain in detail?
17. Explain in detail about removal of blur caused by uniform linear motion?
18. Explain in detail about constrained an unconstrained restoration
19. Illustrate the different causes of Image degradation?
20. Describe constrained least square filtering for image restoration and derive its transfer function?
21. Explain the concept of geometric transformation for image restoration?
22. Apply order statistics filter on the selected pixels in the images.(Nov/Dec 2016)
23. Explain how wiener filter is used for image restoration. .(Nov/Dec 2016)
24. Explain the process of edge linking using hough transform. .(Nov/Dec 2016)
25. Explain region based segmentation technique. (Nov/Dec 2016)

UNIT - 4
WAVELETS AND IMAGE COMPRESSION
PART-A

1. What is image compression?

Image compression refers to the process of redundancy amount of data required to represent the given quantity of information for digital image. The basis of reduction process is removal of redundant data.

2. What is Data Compression?

Data compression requires the identification and extraction of source redundancy. In other words, data compression seeks to reduce the number of bits used to store or transmit information.

3. What are two main types of Data compression?

- Lossless compression can recover the exact original data after compression. It is used mainly for compressing database records, spreadsheets or word processing files, where exact replication of the original is essential.
- Lossy compression will result in a certain loss of accuracy in exchange for a substantial increase in compression.
- Lossy compression is more effective when used to compress graphic images and digitised voice where losses outside visual or aural perception can be tolerated.

4. What is the need for Compression? (NOV/DEC 2011, MAY/JUNE 2012,MAY 2013,MAY/JUNE2014)

- In terms of storage, the capacity of a storage device can be effectively increased with methods that compress a body of data on its way to a storage device and decompresses it when it is retrieved.
- In terms of communications, the bandwidth of a digital communication link can be effectively increased by compressing data at the sending end and decompressing data at the receiving end.
- At any given time, the ability of the Internet to transfer data is fixed. Thus, if data can effectively be compressed wherever possible, significant improvements of data throughput can be achieved. Many files can be combined into one compressed document making sending easier.

5. What are different Compression Methods?

Run Length Encoding (RLE) Arithmetic coding Huffman coding and Transform coding.

6. Define is coding redundancy? (NOV/DEC 2015)

If the gray level of an image is coded in a way that uses more code words than necessary to represent each gray level, then the resulting image is said to contain coding redundancy.

7. Define interpixel redundancy?

The value of any given pixel can be predicted from the values of its neighbors.

The information carried by is small. Therefore the visual contribution of a single pixel to an image is redundant. Otherwise called as spatial redundant geometric redundant or

8. What is run length coding? (MAY/JUNE 2014, NOV/DEC 2015)

Run-length Encoding, or RLE is a technique used to reduce the size of a repeating string of characters. This repeating string is called a *run*; typically RLE encodes a run of symbols into two bytes, a count and a symbol. RLE can compress any type of data regardless of its information content, but the content of data to be compressed affects the compression ratio. Compression is normally measured with the compression ratio:

9. Define compression ratio.

Compression Ratio = original size / compressed size: 1

10. Define psycho visual redundancy?

In normal visual processing, certain information has less importance than other information. So this information is said to be psycho visual redundant.

11. Define encoder

Source encoder is responsible for removing the coding and interpixel redundancy and psycho visual redundancy.

There are two components

- Source Encoder
- Channel Encoder

12. Define source encoder

Source encoder performs three operations

1. Mapper -this transforms the input data into non-visual format. It reduces the interpixel redundancy.
2. Quantizer - It reduces the psycho visual redundancy of the input images. This step is omitted if the system is error free.
3. Symbol encoder- This reduces the coding redundancy. This is the final stage of encoding process.

13. Define channel encoder

The channel encoder reduces reduces the impact of the channel noise by inserting redundant bits into the source encoded data. Eg: Hamming code.

14. What are the types of decoder?

Source decoder- has two components

a) Symbol decoder- This performs inverse operation of symbol encoder. b) Inverse mapping- This performs inverse operation of mapper. Channel decoder-this is omitted if the system is error free.

15. What are the operations performed by error free compression?

1) Devising an alternative representation of the image in which its interpixel redundant are reduced.
2) Coding the representation to eliminate coding redundancy

16. What is Variable Length Coding?

Variable Length Coding is the simplest approach to error free compression. It reduces only the coding redundancy. It assigns the shortest possible codeword to the most probable gray levels.

17. Define Huffman coding. (MAY/JUNE 2012, MAY/JUNE 2013)

Huffman coding is a popular technique for removing coding redundancy. When coding the symbols of an information source the Huffman code yields the smallest possible number of code words, code symbols per source symbol.

18. Define Block code

Each source symbol is mapped into fixed sequence of code symbols or code words. So it is called as block code.

19. Define instantaneous code

A code word that is not a prefix of any other code word is called instantaneous or prefix codeword.

20. Define uniquely decodable code

A code word that is not a combination of any other codeword is said to be uniquely decodable code.

21. Define B2 code

Each code word is made up of continuation bit c and information bit which are binary numbers. This is called B2 code or B code. This is called B2 code because two information bits are used for continuation bits

22. Define the procedure for Huffman shift

List all the source symbols along with its probabilities in descending order.

Divide the total number of symbols into block of equal size. Sum the probabilities of all the source symbols outside the reference block. Now apply the procedure for reference block, including the prefix source symbol. The code words for the remaining symbols can be constructed by means of one or more prefix code followed by the reference block as in the case of binary shift code.

23. Define arithmetic coding

In arithmetic coding one to one corresponds between source symbols and code word doesn‘t exist where as the single arithmetic code word assigned for a sequence of source symbols. A code word defines an interval of number between 0 and 1.

24. What is bit plane Decomposition?

An effective technique for reducing an image‘s interpixel redundancies is to process the image‘s bit plane individually. This technique is based on the concept of decomposing multilevel images into a series of binary images and compressing each binary image via one of several well-known binary compression methods.

25. What are three categories of constant area coding?

The three categories of constant area coding are All white All black Mixed intensity.

The most probable or frequency occurring is assign a 1 bit code _0‘, other two categories area assigned as 2 bit code _10‘ and _11‘.

26. How effectiveness of quantization can be improved?

Introducing an enlarged quantization interval around zero, called a dead zero.

Adapting the size of the quantization intervals from scale to scale. In either case, the selected quantization intervals must be transmitted to the decoder with the encoded image bit stream.

27. What are the coding systems in JPEG?

a) A lossy baseline coding system, which is based on the DCT and is adequate for most compression application.
b) An extended coding system for greater compression, higher precision or progressive reconstruction applications.
c) a lossless independent coding system for reversible compression.

28. Define Lossless and lossy compression. (APR/MAY 2015)

Lossless compression: Error free compression is the only acceptable means of data reduction, there is no loss of data. It is applicable to both binary and gray-scale image. They normally provide compression ratio ranging from 2 to 10.

Lossy compression: It can achieve high rates of compression. But they reduce the accuracy of the reconstruction images by producing some distortions.

29. What is image pyramid? (Nov/Dec 2016)

Image features at different resolutions require filters at different scales. Image Pyramid = Hierarchical representation of an image

PART B

1. What is data redundancy? Explain three basic data redundancy?
2. What is image compression? Explain any four variable length coding compression schemes.
3. Explain about Image compression model?
4. Explain about Error free Compression?
5. Explain about Lossy compression?
6. Explain the schematics of image compression standard JPEG.
7. Explain how compression is achieved in transform coding and explain about DCT
8. Explain arithmetic coding
9. Explain about Image compression standards?
10. Discuss about MPEG standard and compare with JPEG
11. Explain two dimensional discrete wavelet transform(DWT) .(Nov/Dec 2016)
12. Encode the word a1.a2,a3 using arithmetic code and generate the tag for the given symbol with probabilities. A1->0.2,a2->0.2,a3->0.4,a4->0.2.(Nov/Dec 2016)
13. What is the need for image compression? Explain image compression standard in detail? (Nov/Dec 2016)

UNIT-5
IMAGE REPRESENTATION AND RECOGNITION
PART-A

1. Define representation. Mention its types.

Representation is defined as the process of characterizing the quantity represented by each pixel. It is used to change the output of segmentation which is a raw pixel data in to a form suitable for further computer processing.

Two Types: 1. Boundary Representation 2. Regional Representation

2. What are chain codes?

Chain codes are used to represent a boundary by using a connected sequence of straight –line segments with specified length and direction. In this Representation, each segment of different direction is given a different number.

3. Define convex hull.

A set 'A' is said to be convex if the straight line joining any two points in 'A' lies entirely within 'A'. The convex hull, H of an arbitrary set S is defined as the smallest convex set containing S.

4. What is meant by Thinning or Skeletonizing?

A skeletonizing is a graph representation of the structural shape of a plane region,which is a regional representation. The process of generating skeletons is known as Thinning or Skeletonizing.

5. Mention the types of descriptors.

- Boundary descriptors
- Regional descriptors
- Relational descriptors.

6. Give any four simple descriptors used to describe the boundary of a region.

1.Length 2.Diameter 3.Major and Minor axis 4.Eccentricity

7. What is texture?(Nov/Dec 2016)

Texture content is an important quantity used to describe a region. The texture of a region provides measures of properties such as smoothness, coarseness and regularity.

8. Define entropy.

Entropy is defined as a measure of variability of an image. It is one of the measure of texture.

9. Define topological description.

Topology is defined as the study of properties of an image which are not affected by any deformation such as stretching, rotation. These properties will change only when there is tearing of the image. Using such properties to describe an image is called topological description.

10. What are the approaches used to describe the texture?

1. Statistical approaches: Used to characterize the texture as smooth,coarse grainy
2. Structural approaches: Based on the arrangement of image primitives.
3. Spectral approaches: Based on the properties of the fourier spectrum.

11. Define cellular complex.

The set of cells enclosing a digital boundary, described in the previous paragraphs is called cellular complex.

12. What is merging techniques.

Merging techniques based on average error or other criteria have been applied to the problem of polygon approximation.

13. Explain splitting techniques.

One approach to boundary segment splitting is to subdivide a segment successively into two parts until a specified criterion is satisfied.

14. Define signature.

A signature is a 1-D functional representative of a boundary and may be generated in various ways . One of the simplest is to plt the distance from centroid to the boundary as a function of angle.

15. Define convex deficiency

The convex hull H of an arbitrary set S the smallest convex set containing S. The set difference H-S is called the convex deficiency.

16. What is circularity ratio?

It is defined as the ratio of area of a region to the are of a circle having the same perimeter .

17. Define topological descriptor.

Topology is the study of properties of a figure, that are unaffected by any deformation as long as there is no joining of the figure .It is also called rubber sheet distortion.

18. Define minutiae.

The fingerprint recognition is based on the interrelationship of print features.

19. Define Bayes classifier.

The classifier that minimizes the total average loss.

20. What is mean by neural network.

The essence of the material that follows is the use of multitude of the elemental nonlinear computing elements organized as networks reminiscent of the way in which neurons are believed to the interconnected in the brain.

21. What is skeletonizing? (Nov/Dec 2016)

Skeletonization is a process for reducing foreground regions in a binary image to a skeletal remnant that largely preserves the extent and connectivity of the original region while throwing away most of the original foreground pixels.

PART B

1. What is Boundary descriptor? Explain in detail.
2. Describe the Boundary representatives with neat circuit diagram.(Nov/Dec 2016)
3. Explain with neat diagram Chain code.
4. Explain about Boundary segment?
5. Explain about Fourier descriptor?
6. Explain the regional descriptor in detail.
7. Explain in detail about texture.
8. Explain in detail about topological feature.
9. Explain about pattern and pattern classes.
10. Discuss about shape number.
11. Explain image recognition based on matching.(Nov/Dec 2016)

Anna University Question Papers

Anna University , Chennai

B.E./B.Tech. Degree Examination, November/December 2012

Seventh Semester

Electronics and Communication Engineering

EC 2029/EC 708 - Digital Image Processing

(Regulation 2008)

Time: Three hours **Maximum : 100 marks**

Answer ALL questions

Part A - (10 * 2 = 20 marks

1. What is meant by brightness and contrast?
2. Justify that KLT is an optimal transform.
3. What are the types of image enhancement available?
4. Mention the procedure involved in marker selection.
5. What is bit plane slicing?
6. List out the coding systems defined in JPEG standard.
7. Why the image is subjected to Wiener filtering?
8. How are shift codes generated?
9. Define Sobel operator.
10. Write the Hadamard transform matrix Hn for n = 3.

Part B - (5 * 16 = 80 marks)

11. (a) (i) Explain any four basic relationships between pixels.(8 marks)
11. (a) (ii) What are the different transforms used in DIP? Explain the most advantageous one in detail.(8 marks)

Or

11. (b) (i) What is a frame buffer? Discuss the categories of digital storage for image processing applications.(8 marks)
11. (b) (ii) Describe in detail about the elements of digital image processing system.(8 marks)

12. (a) What is histogram equalization? Discuss in detail about the procedure involved in histogram matching.(16 marks)

Or

12. (b) (i) Specify the expressions for the following filters.
1. Geometric mean filter
2. Harmonic mean filter
3. Contraharmonic mean filter (6 marks)

12. (b) (ii) Write notes on Homomorphic filtering.(10 marks)
13. (a) (i) What is gray level interpolation? Explain the schemes involved in it.(8 marks)
13. (a) (ii) Differentiate constrained and unconstrained restoration.(8 marks)

13. (b) Write notes on
1. Inverse Filtering
2. Least square error filter (16 marks)

14. (a) (i) Explain global processing using Hough transform.(8 marks)
14. (a) (ii) What do you understand by dilation and erosion in morphological operation? Explain in detail.(8 marks)

Or

14. (b) (i) Discuss in detail about the threshold selection based on boundary characteristics.(8 marks)
14. (b) (ii) Elaborate the process of dam construction along with the watershed segmentation algorithm.(8 marks)

15. (a) Determine the Huffman code assignment procedure for the following data. Compute the average length of the code and the entropy of the source. Is Huffman code uniquely decodable? If so, justify your answer. (16 marks)

Or

15. (b) (i) Discuss the methods of constructing the masking function based on maximum variance and maximum magnitude.(8 marks)
15. (b) (ii) Draw and explain the block diagram of MPEG encoder.(8 marks)

B.E./B.TECH DEGREE EXAMINATION, MAY/JUNE 2013

Seventh Semester

Electronics and Communication Engineering

EC 2029 / EC 708 – DIGITAL IMAGE PROCESSING

(Regulation 2008)

Time: Three hours Maximum : 100 marks

Answer ALL questions

PART A – (10 X 2 = 20 marks)

1. Define Optical illusion and Mach band.
2. Define checker board effect and false contouring.
3. Give the PDF of Gaussian noise and plot it.
4. Define and give the transfer function of contraharmonic filter.
5. Define image degradation model and sketch it.
6. Define rubber sheet transformation.
7. Write sobel horizontal and vertical edge detection masks.
8. Define region splitting and merging.
9. State the optimality conditions for Huffman code.
10. State the need for data compression.

PART B – (5 X 16 = 80 marks)

11. (a) (i) Explain the basic concepts of sampling and quantization with neat sketch. (8)
(ii) Find the DCT Transform and its inverse for the given 2X2 image [3 6 ; 6 4]

(Or)

(b) (i) Obtain forward KL transform for the given vectors.X1 = [1 0 0] ; X2 = [1 0 1] ; X3 = [1 1 0] (Transpose these vectors) and analyse how the principal components are used for remote sensing applications?

12. (a) Describe histogram equalization. Obtain histogram equalization for the following image segment of size 5 X 5. Write the interference on the image segment before and after equalization.
20 20 20 18 16
15 15 16 18 15
15 15 19 15 17
16 17 19 18 16
20 18 17 20 15 (5 X 5) matrix (16)

Or)

(b) (i) Describe how homomorphic filtering is used to separate illumination and reflectance components? (8)
(ii) How mean filters are used for image enhancement. (8)

13. (a) Describe constrained least square filtering for image restoration and derive its transfer function. (16)

(Or)

(b) (i) Explain the concepts of geometric transformation for image restoration? (8)
(ii) How weiner filtering is helpful to reduce the mean square error? (8)

14. (a) (i) How do you link edge pixels through global processing? (8)
(ii) Describe Watershed segmentation algorithm. (8)

(Or)

(b) (i) Explain region based segmentation and region growing with an example. (8)
(ii) Discuss how to construct dams using morphological operation? (8)

15. (a) (i) Briefly explain transform coding with neat sketch. (8)
(ii) A source emits letters from an alphabet A = {a1 , a2 , a3 , a4 , a5} with probabilities P(a1) = 0.2 , P(a2) = 0.4 , P(a3) = 0.2 , P(a4) = 0.1 and P(a5) = 0.1. (8)
(1) Find the Huffman code for this source?
(2) Find the average length of the code and its redundancy?

(Or)

(b) (i) Generate the tag for the sequence 1 3 2 1 for the probabilities P(1) = 0.8 , P(2) = 0.02 , P(3) = 0.18. (8)
(ii) How an image is compressed using JPEG image compression standard? (8)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 31331

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

Seventh Semester

Electronics and Communication Engineering

EC 2029/EC 708 — DIGITAL IMAGE PROCESSING

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Mention the difference between a monochrome and a grayscale image.

2. State two important properties of unitary transforms.

3. What is a bit plane?

4. State how contrast adjustment can be done in an image.

5. List any two properties of a median filter.

6. Mention the drawbacks of inverse filtering.

7. Mention two applications of image segmentation techniques.

8. Write the importance of Edge detection.

9. Distinguish between scalar and vector quantization.

10. Mention the limitations of Huffman coding.

PART B — (5 × 16 = 80 marks)

11. (a) State and prove convolution property of 2D–FFT. (16)

Or

(b) Determine the DCT matrix for N = 4. (16)

12. (a) Illustrate the steps in histogram equalization of the image. (16)

$$\begin{bmatrix} 4 & 4 & 4 & 4 & 4 \\ 3 & 4 & 5 & 4 & 3 \\ 3 & 5 & 5 & 5 & 3 \\ 3 & 4 & 5 & 4 & 3 \\ 4 & 4 & 4 & 4 & 4 \end{bmatrix}$$

Or

(b) With the help of a block diagram, discuss the principle of homomorphic filtering. (16)

13. (a) Illustrate the different causes of image degradation.

Or

(b) A blur filter h(m,n) is given by $\begin{vmatrix} 0.1 & 0.1 & 0.1 & 0 \\ 0.1 & 0.1 & 0.1 & 0.1 \\ 0.05 & 0.1 & 0.1 & 0.05 \\ 0 & 0.05 & 0.05 & 0 \end{vmatrix}$.

Find the deblur filter using inverse filtering.

14. (a) Discuss the principle of image segmentation by watershed transformation and explain its drawbacks. (16)

Or

(b) Discuss image segmentation based on various thresholding techniques. (16)

15. (a) For the image shown below compute the compression ratio that can be achieved using Huffman coding. (16)

$$\begin{bmatrix} 3 & 3 & 3 & 2 \\ 2 & 3 & 3 & 3 \\ 3 & 2 & 2 & 2 \\ 2 & 1 & 1 & 0 \end{bmatrix}$$

Or

(b) A source emits three symbols A,B,C with a probability {0.5,0.25,0.25} respectively. Construct an arithmetic code to encode the word 'C A B'.

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B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2014.

Seventh Semester

Electronics and Communication Engineering

EC 2029/EC 708/10144 ECE 41 — DIGITAL IMAGE PROCESSING

(Regulation 2008/2010)

(Common to 10144 ECE 41 – Digital Image Processing for B.E. (Part-Time) Seventh Semester – ECE – Regulation 2010)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Compare RGB and HSI color image models.

2. Write the Kernel for 2D–DCT and how this lead to data compression.

3. What are the possible ways, for adding noise in images?

4. For the following image region, obtain the median filtered output.

72	55	33	65	32	30	21	12
15	20	3	5	18	21	65	30
35	40	34	255	200	17	51	87
0	255	20	100	101	87	59	42
65	32	18	78	86	50	21	11
30	11	8	97	108	129	151	2
68	72	19	37	14	27	50	64
36	202	111	18	26	192	23	63

5. What is Lagrange multiplier? Where it is used?

6. Why blur is to be removed from images?

7. How edges are linked through Hough transform?

8. State the problems in "region splitting and merging" based image segmentation.

9. What is a shift code? How this is used in image analysis?

10. Write the performance metrics for image compression.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Write the elements of an image processing system and its working. Describe the working principle of operation of vidicon camera. (8)

(ii) How do you obtain the 2D-DFT for a digital image? Discuss about the time complexities. (8)

Or

(b) (i) What is visual perception model and explain. How this is analogous to a DIP system. (8)

(ii) When do you prefer non-uniform sampling and quantization? Justify. (8)

12. (a) (i) Write the salient features of image histogram. What do you infer? (8)

(ii) Explain any two techniques for color image enhancement. (8)

Or

(b) (i) How do you perform directional smoothing, in images? Why it is required? (8)

(ii) What is geometric mean and harmonic mean with reference to an image? What purpose do they serve for image analysis? Discuss. (8)

13. (a) (i) Describe how image restoration can be performed for black and white binary images. (8)

(ii) Compare restoration with image enhancement. (8)

Or

(b) (i) What is Weiner filtering approach? How this is used for image restoration? Describe. (8)

(ii) What are the performance measures for ascertaining the adequacy of image restoration? (8)

(a) (i) How edge detection is performed in digital images using
(1) Laplacian operator
(2) Sobel operator and
(3) Prewitt operator and compare their out comes. (2)

(ii) Write morphological concepts applicable for image processing. (2)

(2+2)

Or

(b) (i) What is meant by optimal thresholding? How do you obtain the threshold for image processing tasks? (8)

(ii) Describe watershed segmentation algorithm and compare with region based approaches. (8)

(a) (i) Discuss the need for image compression. Perform Huffman algorithm for the following intensity distribution, for a 64×64 image. Obtain the coding efficiency and compare with that of uniform length code. (8)

$r_0 = 1008$

$r_1 = 320$

$r_2 = 456$

$r_3 = 686$

$r_4 = 803$

$r_5 = 105$

$r_6 = 417$

$r_7 = 301$

(ii) What is arithmetic coding? Illustrate. (8)

Or

(b) (i) Explain the procedure for obtaining Run Length Coding (RLC). What are the advantages if any? (8)

(ii) Write short notes on (4)
(1) Vector Quantization (4)
(2) JPEG Standard.

Question Paper Code : 71414

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015

Seventh Semester

Electronics and Communication Engineering

EC 2029/EC 708/10144 ECE 41 — DIGITAL IMAGE PROCESSING

(Regulation 2008/2010)

(Common to 10144 ECE 41 – Digital Image Processing for B.E. (Part-Time) Seventh Semester – ECE – Regulation 2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define simultaneous contrast and mach band effect.

2. Define brightness and contrast.

3. Give the PDF of uniform noise and sketch it.

4. Define and give the transfer function of Mean and Geometric Mean filter.

5. Define image degradation model and sketch it.

6. Define Geometric transformation.

7. Write the properties of first order and second order derivative.

8. Define local thresholding for edge detection.

9. State the need for data compression and compare lossy and lossless compression techniques.

10. List the advantages of transform coding.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Describe how the image is digitized by sampling and quantization and explain about checker board effect and false contouring with neat sketch. (8)

(ii) Find Discrete Cosine Transform and its inverse for the following image data. [0255; 2550] [2 × 2] matrix. (8)

Or

(b) Obtain Discrete Fourier transform for the given vectors. Input image matrix = [0 0; 255 255] [2 × 2] matrix. Also analyze how the Fourier transform is used if the image is rotated or translated. (16)

12. (a) Describe histogram equalization. Obtain Histogram equalization for the following 8 bit image segment of size 5 × 5. Write the inference on image segment before and after equalization. (16)

200 200 200 180 240

180 180 180 180 190

190 190 190 190 180

190 200 220 220 240

230 180 190 210 230 (5 × 5) matrix.

Or

(b) (i) Describe how homomorphic filtering is used to separate illumination and reflectance component. (8)

(ii) How color image is enhanced and compare it with grayscale processing? (8)

13. (a) Describe inverse filtering for removal of blur caused by any motion and describe how it restore the image. (16)

Or

(b) How wiener filter is helpful to reduce the mean square error when image is corrupted by motion blur and additive noise?

14. (a) (i) How do you link edge pixels through Hough transform? (8)

(ii) Describe Watershed segmentation algorithm. (8)

Or

(b) (i) Explain region based segmentation and region growing with an example. (8)

(ii) Discuss how to construct dams using morphological operations. (8)

Question Paper Code : 21414

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Seventh Semester

Electronics and Communication Engineering

EC 2029/EC 7029/10144 ECE 41 — DIGITAL IMAGE PROCESSING

(Regulations 2008/2010)

(Common to PG141 ECE 41 — Digital Image Processing for B.E. (Part Time) Seventh Semester – ECE – Regulations 2010)

Time : Three hours. Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State Mach band effect.
2. Give the transform pair equation of 2D DFT.
3. What is histogram equalization?
4. Define directional smoothing filter.
5. Distinguish between image enhancement and image restoration.
6. What are the various geometric transformations?
7. Give the principle of region growing.
8. What is global thresholding?
9. Define coding redundancy.
10. What is the basic concept of run length coding?

PART B — (5 × 16 = 80 marks)

11. (a) (i) List and explain various elements of a digital image processing system. (8)

(ii) Explain the working principle of a digital camera with a diagram. (8)

Or

(b) (i) Discuss HSI color model in detail. (6)

(ii) Describe various steps involved in the computation of KL transform with equations. How will you use it for data compression? (10)

12. (a) (i) Explain histogram specification technique in detail with equations. (8)

(ii) Discuss the following spatial enhancement techniques.

(1) Spatial averaging (4)

(2) Median filtering. (4)

Or

(b) (i) Explain the following filtering techniques.

(1) Geometric mean filter (3)

(2) Harmonic mean filter (3)

(3) Homomorphic filter (4)

(ii) Describe the basics of color image enhancement. (6)

13. (a) (i) What is inverse filtering? Explain inverse filter with an equation (8)

(ii) Discuss constrained least square filtering method of restoration in detail. (8)

Or

(b) (i) Explain Wiener filtering with equations. (8)

(ii) Discuss various types of spatial transformations. (8)

14. (a) (i) Describe gradient operators based edge detection method with necessary masks and equations. (8)

(ii) Explain region splitting and merging method of image segmentation. (8)

Or

(b) (i) Explain the procedure to construct the dam for segmentation. (6)

(ii) Discuss watershed segmentation algorithm in detail. (10)

15. (a) (i) Obtain Huffman coding for the source symbols $S = \{S_0, S_1, S_2, S_3, S_4\}$ and the corresponding probabilities $P = \{0.4, 0.2, 0.2, 0.1, 0.1\}$. (7)

(ii) Explain the principle of arithmetic coding with an example. (9)

Or

(b) (i) Explain vector quantization. (8)

(ii) Draw and explain the block diagram of transform coding. (8)

Question Paper Code : 80593

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Sixth Semester

Electronics and Instrumentation Engineering

IT 6005 — DIGITAL IMAGE PROCESSING

(Regulations 2013)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is Machband Effect?

2. Define Checker Board Effect.

3. What is meant by bit plane slicing?

4. What is unsharp masking?

5. State the causes of degradation in an image?

6. What do you understand by Mexican hat function?

7. What is an image pyramid?

8. State whether the given Huffman code 0, 10, 01, 011 for the symbols a1, a2, a3, a4 is uniquely decodable or not?

9. What is Skeletonizing?

10. Define texture.

PART B — (5 × 16 = 80 marks)

11. (a) (i) With necessary diagrams explain how an Analog image is Converted into digital image. (8)

(ii) What is meant by image sensing? Explain in detail the construction and operation of various image acquisition devices. (8)

Or

(b) (i) What is a color model? What are its types? Explain RGB and HSI models with necessary diagrams. (12)

(ii) Explain the various distance measures used for image analysis. (4)

12. (a) (i) Briefly discuss about histogram equalization technique. (8)

(ii) Perform histogram equalization of the image. (8)

$$\begin{bmatrix} 4 & 4 & 4 & 4 & 4 \\ 3 & 4 & 5 & 4 & 3 \\ 3 & 5 & 5 & 5 & 3 \\ 3 & 4 & 5 & 4 & 3 \\ 4 & 4 & 4 & 4 & 4 \end{bmatrix}.$$

Or

(b) (i) Explain in detail the method for smoothening the image in frequency domain. (10)

(ii) Explain Gradient operators for Image Enhancement. (6)

13. (a) (i) Apply order statistics filters on the selected pixels in the image.

(ii) Explain how wiener filter is used for image restoration. (8)

$$\begin{pmatrix} \boxed{1} & 2 & 3 \\ 0 & \boxed{1} & \boxed{2} \\ 1 & 4 & 5 \end{pmatrix}$$

Or

(b) (i) Explain the process of edge linking using Hough transform. (8)

(ii) Explain region based segmentation techniques. (8)

14. (a) (i) Explain two dimensional Discrete Wavelet Transform (DWT). (8)

(ii) Encode the word $a_1\ a_2\ a_3\ a_4$ using arithmetic code and generate the tag for the given symbol with probabilities.

$a_1 \rightarrow 0.2,\ a_2 \rightarrow 0.2,\ a_3 \rightarrow 0.4,\ a_4 \rightarrow 0.2$ (8)

Or

(b) What is the need for image compression? Explain image compression standards in detail. (16)

15. (a) Explain in detail any two boundary representation schemes and illustrate with examples. (16)

Or

(b) Explain image recognition based on matching. (16)

EC6009 ADVANCED COMPUTER ARCHITECTURE L T P C

3 0 0 3

UNIT I FUNDAMENTALS OF COMPUTER DESIGN 9

Review of Fundamentals of CPU, Memory and IO – Trends in technology, power, energy and cost, Dependability - Performance Evaluation

UNIT II INSTRUCTION LEVEL PARALLELISM 9

ILP concepts – Pipelining overview - Compiler Techniques for Exposing ILP – Dynamic Branch Prediction – Dynamic Scheduling – Multiple instruction Issue – Hardware Based Speculation – Static scheduling - Multi-threading - Limitations of ILP – Case Studies

UNIT III DATA-LEVEL PARALLELISM 9

Symmetric and Distributed Shared Memory Architectures – Performance Issues –Synchronization – Models of Memory Consistency – Case studies: Intel i7 Processor, SMT & CMP Processors

UNIT IV THREAD LEVEL PARALLELISM 9

Symmetric and Distributed Shared Memory Architectures – Performance Issues –Synchronization – Models of Memory Consistency – Case studies: Intel i7 Processor, SMT & CMP Processors

UNIT V MEMORY AND I/O 9

Cache Performance – Reducing Cache Miss Penalty and Miss Rate – Reducing Hit Time – Main Memory and Performance – Memory Technology. Types of Storage Devices – Buses – RAID – Reliability, Availability and Dependability – I/O Performance Measures.

TOTAL PERIODS: 45

TEXT BOOKS:

T1. John L Hennessey and David A Patterson, “Computer Architecture A Quantitative Approach”, Morgan Kaufmann/ Elsevier, Fifth Edition, 2012

REFERENCES:

R1. Kai Hwang and Faye Briggs, “Computer Architecture and Parallel Processing”, Mc Graw-Hill International Edition, 2000.

R2. Sima D, Fountain T and Kacsuk P, ”Advanced Computer Architectures: A Design Space Approach”, Addison Wesley, 2000.

UNIT -1
FUNDAMENTALS OF COMPUTER DESIGN
PART A

1. What are the classes of computers?

- Personal mobile device
- Desktop
- Server
- Clusters/warehouse scale computer
- Embedded

2. Define instruction set architecture.

The instruction set architecture is the part of the processor that is visible to the programmer or compiler writer. The ISA serves as the boundary between software and hardware.

3. What are clusters/warehouse-scale computers?

The growth of a class of computers called clusters. The largest of the clusters are called warehouse-scale computers. Example: Super computers are related to WSC.

4. What is embedded computer?

An embedded system is a special purpose system in which the computer is completely encapsulated by the device it controls. Unlike a general purpose computer, such as personal computer, an embedded system performs pre-defined tasks usually with very specific requirements.

5. What are the dimensions of an ISA.

- Class of ISA.
- Memory addressing
- Addressing modes
- Types and sizes of operands
- Operands
- Control flow instructions
- Encoding an ISA.

6. What are the trends in technology?

- Integrated circuit logic technology
- Semiconductor DRAM
- Semiconductor flash
- Magnetic disk technology
- Network technology.

7. What is cost of an integrated circuit?

Cost of integrated circuit= [cost of die+ cost of testing die + cost of packaging and final test] / final test yield.

8. Define cost of die.

Cost of die = [cost of wafer/(dies per wafer x die yield)]

9. What is cost versus price?

Cost: With the commoditization of computers, the margin between the cost to manufacture a product. Price: The product sells for has been shrinking. Those margins pay for a company's research and development.

10. Define processor throughput.

Throughput is the total amount of work done in a given time, such as megabyte per second for a disk transfer. Processor throughput (Wp)= Number of machine instruction executed per second/number of machine instruction per program. Processor throughput (Wp)= MIPS X 10^6.

11. Draw the MIPS 64 instruction set architecture formats.

	6 bits	5 bits	5 bits	5 bits	5 bits	6 bits
R:	op	rs	rt	rd	shamt	funct
I:	op	rs	rt	address / immediate		
J:	op	target address				

op: basic operation of the instruction (opcode)
rs: first source operand register
rt: second source operand register
rd: destination operand register
shamt: shift amount
funct: selects the specific variant of the opcode (function code)
address: offset for load/store instructions (+/-2^{15})
immediate: constants for immediate instructions

12. Name the system attributes to performance?

- Clock rate ®
- Performance factors
- Million instructions per second rate(MIPS Rate)
- Throughput Rate.

13. What is CPU Time & CPI?

- CPU Time=Central processing Unit clock cycles for a program x clock cycle time.
- Cycles per instruction (CPI) or clock rate = 1/cycle time

14. What is the maximum power a processor ever requires?

If a processor attempts to draw more power than a power supply system can provide, the result is a voltage drop, which can cause the device to malfunction. Modern processors can vary widely in power consumption with high peak currents hence, they provide voltage indexing methods that allow the processor to slow down and regulate voltage within a wider margin. Doing so decreases performance.

15. Define dependability give one example.

Dependability is the ability of a system to deliver a specified service. System service is classified as proper if it is delivered as specified; otherwise it is improper.

Example : Internet Service Provider.

16. What is SLA's & SLO's? how does SLA decide system is up or down?

ISP architecture providers started offering Service Level Agreements (SLA's) or Service Level Objectives (SLO's) to guarantee that their networking or power service would be dependable. For example, they would pay the customer a penalty if they did not met an agreement more than the some hours per month. Thus, an SLA could be used to decide whether the system was up or down.

17. What are the main measures of dependability?

- Module Reliability : Is A Measure Of Service Accomplishment
- Module Availability: Is A Measure Of Service Interruption.

18. Define SPEC and SPEC Ratio.

SPEC – Standard performance Evaluation Corporation creates, maintains, distributes, and endorses a standardized set of application-oriented programs to be used as benchmarks.

SPEC Ratio: Time on reference computer/Time on computer being rated.

19. What is benchmark?

Benchmark is a program specifically chosen to measure the performance of a target system. The benchmarks form a workload that the user hopes will predict the performance of the actual workload.

20. For die of 0.7 cm on a side, find the number of dies per wafer of 30 cm diameter.

Number of die per wafer= wafer area /die area –(wafer waist area)

= 3014(30/2)^2/0.49-(3.14x30/sqrt 2x0.49)

= 1441.83-95.16

= 1346.67 dies

PART-B

1) Write short notes on trends in power and energy. (8 Marks)
   Refer Pg. No: 1-10, Section 1.4
2) Briefly explain about dependability. (8 Marks)
   Refer Pg. No: 1-14, Section 1.6
3) Explain about various system attributes used to measure the performance (16 Marks)
   Refer Pg. No: 1-19, Section 1.7.1
4) Explain the trends in technology (8 Marks)
   Refer Pg. No: 1-8, Section 1.3
5) Explain the trends in cost and price of integrated circuits. (8 Marks)
   Refer Pg. No: 1-12, Section 1.5
6) Explain about how performance can be evaluated in advanced design Architecture. (8 marks)
   Refer Pg. No: 1-16, Section 1.7
7) Assume a disk subsystem with the following components and MTTF: (16 Marks)
   - 10 disks, each rated at 1,000,000-hour MTTF.
   - 1 ATA controller, 500,000-hour MTTF.
   - 1 power supply, 200,000-hour MTTF
   - 1 fan, 200,000-hour MTTF
   - 1 ATA cable, 1,000,000-hour MTTF

   Using the simplifying assumptions that the lifetimes are exponentially distributed and those failures are independent, compute the MTTF of the system as a whole.

   Refer Pg. No: -35 Section 1.7 [DAVID A. PATTERSON]
8) Suppose we have made the following measurements:
   - Frequency of FP operations = 25%.
   - Average CPI of FP operations =4.0
   - Average CPI of other instructions= 1.33
   - Frequency of FPSQR=2%

Assume that the two design alternatives are to decrease the CPI of FPSQR to 2 or to decrease the average CPI of all FP operations to 2.5. Compare these two design alternatives using the processor performance equation. (16 Marks)

Refer Pg. No: -50 Section 1.9 [DAVID A. PATTERSON]

9) Find the number of dies per 300 mm (30 cm) wafer for a die that is 1.5 cm on a side and for a die that is 1.0cm on a side. (8 Marks)

Refer Pg. No: -31 Section 1.6 Example 1 [DAVID A. PATTERSON]

10) Find the die yield for dies that are 1.5 cm on a side and 1.0cm on a side assuming a defect density of 0.031 per cm^2 and N is 13.5. (8 Marks)

Refer Pg. No: -31 Section 1.6 Example 2 [DAVID A. PATTERSON]

UNIT-2
INSTRUCTION LEVEL PARALLELISM
PART A

1. What is meant by Instruction Level Parallelism?

Instruction-Level Parallelism is a measurement of the number of operations that can be performed simultaneously in a computer program. Microprocessors exploit ILP by executing multiple instructions from a single program in a single cycle.

2. What is meant by loop unrolling?

Loop unrolling, also known as loop unwinding, is a loop transformation technique that attempts to optimize a program's execution speed at the expense of its binary size, which is an approach known as the space-time tradeoff. The transformation can be undertaken manually by the programmer or by an optimizing compiler.

3. What is meant by dependence? List the type of dependence.

Dependency (computer science) or coupling is a state in which one object uses a function of another object. Data dependency, describes a dependence relation between statements in a program.

List of dependence: 1. Data dependence 2. Name dependence 3. Control dependence 4. Resource dependence

4. Write down the formula to calculate the pipeline CPI?

Pipeline CPI = Ideal pipeline CPI + structural stalls data hazards stalls + control stalls

5. What are the two conditions imposed by control dependences?

The two conditions imposed by control dependences are:

- An instruction that is control dependent on a branch cannot be moved before the branch so that its execution is no longer controlled by the branch.
- An instruction that is not control dependent on a branch cannot be moved after the branch so that its execution is controlled by the branch.

6. What are the advantages of dynamic scheduling?

- It handles dependences that are unknown at compile time.
- It simplifies the complier.
- It uses speculation techniques to improve the performance.

7. What is meant by Reservation Station (RS)?

Hazard detection and execution control are distributed. Results are passed directly to functional units from the reservation stations where they are buffered, rather than going through the registers.

8. What is meant by Branch Prediction buffer?

Branch prediction buffer is a small memory indexed by the lower portion of the address of the branch instruction. The memory contains a bit that says whether the branch was recently taken or not.

9. What are the types of branch prediction techniques?

- Static branch prediction
- Dynamic branch prediction

10. When antidependence occurs in name dependence?

Antidependence between instruction 'I' and instruction 'j' occurs when instruction 'j' writes a register or memory location that instruction 'I' reads.

11. What are the properties used for preserving control dependence?

Control dependence is preserved by two properties in a simple pipeline.

- Instruction execute in program order
- Detection of control or branch hazards.

12. Define RAW, WAW, WAR hazards.

Raw –read after write WAW-write after write WAR-write after Read.

13. What is meant by Speculation?

If the branch is taken, the DSUBU instruction will execute and will be useless, but it will not affect the program results. This type of code scheduling is called speculation.

14. What is score boarding technique?

Sore boarding is a technique for allowing instructions to execute out of order when there are sufficient resources and no data dependence.

15. Give the two stages in Out-of-order execution.

- Issue: read the next instruction from queue, decode it. After decoding check for structural hazards.
- Read operands: wait in case of data hazards, start instruction as soon as operands are availbel.

16. What is ROB? Give the fields that ROB contains.

Re Order Buffer (ROB) is a hardware buffer. It holds instructions in first in first out order exactly as there were issued.

- Instruction type field
- Destination field
- Value filed
- Ready field.

17. Compare CLIW, CISC AND RISC.

PARAMETERS	CISC	RISC	VLIW
Instruction size	Varies	One size(32-bit)	One size
Instruction format	Field placement varies	Consistent placement of fields	Consistent placement of fields
Registers	Few, sometimes special	Many, general purpose	Many, general purpose
Memory references	Bundled with operations in many different types of instructions.	Not bundled with operations i.e. load/store architecture	Not bundled with operations i.e. load/store architecture
Hardware desing	Exploit micro coded implementations	Exploit implementations with one pipeline and no mocro code	Exploit implementations with multiple pipelines and no micro code and no complex is patch logic

18. What is EPIC?

EPIC stand for explicit parallel instruction computing. it is an architecture framework proposed by HP and based on VLIW and was designed to overcome the key limitations of VLIW.

19. Define tournament predictors.

- It a method of implementing dynamic scheduling. This scheme was invented by Robert Tomasulo and was first used in IBM 360/91.
- Tomasulo's algorithm differs from score boarding in that it uses register renaming the eliminate output and anti dependences. i.e. WAW and WAR hazards.

PART B

1. What is instruction-level parallelism? Explain in details about the various dependences caused in ILP? (16mark)
   Refer Pg. No: 2-2, Section 2.1
2. Explain the implementation methods of Tomasulo's approach**.** (10marks)
   Refer Pg. No: 2-27, Section 2.5.1
3. Explain the mechanism and steps involved in speculation. (16marks)
   Refer Pg. No: 2-31, Section 2.6
4. Explain the compiler technique that is used to expose ILP. (16 marks)
   Refer Pg. No: 2-18, Section 2.3.
5. Explain briefly about dynamic branch prediction. (16 marks)
   Refer Pg. No: 2-20, Section 2.4
6. What is ILP? Explain the dependence and data hazards in ILP (16marks)
   Refer Pg. No: 2-3, Section 2.1
7. Explain in details about static branch prediction and dynamic branch prediction (16 marks)
   Refer Pg. No: 2-20, Section 2.4
8. Explain the techniques to overcome data hazards with dynamic scheduling? (16 marks)
   Refer Pg. No: 2-26, Section 2.54
9. Explain in detail the hardware based speculation for a MIPS processor (16 marks)
   Refer Pg. No: 2-32, Section 2.6.1
10. Explain Intel IA-64 Architecture in detail with suitable reference to Itanium processor. (16 Marks)
    Refer Pg. No: 2-45, Section 2.11

UNIT-3
DATA-LEVEL PARALLELISM
PART A

1. What is data level parallelism?

Data level parallelism uses vectorization techniques to specify with a single instruction a large number of operations to be performed on independent data. A few of these vector instructions running concurrently can provide a large operation parallelism for many consecutive cycles. Data parallelism is the simultaneous execution on multiple cores of the same function across the elements of a dataset.

2. How vector processor works give example?

A vector processor is an ensemble of hardware resources, including vector registers, functional pipelines, processing elements and register counters, for performing vector operations, vector processing occurs when arithmetic or logical operations are applied to vectors. The conversion from scalar processing to vector code is called vectrorization.

Example : Y= a x X + Y;

Where X&Y are vectors, initially resident in memory , 'a' is scalar .

3. Write the advantages of vector processors.

- Require lower instruction bandwidth, Easier addressing main memory, Elimination of memory wastage, Simplification of control hazards.

4. Name the vector processor models.

- Register –to-register model
- Memory-to-memory vector processors

5. List the types of parallelism in applications.

- Instruction level parallelism (ILP)
- Thread level or task level parallelism (TLP)
- Data level parallelism (DLP)
- Transaction level parallelism (TLP)

6. What are the hardware parallelisms?

- CPU level parallelism
- system level parallelism

7. What is parallel execution?

Using TWO-issue processor, the processor can execute one memory access (load or store) and one arithmetic operation (divide, add, subtract) simultaneously.

8. Classify the Flynn Taxonomy's?

SISD-(Single Instruction and Single Data Stream). SIMD-(Single instruction and multiple data stream). MISD-(multiple instruction and single data stream). MIMD-(multiple instruction and multiple data stream).

9. Define single instruction and multiple data streams.

There are multiple data streams in parallel with a single instruction steam. The controller transmits this instruction to all the processors. This is typically done by replacing arithmetic units in a CPU and allowing the different units to refer different operands.

10. What is non-uniform memory access(NUMA)?

In a distributed shared memory computer system, each processor may its own local memory and may or may not share a common memory. For these systems, the time taken to access a word in local memory smaller than the time taken to access a word stored in memory of other computer.

11. What are the Dataflow Models?

- Static dataflow model.
- Dynamic dataflow model.

12. Write the advantages.

Advantages :

Better performance as it allows multiple tokens on each arc thereby unfolding more parallelism

13. Write the limitations of dynamic dataflow

Limitations :

- Efficient implementation of the matching unit that collects tokens with matching tags.
- Associative memory would be ideal
- It is not cost effective
- All existing machines use some form of hashing techniques that are typically not as fast as associative memory.

14. Compare SIMD and MIMD.

SL.NO.	SIMD	MIMD
1)	SIMD stands for single instruction and multiple data streams	Multiple instruction and multiple dta
2)	Architecture is simple	Architecture is complex
3)	Low cost	Medium coast
4)	Size and performance is scalable	Complex size and good performance
5)	Automatic synchronization of all send and receive operations	Explicit synchronization and identification protocols needed.

15. Write any four VMIPS vector instructions floating point operations

- ADDVV.D V1,V2,V3→ Add elements of v2 and v3, then put each result in v1.
- LV V1,R1→ load vector register V1 from memory starting at address R1.
- SVI (R1=V2),V1 → store V1 to vector whose elements are at R1+V2(i)
- MVTM VM,FO → move contents of F0 to vector mask register VM.

16. What is demand driven computation?

In demand driven computation, each processor assigns a task to perform and is responsible for all computations related to those tasks. Demand driven machines also known as reduction machines.

17. What is loop level parallelism?

To increase amount of parallelism available among instructions is to exploit parallelism among iterations of a loop. This type of parallelism is often called loop level parallelism.

18. Use the GCD test to determine whether dependences exist in the following loop;

```
For (i=0; i<100; i=i++)
{
        X[2*i+3]=X[2*i]*5.0;
}
```

Answer:

Given the values a=2;b=3;c=2 and d=0, then GCD(a,c)=2 and d-b=-3. Since 2 does not divide-3, no dependence is possible.

19. What is GPU?

A Graphics processing unit is a single chip processor primarily used to manage and boost the performance of video and graphics.

20. What is tree height reduction?

Tree height reduction is a optimization techniques which reduces the number of operations or code length. It increases parallelism of the code.

PART B

1) Explain briefly hardware and software approaches. (8marks)
Refer Pg. No: -3-3 , Section 3.2

2) Briefly explain the flynn's classification (16 Marks)
Refer Pg. No: -3-5 to 3-9 , Section 3.3 to 3.3.4

3) With the suitable diagrams explain Shared memory MIMDs (8 marks)
Refer Pg. No: -3-10 to 3-11 , Section 3.4.1 to 3.4.2

4) Briefly explain the dataflow models (8 Marks)
Refer Pg. No: -3-11 to 3-13 Section 3.3.6

5) Draw and explain the architecture **of vector supercomputer** (16 Marks)
Refer Pg. No: -3-16 to 3-19 Section 3.4

6) Draw and explain the architecture of graphics processing units (16 Marks)
Refer Pg. No: -3-19 to 3-24 Section 3.5

7) Explain the loop level parallelism (8 marks)
Refer Pg. No: -3-24 to 3-26 Section 3.6

8) With the suitable examples writes the finding dependences. (8 marks)
Refer Pg. No: -3-26 to 3-28 Section 3.6.1

9) Write the similarities and differences between vector architectures and GPUs (8Marks)
Refer Pg. No: -308 to 311 Section 4.4 [DAVID A. PATTERSON]

10) Suppose we have 8 memory banks with a bank busy time of 6 clocks and a total memory latency of 12 cycles. How long will it take to complete a 64 element vector load with a stride of 1? With a stride of 32? (16Marks)

- Since the number of banks is larger than the bank busy time, for a stride of 1 the load will take 12+64=76 Or 1.2 clock cycles per element.
- The worst possible stride is a value that is a value that is a multiple of the number of memory banks, as in this case with a stride of 32 and 8 memory banks.
- Every access to memory after the first one will collide with previous access and will have to wait for the 6-clock-cycle bank busy time.
- The total time will be 12+1+6*63=391clcock cycles, or 6.1 clock cycles per element.

Refer Pg. No: -279 Section 4.2 [DAVID A . PATTERSON]

UNIT-4
THREAD LEVEL PARALLELISM
PART – A

1. What are multiprocessors? Mention the categories of multiprocessors?

Multiprocessors are used to increase performance and improve availability.
The different categories are SISD, SIMD, MISD, and MIMD.

2. What are threads?

These are multiple processors executing a single program and sharing the code and most of their address space. When multiple processors share code and data in the way, they are often called threads.

3. What is cache coherence problem?

Two different processors have two different values for the same location.

4. What are the protocols to maintain coherence?

- Directory based protocol
- Snooping Protocol

5. What are the ways to maintain coherence using snooping protocol?

- Write Invalidate protocol
- Write update or write broadcast protocol

6. What is Write invalidate?

Write invalidate provide exclusive access to caches. This exclusive cache ensures that no other readable or writeable copies of an item exist when the write occurs.

7. What is Write update?

Write update updates all cached copies of a data item when that item is written

8. What are the disadvantages of using symmetric shared memory?

Compiler mechanisms are very limited larger latency for remote memory access,
Fetching multiple words in a single cache block will increase the cost.

9. Mention the information in the directory?

- It keeps the state of each block that is cached.
- It keeps track of which caches have copies of the block.

10. What are the operations that a directory based protocol handle?

- Read Miss
- Write Miss

11. What are the states of cache block?

Shared, Un cached, Exclusive

12. What are the uses of having a bit vector?

When a block is shared, the bit vector indicates whether the processor has the copy of the block. When block is in exclusive state, bit vector keep track of the owner of the block.

13. When do we say that a cache block is exclusive?

When exactly one processor has the copy of the cached block, and it has written the block. The processor is called the owner of the block.

14. Explain the types of messages that can be sent between the processors and directories?

a). Local node – Node where the requests originates
b). Home Node – Node where memory location and directory entry of the address resides.
c). Remote Node - The copy of the block in the third node called remote node

15. What is consistency?

Consistency says in what order a processor must observe the data writes of another processor.

16. Mention the models that are used for consistency?

- Sequential consistency model
- Relaxed consistency model

17. What is sequential consistency?

It requires that the result of any execution be the same, as if the memory accesses executed by each processor were kept in order and the accesses among different processors were interleaved.

18. What is relaxed consistency model?

Relaxed consistency model allows reads and writes to be executed out of order. The three set of ordering are: W-> R ordering W->W ordering R->W and R-> R ordering.

19. What is multithreading?

Multithreading allows multiple threads to share the functional uits of the single processor in an overlapping fashion.

20. What is fine grained multithreading?

It switches between threads on each instruction, causing the execution of multiple threads to be interleaved.

21. What is coarse grained multithreading?

It switches threads only on costly stalls. Thus it is much less likely to slow down the execution of an individual thread.

PART – B

1. Explain the snooping protocol with a state diagram? (16 Marks)
   Refer Pg. No: 4-7, Section 4.2.2
2. Explain the directory based protocol with a state diagram? (8 Marks)
   Refer Pg. No: 4-17, Section 4.3.2
3. Explain Symmetric Shared Memory Architecture? (16 Marks)
   Refer Pg. No: 4-5, Section 4.2
4. Discuss about Distributed Shared Memory Architecture? (16 Marks)
   Refer Pg. No: 4-15, Section 4.3
5. Define synchronization and explain the different mechanisms employed for synchronization among processors? (16 Marks)
   Refer Pg. No: 4-21, Section 4.5
6. Discuss about the different models for memory consistency? (8 Marks)
   Refer Pg. No: 4-25, Section 4.6
7. How is multithreading used to exploit thread level parallelism within a processor? (16 Marks)
   Refer Pg. No: 4-30, Section 4.8
8. Write the case study about Intel Nehalem or Intel Core i7 Processor Architecture in detail?
   Refer Pg. No: 4-27, Section 4.7 (16 Marks)
9. Write the case study about Simultaneous Multithreading Processor in detail? (16 Marks)
   Refer Pg. No: 4-30, Section 4.8
10. Write the case study about SUN CMP Architecture in detail? (16 Marks)
    Refer Pg. No: 4-35, Section 4.9

UNIT-5
MEMORY AND I/O
PART A

1. What is memory?

Memory is a device used to store the data and instructions required for any operation**.**

2. Define cache.

It's a small fast intermediate memory between the processor and the main memory.

3. What is memory stall cycle?

The number of cycles during which the CPU is stalled waiting for a memory access is called memory stall cycles.

4. Write the types of Memory hierarchy questions.

a) Where can a block be placed in the upper level? (block placement)
b) How is a block found if it is in the upper level? (block identification)
c) Which block should be replaced on a miss? (block replacement)
d) What happens on a write? (write strategy)

5. Write a formula for average memory access time.

Average memory access time=Hit time +Miss rate x Miss Penalty

6. List the method to improve the cache performance.

Improving the cache performance following methods are used

a) reduce the miss rate
b) reduce the miss penalty
c) reduce the time to hit in the cache.

7. What are the techniques to reduce the hit time?

a) Small and simple cache: Direct mapped
b) Avoid address translation during indexing of the cache
c) pipelined cache access.
d) trace cache.

8. How are the conflicts misses divided?

Four divisions of conflict misses are

Eight way: conflict misses due to going from fully associative to eight way associative.
Four way: conflict misses due to going from eight way associative to four way associative.
Two way: conflict misses due to going from four way associative to two way associative.
One way: conflict misses due to going from two way associative to one way associative.

9. Write the formula to calculate the CPU execution time.

CPU EXE Time= (CPU Exe CLK Cycle + Memory Stall CLK Cycle) x clock cycle time.

10. Write the formula to calculate the CPU time.

CPU time = (CPU exe clock cycle + memory stall clock cycles) x clock cycle time.

11. Explain the term availability and dependability.

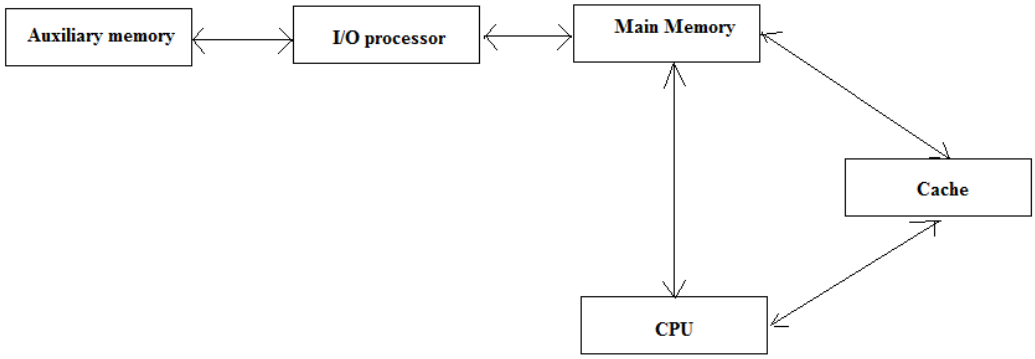
- Availability is a measure of the service accomplishment with respect to the alternative between the two states of accomplishment and interruption.
- Dependability is the quality of delivered service such that reliance can justifiable be placed on this service.

12. Differentiate between write though cache and snoopy cache.

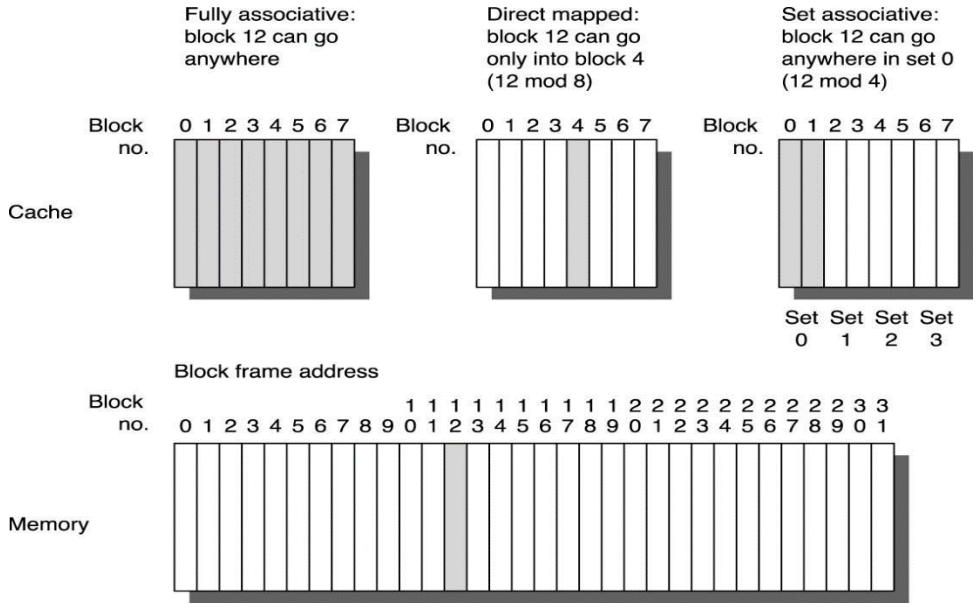
In write though cache, it is easy to find the recent value of a data item, since all written data are always sent to the memory, from which the most recent value of a data item can always be fetched. In a snoopy cache, each cache watches the memory bus for any requests for a line that they have.

13. Draw the memory Hierarchy with neat diagram

The memory unit is an essential component in any digital computer since it is needed for storing programs and data. Not all accumulated information is needed by the CPU at the same time. Therefore, it is more economical to use low-cost storage devices to serve as a backup for storing the information that is not currently used by CPU



14. Draw the frame structure cache has eight block frames and memory has 32 blocks.



15. Compare software and hardware RAID.

Parameters	Software RAID	Hardware RAID
Write back caching	No	yes
Disk hot swapping	No	Yes
Boot partition	No	Yes
Support for hot spare	No	Yes
Performance	Usage	High
CPU, RAM overheads	Usage	No overhead
Cost	Low	High
Complexity	Medium	Low

16. Calculate the access time for a disk with 512 byte/sector and 12 ms advertised seek time. The disk rotates at 5400 rpm and transfers data at a rate of 4 mbps. The controller overhead is 1 ms. Assume that the queue is idle (so no service time).

Disk access time = seek time + Rotational latency + transfoe time + controller time + quenuing delay.
= 12 ms + 0.5/5400 rpm + 0.5 kB / 4 MB /s +1ms + 0.
= 12 ms + 0.5 /90 rps + 0.125 /1025 s + 1 ms + 0
= 18.6 ms

17. What are differences and similarities between SCSI and IDE?

Parameters	IDE	SCSI
Cost	IDE is a much cheaper	Is often more expensive to implement and support
Expansion	It allows to two devices per channel	Is capable of supporting up to 7 or 15 devices.
Ease	It is commonly a much easier product to setup	Configuring scsi can be more difficult for most users when compared to ide
CPU	IDE devices cannot communicate independently from the CPU	SCSI devices can communicate independently form he CPU over the SCSI Bus.

18. What is the average time to read 512byte sector for a disk. Average seek time is 5ms, the transfer rate is 40 MB/sec, it rotates at 10,000 rpm and he controller overhead is 0.1 ms. Assume the disk is idle so that there is no queuing delay.

Disk latency = average seek time + average rotational delay + Transfer time + controller overhead
= 5 ms + 0.5 x 1/ (10,000 rpm) + 512 B / (40 MB/s) + 0.1 ms.
= 5 + 3 + 0.013 + 0.1
= disk latency = 5.11 ms.

19. What is local miss rate and global miss rate?

- Local miss rate is number of misses in the cache divided by the total number of memory accesses to this cache miss rate is l2
- Global miss rate is number of misses in the cache divided by the total number of memory accesses generated by the CPU miss rage l1 x miss rate l1.

PART B

1. Describe in detail how the four memory hierarchical questions can be handled? Illustrate the answers with an example. (16 Marks)
   Refer Pg. No: 5-4, Section 5.1.2
2. Explain how cache performance is measured and how it can be improved? (16 Marks)
   Refer Pg. No: 5-8, Section 5.2 & 5.3
3. Discuss in detail the various techniques available for reducing cache miss penalty? (8 Marks)
   Refer Pg. No: 5-9, Section 5.3.2
4. Discuss how cache behavior can be improved by reducing the miss rate? (8 Marks)
   Refer Pg. No: 5-8, Section 5.3.1
5. Discuss how reducing cache miss penalty or miss rate by parallelism would provide scope for performance improvement in a memory module? (16 Marks)
   Refer Pg. No: 5-8, Section 5.3
6. Explain how reducing hit time in a cache would speed up the memory module? (8 Marks)
   Refer Pg. No: 5-10, Section 5.4
7. Describe in detail how performance improvement of main memory could be targeted? (16 Marks)
   Refer Pg. No: 5-15, Section 5.5
8. Elaborate on the various memory technologies that you know and give a comparative study. (8 Marks)
   Refer Pg. No: 5-21, Section 5.6
9. Discuss in detail the various types of storage devices. (16 Marks)
   Refer Pg. No: 5-23, Section 5.7
10. Explain the Bus standards and the interfaces. With timing diagrams, explain the read and write operations occurring in a typical bus. (16 Marks)
    Refer Pg. No: 5-27, Section 5.8
11. Explain with a neat diagram, the interfacing of storage devices to the CPU.
    Refer Pg. No: 5-32, Section 5.8.7
12. Discuss Reliability, Availability and Dependability for storage devices in detail. (16 Marks)
    Refer Pg. No: 5-40, Section 5.10
13. Explain RAID architecture in detail. (16 Marks.)
    Refer Pg. No: 5-34, Section 5.9
14. Explain in detail how I/O performance of storage systems can be measured? (16 Marks)
    Refer Pg. No: 5-42, Section 5.11

Anna University Question Papers

Reg. No. : [ ]

Question Paper Code : 80320

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Seventh Semester

Electronics and Communication Engineering

EC 6009 — ADVANCED COMPUTER ARCHITECTURE

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the five trends in Computer Technology?
2. How to find the cost of an integrated circuit?
3. Explain the idea behind dynamic scheduling.
4. Give an example for data dependence.
5. Differentiate GPU and CPU.
6. What are the primary components of instruction set architecture of VMIPS?
7. List the methods for providing synchronization in threads.
8. Define sequential consistency.
9. List the six basic optimizations techniques of Cache.
10. What are the types of storage devices?

PART B — (5 × 16 = 80 marks)

11. (a) Write short notes on energy and power consumption in a microprocessor. (16)

Or

(b) Discuss the performance evaluation methods of different computers. (16)

12. (a) (i) Explain the types of dependencies in ILP. (8)

(ii) Explain the compilation techniques that can be used to expose Instruction level parallelism. (8)

Or

(b) (i) Explain dynamic scheduling. Explain how it is used to reduce data hazards. (8)

(ii) Define Multithreading. Explain how ILP is achieved using multithreading with an example. (8)

13. (a) Discuss similarities and differences between Vector Architectures and GPUs. (16)

Or

(b) Explain detecting and enhancing loop level parallelism in detail. (16)

14. (a) Describe distributed shared memory Architecture in detail. (16)

Or

(b) Explain models of memory consistency in detail. (16)

15. (a) Explain the categories of misses and how will you reduce cache miss rate. (16)

Or

(b) (i) Explain the various ways to measure I/O performance. (8)

(ii) Explain the various levels of RAID. (8)

EC6016 OPTO ELECTRONIC DEVICES L T P C

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UNIT I ELEMENTS OF LIGHT AND SOLID STATE PHYSICS 9

Wave nature of light, Polarization, Interference, Diffraction, Light Source, review of Quantum Mechanical concept, Review of Solid State Physics, Review of Semiconductor Physics and Semiconductor Junction Device

UNIT II DISPLAY DEVICES AND LASERS 9

Introduction, Photo Luminescence, Cathode Luminescence, Electro Luminescence, Injection Luminescence, Injection Luminescence, LED, Plasma Display, Liquid Crystal Displays, Numeric Displays, Laser Emission, Absorption, Radiation, Population Inversion, Optical Feedback, Threshold condition, Laser Modes, Classes of Lasers,Mode Locking, laser applications

UNIT III OPTICAL DETECTION DEVICES 9

Photo detector, Thermal detector, Photo Devices, Photo Conductors, Photo diodes, Detector Performance

UNIT IV OPTOELECTRONIC MODULATOR 9

Introduction, Analog and Digital Modulation, Electro-optic modulators, Magneto Optic Devices, Acoustoptic devices, Optical, Switching and Logic Devices

UNIT V OPTOELECTRONIC INTEGRATED CIRCUITS 9

Introduction, hybrid and Monolithic Integration, Application of Opto Electronic Integrated Circuits, Integrated transmitters and Receivers, Guided wave devices.

TOTAL PERIODS: 45

TEXT BOOKS:

T1. Pallab Bhattacharya "Semiconductor Opto Electronic Devices", Prentice Hall of India Pvt., Ltd., New Delhi, 2006

T2. Jasprit Singh, "Opto Electronics – As Introduction to Materials and Devices", Mc Graw-Hill International Edition, 1998

REFERENCES:

R1. S C Gupta, Opto Electronic Devices and Systems, Prentice Hal of India, 2005

R2. J. Wilson and J.Haukes, "Opto Electronics – An Introduction", Prentice Hall, 1995

UNIT – I
ELEMENTS OF LIGHT AND SOLID STATE PHYSICS
PART – A

1. Define opto electronics.

Optoelectronics is the branch of technology concerned with combined use of electronics and light. It can be defined as the study and application of electronic devices that source, detect, and control light. Optoelectronics can be considered as the subfield of photonics. Photonics includes the generation, emission, transmission, modulation, signal processing, amplification, detection, and sensing of light.

2. Define optoelectronic devices.

Opto electronic devices can be defined as electrical to optical or optical to electrical transducers. This means that these devices are capable of converting light into electrical form as well as electricity into light form.

3. What do you meant by corpuscular theory

Corpuscular theory states that light is made up of small particles called corpuscles, which travel in straight line with finite velocity and also possesses sufficient kinetic energy.

4. What do you meant by the term interference?

Interference can be defined as the superimposition or mixing up of two or more waves, which results in forming another new wave. Interference is denoted as 'I'.

5. What is meant by diffraction? (NOV/DEC2016)

Diffraction refers to change in wave parameters when it encounters an obstacle. It can be defined as the apparent bending of wave around small obstacles or spreading out of wave when it passes through some openings.

6. What do you meant by the term wavefront?

Wavefront is the locus i.e., line or a wave propagating in three dimension or a surface of points having same phase.

7. What are light sources and name the different types of light sources?

Light sources are also known as thermal sources or classical sources. All light sources are related to light. These sources are named like this because they radiate electromagnetic energy in direct relation to their temperature. Light sources are divided into two namely, blackbody sources and line sources.

8. What are line sources?

Line sources radiate at discrete wavelength. This is because it has only less interaction between particles or atoms of wave.

9. What do you understand by the quantum mechanical concepts of light?

Quantum mechanical concepts of light suggest three concepts. The first one is light possesses dual nature i.e., it has both particle and wave nature. The second concept is the amplitude of wave is related to the probability of locating the particle in a given region of space. The third concept is the wave function has to be find out. Wave function can be defined as probability of finding particle in the region of space between x and x+dx, y and y+dy, and z+dz. Wave function 'Ψ' is given as $\Psi^* \Psi dxdydz$.

10. What do you meant by semiconductors and name the different types of semiconductors?

Semiconductors are materials which has a medium conductivity. That means its conductivity is below conductors and higher than insulators. There are two types of semiconductors namely intrinsic semiconductors and extrinsic semiconductors.

11. What are intrinsic semiconductors?

Intrinsic semiconductors are semiconductor crystals which contain no impurities or lattice defects. In this material, there are no charge carriers. As temperature rises, electron-hole pairs are generated. The value of n material varies exponentially with temperature and this acts as the charge carriers in intrinsic semiconductor.

12. What are extrinsic semiconductors?

Extrinsic semiconductors are semiconductors formed by the process called doping. Doping increases the number of charge carriers. Doping refers to adding appropriate amount of impurities to increase conductivity of material. By doping, we can either make n-type material or a p-type material. In n-type material the majority carriers are electrons and in p-type material the majority carriers are holes.

13. List out the major differences between intrinsic and extrinsic semiconductors.

Intrinsic Semiconductor	Extrinsic Semiconductor
1.Contains no impurities	1. Made by adding impurities.
2.Contains no defect structure	2. May occur defect in structure when impurities are added.
3.No charge carriers	3.Contains both majority & minority charge carriers

14. Define radiative recombination and non-radiative recombination process.

When temperature rises up, if a photon is released then that type of process is known as radiative recombination. If no emission of photon occurs, then that type of process is known as non-radiative process.

15. Name the two ways in which recombination can occur?

The two ways of recombination are,

- Band-to-band or direct recombination process
- Defect center or indirect recombination process

16. Explain about band-to-band recombination and defect center recombination.

In direct recombination, an electron in conduction band makes a transaction directly to valence band to recombine with hole, thereby makes a radiative recombination process by releasing a photon. In indirect recombination process, recombination takes place via recombination traps or centers. These traps and centers occurs when impurities are added. Here, these traps will capture carrier of one type and centers will capture carrier opposite type, which in turn leads to electron hole recombination.

17. What are Miller indices of crystal?

Ordinarily, Miller indices are always integers by definition, and this constraint is physically significant. To understand this, suppose that we allow a plane (abc) where the Miller "indices" a, b and c are not necessarily integers. If a, b and c have rational ratios, then the same family of planes can be written in terms of integer indices (hkℓ) by scaling a, b and c appropriately: divide by the largest of the three numbers, and then multiply by the least common denominator. Thus, integer Miller indices implicitly include indices with all rational ratios.

18. Differentiate between diffraction and scattering. (MAY/JUNE 2013) (NOV/DEC 2016)

If an opaque object is placed between a source of light and a screen, the shadow cast on the screen is not perfectly sharp. Some light is present in the dark zone of the geometrical shadow. Similarly light which emerges from a small aperture or narrow slit is observed to spread out. This failure of light to travel in straight line is called diffraction.

19. The average electric field in a particular 2.0µm GaAs device is 5Kv/Cm. Calculate the average velocity of electron if its mobility value is 8000 cm^2/V-s. *(MAY/JUNE 2013)*

Solution:

$\sigma = ne^2t/m_e$

20. What do you understand by wave particle duality of light? *(NOV/DEC 2013)*

Wave -particle duality is the concept that every elementary particles or quantic entity exhibits the properties of not only particles, but also waves. It addresses the inability of the classical concepts particle or wave to fully describe the behavior of quantum –scale objects.

21. Estimate the energy required to excite electrons from the donor levels to the conduction band in silicon, given that m_c=0.26 m and the relative permittivity of 11.8. *(NOV/DEC 2013)*

Solution:

Given m_c=0.26 m and the relative permittivity of 11.8

Excitation energy=13.6 $m_{c/}m$ *$(1/\varepsilon_r)$ Ev

$=13.6*0.26(1/11.8)^2=0.025$Ev.

22. What are black body sources? (NOV/DEC 2016)

Black body sources are opaque bodies or hot dense glasses which radiate energy in all wavelengths. These sources absorb all components and allow only black components. Theses sources absorb all components and allow only black components. These sourses emit energy proportional to 4th power of absolute temperature.

PART-B

1. Derive Bragg'S law in X ray diffraction.
2. Discuss the powder method of crystal structure analysis.
3. Describe with the help of experimental set up, how will you determine the nature of a semiconductor using Hall Effect.
4. Describe the crystal structure of silicon and Ga As?
5. Explain the energy values of electrons in a metal.
6. How does the electrical conductivity of extrinsic semiconductors vary with temperature & impurity addition?
7. Explain the frequency response of silicon photodiodes using a suitable graph.
8. Derive expression for density of carrier in intrinsic and extrinsic semiconductor.
9. Write short note on diffraction, polarization, various light source and interference.
10. Derive the expression for carrier concentration nin an intrinsic semiconductor and hence show that the Fermi level lies in the center of the forbidden energy band.

UNIT – 2
DISPLAY DEVICES AND LASERS
PART-A

1. What do you mean by display devices?

Display device is an output device for presenting information in visual form. When the input information is supplied with an electrical signal, then that display device is called an electronic display device. There are two categories of display device. Display device that emit their own radiation or active devices and display device that modulate the incident radiation to provide display information.

2. What are the different luminescent processes?

- Electro luminescent processes
- Cathode luminescent processes
- Photo luminescent processes
- Injection luminescent processes

3. Define the different types of luminescent processes.

Electroluminescent processes are luminescent process in which excitation results from the application of electric field. In cathodoluminescent process, excitation occurs due to the bombardment with beam of electrons. In photo luminescent processes, excitation occurs from the absorption of photons. In injection luminescent processes, excitation occurs by electron-hole recombination by crossing the pn junction diode.

4. Name the different types of display devices.

- Plasma devices
- Numeric display devices
- LED
- LCD
- LASER

5. What are plasma devices?

Plasma devices are display devices in which, emission of light takes place when an electric current is passed through a gas. Free electrons are present in the gas. When an electric current is passed, these free electrons acquire high kinetic energy and collide with the atoms in gas. This lead to energy level greater than the ground level. After that, it will again loose energy and reaches in the ground state by emitting light.

6. Discuss briefly about LCD.

This is one of the most common passive display device. LCD consumes least power.

7. What are the two types of LCD?

- Reflective LCD
- Transmissive LCD

8. What do you meant by nematic ordering and cholesteric ordering?

- In nematic ordering, the molecules are aligned parallel to each other. The molecules are Free to move each other with the properties of liquid. It consists of two benzene rings linked with a central group. Eg: 4-methoxybenzylidine-4-butylanaline.
- In cholesteric ordering, materials are made up of large number of planes having nematic structure. In this type, the ordering changes from one below the other. distance between planes of same orientation

are referred to as pitch.

9. Mention some important LED materials. (NOV/DEC 2016)

- Gallium Arsenide(GaAs)
- Gallium Phosphide(GaP)
- Gallium Arsenide Phosphide($GaAs_{1-x}P_x$)
- Gallium Aluminum Arsenide($Ga_xAl_{1-x}As$)

10. What are the two common electroluminescent devices?

- AC power display
- DC power display

11. What are numeric display devices?

This is also a type of optical display device. Numerical displays are used for conveying more Information compared to other display devices. It is a simplest display format used to form the numbers from 0 to 9. It consists of seven bar segments. Each bar consists of several discrete display elements depending on size. More complex characters can be obtained using 7 x 5 matrix. This type consists of 7 rows and 5 columns. In LED, if we are using numerical display of this type, these 35 elements will be grown to a single substrate. Here each bars consists of 35 discrete elements. All the characters are less than 5mm.

12. What do you meant by laser?

A laser is a device that emits light (electromagnetic radiation) through a process of optical amplification based on the stimulated emission of photons. The term "laser" originated as an acronym for Light Amplification by Stimulated Emission of Radiation.

13. What is meant by optical pumping in lasers?

Optical pumping is a process in which light is used to raise (or "pump") electrons from a lower energy level in an atom or molecule to a higher one. It is commonly used in laser construction, to pump the active laser medium so as to achieve population inversion.

14. Discuss about the threshold conditions in laser.

- A steady state level of oscillation should be reached when rate of amplification is balanced by rate of loss in continuous laser.
- Population inversion is a necessary condition in pulse laser.
- The gain coefficient must be large enough to overcome losses and oscillations.

15. What are major causes of losses in laser?

a) Transmission at the mirrors
b) Absorption and scattering at the mirrors
c) Absorption in the laser medium
d) Scattering at laser medium
e) Diffraction losses at the mirrors

16. Mention the different classes of laser.

i) Doped insulator laser
ii) Semiconductor lasers
iii) Gas lasers
iv) Dye lasers

17. State Heisenberg's uncertainty principle

In quantum mechanics, the Heisenberg uncertainty principle states a fundamental limit on the accuracy with which certain pairs of physical properties of a particle, such as position and momentum, can be simultaneously known. The uncertainty principle was a monumental discovery in the early development of quantum theory. It implies that it is impossible to simultaneously measure the present position while also determining the future motion of a particle or of any system small enough to require quantum mechanical treatment.

18. Why cathode luminescence is less efficiency than photo luminescence? (MAY/JUNE 2013)

- When electrons have energies between this value and Ec they can lose energy by exciting lattic vibrations.
- Energy may be wasted in photon generation. For a range of semiconductor materials that the total number of electron –hole pairs generated may be written as Eb/Eg

  Where Eb –total electron beam energy.

19. Find the Q-factor of a laser cavity oscillating at 650nm and having a line width of 1MHZ. *(*MAY/JUNE 2013)

Solution: Q=Resonant Frequency/Line width

=V/ΔV

=1MHZ/650nm.

20. What is meant by stroke shift? *(NOV/DEC 2013)*

In characteristics, luminescent materials the activator ion itself absorbs the photon directly. It might be expected the same energy levels are involved in absorption as in emission, and then the wavelengths for absorption and emission would be identical. The peak emission wavelengths are invariably shifted towards the red end of the spectrum compared to the peak of the absorption spectrum.

21. A typical He-Ne laser operates with a current of 10mA at a dc voltage of 2500V and gives a output of 5mW.Determine the overall power efficiency? *(NOV/DEC 2013)*

Solution:

Overall power efficiency=5m/2500*10m

=0.02%

22. What do you meant by mode locking? (NOV/DEC 2016)

Mode locking is a technique for producing periodic, high power short duration laser pulses. Normally laser cavity supports many modes simultaneously. In such lasers output depends on phases, frequencies, and amplitude of the nodes.

PART-B

1. Explain the operation of LED and derive an expression for the frequency response and bandwidth of an LED.
2. What are the major advantages of LED over LCD?
3. Derive expressions for gain in level laser medium?
4. Explain the basic principle of LED?
5. Explain the transient response of LEDS?
6. Discuss the different types of hetero structure LEDS along with diagrams?
7. Derive the expression for total photon flux emitted by in LED due to forward bias injection.
8. Explain about different types of luminescence and its application?
9. Explain the operation principle of junction LASER with the neat diagrams.
10. Explain about LASER modes and classes of LASER's.

UNIT – 3
OPTICAL DETECTION DEVICES
PART-A

1. Explain thermal detectors.

Thermal detectors are devices that work by absorbing the incident photon. It consists of a sensing element and an heat sink connected to it. The sensing element will absorb the photon, which results in production of heat. This heat produced will increases the temperature of heat sink connected to it.

2. What is the internal quantum efficiency of photodetector?

Quantum efficiency is also known as responsivity. It is defined as the ratio of the number of photo generated carriers to incident photons and thus a unit less quantity.

η= Number of corresponding electrons in the external circuit / number of incident photons.

3. Explain photoconductors.

It is the simplest optical detector. It exhibits an internal gain mechanism. It also clearly demonstrates the gain-bandwidth limitations. Its operation is based on the increase in conductivity of specific region with photon excitation. The generated electrons and holes are collected at opposite end and results in photocurrent.

4. What do you mean by Kerr effect?

Magneto-optic Kerr effect (MOKE) is one of the magneto-optic effects. It describes the changes of light reflected from magnetized media. The light that is reflected from a magnetized surface can change in both polarization and reflected intensity. The effect is identical to the Faraday effect except that the magneto-optical Kerr effect is a measurement of the reflected light, while the Faraday effect is a measurement of the transmitted light.

5. Name the different types of thermal detectors?

- Thermoelectric detectors
- Bolometer
- Pneumatic detectors
- Pyroelectric detectors

6. Define photodetectors.

Photodetector is an optoelectronic device that absorbs optical energy and converts it into electrical energy that produces photocurrent. Photodetectors are used to detect optical signal ranging over a very wide range of optical spectrum.

7. What are the different types of photodetectors?

- Photoconductors
- Pin diodes
- Avalanche photodiode
- Intrinsic photodetectors
- Extrinsic photodetectors

8. What are the two types of photo conductors?

- AC photo conductor
- DC photo conductor

9. What are the factors that limit the response time of photodiodes?

- Diffusion time of carriers to the depletion region
- Drift time of carriers to the depletion region
- Junction capacitance effects

10. Define responsivity.

Responsivity is also known as Quantum efficiency. Responsivity is defined as the ratio of the number of photo generated carriers to incident photons and thus a unit less quantity.

11. Define noise equivalent power.

It is defined as the power of sinusoidally modulated chromatic radiation, which would result in the same root mean square output signal in an ideal noise free detector as the noise signal encountered in the real detector. If we assume that noise power generated in a detector is NEP*=NEP/(AΔf).

12. Define pin photodiode.

A PIN diode is a diode with a wide, lightly doped 'near' intrinsic semiconductor region between a p-type semiconductor and an n-type semiconductor region. The p-type and n-type regions are typically heavily doped because they are used for ohmic contacts.

13. How Schottky photodiodes are made?

In Schottky photodiode, a thin metal coating is applied to an n-type silicon substrate. When an electron-hole pair is generated within the depletion region, the electron and hole will be separated by the action of internal field.

14. What is bolometer? (NOV/DEC 2016)

Bolometer is a thermal detector. The structure of bolometer is similar to wheatstone bridge. In this, a sensing element is placed instead of one of the resistor. This sensing element will absorb the incident radiation.

15. What is the working principle of thermal detectors?

Thermal detectors are devices that work by absorbing the incident photon. It consists of a sensing element and an heat sink connected to it. The sensing element will absorb the photon, which results in production of heat. This heat produced will increases the temperature of heat sink connected to it.

16. Define signal to noise ratio in photoconductors.

It is defined as the ration of conductivity of thermal noise to conductivity of dark current.

$$SNR = (\text{conductivity})_{light}/(\text{conductivity})_{dark}$$

17. How is a photodiode designed and why it is designed so?

A photodiode is designed to operate in reverse bias condition. If an electron-hole pair is generated by photon absorption in this junction, the internal field will cause electron and hole to separate.

18. What are the various processing steps taking place inside a photodetector?

- Absorption of optical energy and generation of carriers
- Transportation of photo generated carrier with or without gain
- Carrier collection and generation of photocurrent that flows through external circuit.

19. What are the advantages of photoconductive detector? *(MAY/JUNE 2013)*

As long as the electron remains in the conduction band, it will cause an increase in the conductivity of the semiconductor .this phenomenon is called photoconductivity, which is the basic mechanism operative in photoconductive detector.

20. Calculate the maximum frequency of operations of the thermal detector with thermal time constant of 1mS? ***(NOV/DEC 2013)***

Solution:

The maximum frequency of operation:

$\Delta T = Wf/G(1+4\pi f^2 t^2)^{1/2}$

$t_H = H/G$.

t_H=Thermal time constant.

21. What are the limitations of germanium based photo diode? ***(NOV/DEC 2013)***

Because of their greater bandgap, germanium based photo diodes generate more noise than silicon based photo diode.

22. What are the various modes involved in charge separation of photo diodes? (NOV/DEC2016)

- Photo voltaic mode of operation
- Photo conductive mode of operation

PART-B

1. Explain the basic principle of electro-optic modulators?
2. Describe the electro –optic modulation with neat sketch?
3. Explain the quantum, confined stark effect (QCSE)?
4. Explain the self-electro –optic device(SEED)?
5. Discuss the different types of noises in the photodiodes.
6. Give an account on the high speed and long wavelength photodiodes?
7. Derive expressions for the gain of a photoconductor with dc excitation at different levels of increasing applied bias?
8. Discuss the characteristics of p-i-n photodiodes with energy band diagrams.
9. Explain briefly about thermal detector, APD and photo devices?
10. Write short note on shot noise, shot noise current, noise equivalent power and specific detectivity.

UNIT – 4
OPTOELECTRONIC MODULATOR
PART-A

1. Compare analog and digital modulation. (NOV/DEC 2016)

Analog Modulation	Digital Modulation
Both message and carrier waves are continuous	Message signal will be in continuous form and carrier will be digital
Requires higher SNR	Requires low SNR
Good for only low frequency and low frequency bandwidth signals	Good for high frequency and high bandwidth signals
High current levels are needed for modulating higher bandwidth signals	Lower current levels is needed for modulating higher bandwidth signals

2. Mention the advantage of high bandwidth?

The main advantages of using high bandwidth is we can able to modulate higher frequency signals with low SNR. Also, current needed is very low.

3. Name the different types of electro-optic modulators.

- Electro-optic amplitude modulation
- Quantum well modulators
- BRAQWET

4. What are the drawbacks of analog modulation?

- Requires high SNR
- For large bandwidth, higher amount of current is needed
- Suitable only for low frequency signal modulation

5. Define electro-optic modulators.

Electro-optic modulators are an optical device in which a signal controlling element displays electro-optic effect to modulate a beam of light. The modulation can be done by changing phase, frequency, amplitude, or polarization of the modulated beam.

6. Define electro-optic effect. *(MAY/JUNE 2013)*

Electro-optic effect refers to change in refractive index of the material resulting from application of a d.c. or low frequency electric field.

7. Define the term birefringence.

Birefringence refers, for a linearly polarized wave that is propagating in z-direction, its polarization vector will depend on the direction of electric field. Due to this effect, the amplification of electric field in one direction will not be same in opposite direction.

8. What are mageneto-optic devices?

These are devices which work under magneto-optic effect. A magneto-optic effect is a phenomenon in which an electromagnetic wave propagates through a medium that has been altered by the presence of a quasi-

static magnetic field. In such a material, which is also called gyrotropic or gyromagnetic, left- and right-rotating elliptical polarizations can propagate at different speeds, leading to a number of important phenomena.

9. What are acoustopic devices?

Acoustopic devices are devices which work under acoustoptic effect. Acoustoptic effect refers to there will be a change in material permittivity 'ε' due to mechanical strain 'α'.

10. What do you mean by SEED?

This is a device exhibiting nonlinear absorption or reflection of an optical signal, photonic switching, bistability, and optically induced oscillations. It is a combination of a detector self biasing a n electro-absorption modulator. The working is based upon multiple quantum well (MQW)-III V technology.

11. What are the different types of SEED?

- R-SEED or Resistor Loaded SEED Function
- D- SEED
- S- SEED
- L- SEED

12. Why we go for bipolar controller modulator?

In SEED, the path and effects of the signal and control beam are same. So, it is difficult to distinguish between the two. Also, it does not have any gain. To achieve larger tolerance gain is very sufficient. So we go for bipolar controller modulator.

13. What are the advantages of bipolar controller modulator?

- High gain
- Large uniform electric field

14. Mention the categories of acoustoptic devices.

- Acoustoptic modulator
- Acoustoptic filter
- Acoustoptic deflectors

15. What are acoustoptic modulators?

These devices will vary the acoustic wave properties such as amplitude, phase, frequency, or polarization to modulate acoustic wave. These properties can be varied by making the optical wave travelled through acoustic field.

16. What are the limitations of acoustoptic modulators?

- The design is complex and should be carefully designed
- Switching speed is limited
- Light cannot be fully switched ON and OFF

17. Define acoustoptic filter.

The principle of operation of acoustoptic filter is based up on the wavelength of diffracted light. Wavelength depends on frequency. By tuning the frequency of acoustic wave, desired wavelength of optical wave can be diffracted.

18. Mention the types of acoustoptic filter.

- Collinear filters

- Noncollinear filters

19. Define collinear filter and non-collinear filter.

Collinear filters does not need to be polarized for modulating the optical wave. Non-collinear filters has to be polarized for modulating.

20. What are acoustoptic deflectors?

Acoustoptic deflectors spatially control the optical beam. In the operation, power of the transducer is kept at a constant level, while the acoustic wave frequency is varied to deflect the optical beam in different angular positions.

21. What is the principle of quantum confined stark effect (QCSE) based optical modulation. ***(MAY/JUNE 2013), (NOV/DEC 2013)***

- In quantum wells, the electro-optic effect is different from that in bulk semiconductors. There is no linear effect is present here. In quantum, well heterostructure there will be a strong interaction of the electrical field with the optical wave.
- The absorption in the sub bands transition energy is dominated by excitonic effects and the electro absorption is greatly enhanced. This is known as quantum confined stark effect (QCSE).

22. Determine the change in refractive index due to Pockel's effect in a 10mm wide KD*P crystal, For an applied voltage of 4kV.the electro optic coefficient and refractive index material are 26.4*10^{-12m}/V and 1.51 respectively. ***(NOV/DEC 2013)***

The field –dependent change in the refractive index can be expressed as

$$\Delta(1/nr^2)=r^lE+S^qE^2$$

Where r^l -linear electro optic coefficient

S^q - Quadratic electro optic coefficient

If is r^l very large, the corresponding electro optic coefficient is called 'Pockel's effect'.

If S^q is large, the corresponding electro optic coefficient is called 'Kerr effect'.

PART-B

1. Differentiate analog and digital modulation techniques.
2. What is electro-optic effect and explain how this is suitable for electro-optic phase and electro-optic amplitude modulation.
3. Explain quadratic electro-optic effect with suitable diagram.
4. Discuss in detail the operation of Electro-optic Amplitude modulation with necessary diagram.
5. Explain the operation of self Electro-optic device with necessary diagram.
6. Write short note on Bipolar controller modulator.
7. Write short note on programmable memory devices.
8. Explain about (i) Tunable threshold logic gates (ii) Optical cross bar switching

UNIT – 5
OPTOELECTRONIC INTEGRATED CIRCUITS
PART-A

1. How guided waves are can be formed?

Guided wave devices are used for routing optical signal on a chip and also make it perform the function of directional coupling, filtering, and modulation. Simplest method for forming guided waves is by introducing free carriers in the semiconductor material. This will reduce the refractive index of the material.

2. What are optoelectronic integrated circuits?

Optoelectronic integrated circuits refer to the integration of electric and optical components and optical interconnection. Optoelectronic devices make electrons and photons to perform single function. These devices are capable of converting optical to electric form and vice versa.

3. What are active guided wave devices and give examples?

Active guided wave devices refer to the active components present in the guided wave. These devices can be integrated with OEIC with active optoelectronic devices.

4. Mention the applications of optoelectronic integrated circuits

It is applicable in the field of telecommunication and radar applications.

5. List out the advantages of optoelectronic integrated circuits

- Low Cost
- Large scale integration
- Photonic devices and circuits can serve unique functions
- New functional capabilities can be emerge by integrating electronic and photonic devices and circuits.

6. Mention the types of integrated transmitters.

Optoelectronic integrated transmitters can use either laser or LED as transmitting devices.

7. Mention the types of integrated receivers.

Front-end photoreceivers and MODFET

8. Define waveguide.

A waveguide is a dielectric region through which light is propagated. These regions were also surrounded by dielectric regions or air having smaller dielectric medium.

9. Mention the types of waveguides.

- Ridge waveguide
- Buried channel waveguide
- Strip-loaded waveguide

10.Explain briefly about directional coupler.

This is simplest coupler formed by the integration of optical circuit. This is useful in transferring energy from one waveguide to another. It consists of two parallel waveguides. Transfer of optical energy takes place between these two waveguides.

11. What do you meant by front-end photo receivers?

The basic purpose of detector is to detect the incident light and convert it into an electrical signal containing the information on the light at transmitting end. The important performance characteristics of photoreceiver are operating bandwidth and sensitivity.

12.What do you meant by MODFET?

MODFET refers to modulation doped field effect transistor. MODFET can be regrown with help of monolithic integration of $In_{0.53}Ga_{0.47}As$ photodiode with $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ modulation doped FET by regrowth on InP. The MODFET consists of a layer of undoped low band gap material forming a hetero junction with a highly doped high band gap material.

13.Write briefly about hybrid integration.

In this type of integration, as the name suggests discrete devices on separate functional block or chips are connected using electronic or optical interconnections. An example for this type of integration is junction laser with its driver circuit consisting of bipolar transistor to form a transmitter. Advantage of this type hybrid integration is the possibility of using high performance discrete devices as components. The disadvantages are lack of compactness and enhanced parasitic effects in terms of interconnects bonding and lead wires.

14.Write briefly about monolithic integration.

In monolithic integration, all active and passive components are fabricated on the same chip. Unlike silicon ICs almost all parts are made with the same material and same processing steps. Monolithic integration can be achieved in either vertical or horizontal configuration. In the vertical scheme, electronic and optical structures are epitaxially grown sequentially with an isolation layer in between.

15.What is the objective of OEIC?

The objective of OEICs is to bring fiber systems to home and individual subscribers in the form of telephone links and broadcast cable TV. In order to extend optoelectronic technologies to subscriber, the systems need the development of lasers with precise frequency control and tenability and wavelength-selective detectors and receivers. Data transmission rates of several tents of gigabits/sec will be attained by these circuits and system.

16. What are the major differences in characteristics of optoelectronic IC'S when compared to conventional electronic IC'S? (MAY/JUNE 2013)

An optoelectronic device is a good example of collaborative role of electrons and photons to perform a single function either emission or detection. An optoelectronic system in which multiple functions are separately performed by electronic and optoelectronic devices. Such a system by analogy with the integrated circuit(IC) can be called as 'optoelectronic integrated circuit' (OEIC).

17. Give the condition for complete power transfer from one guide to another in an optical waveguide directional coupler. *(MAY/JUNE 2013)*

The guided wave integrated circuit element is called directional coupler. Directional coupler is used for transferring optical energy from one wave guide to another. It consists of two parallel waveguides between which the transfer of optical energy occurs due to the overlapping of waveguides modes.

$P_1(Z) = Cos^2(KZ)\, e^{-\gamma z}$ / $P_2(Z) = Sin^2(KZ) e^{-\gamma z}$

18. What are the disadvantages of hybrid opto electronic integration? *(NOV/DEC 2013)*

Disadvantages are lack of compactness and enhanced parasitic effects in terms of interconnects, bonding and lead wires. parasitic are considerably reduced in 'flip-chip' bonding, in which two chips containing component devices and circuits are interconnected by indium bumps.

19. How can we achieve monolithic integration?

Monolithic integration can be achieved using two schemes namely vertical scheme and horizontal scheme.

20. What is the disadvantage of vertical monolithic integration?

The disadvantage of vertical monolithic integration scheme is it lacks planarity.

21. List the factors that dictate the half wave voltage in an active wave guide device? ***(NOV/DEC 2013)***

$V\pi = \lambda d/\ln r_o^3 r_{ij}^1$

Where,

Subscript π denotes a 'half wave phase shift' and $V\pi$ is also called 'half wave voltage'.

22. What are the advantages of monolithic opto electronic integration?(NOV/DEC 2016)

- Size reduction.
- Reduction of parasitic
- Consequent achievements of higher circuit speed and bandwidth.

PART-B

1. What is the need for integration of opto-electronic devices?
2. Explain briefly the application of opto-electronic integrated circuits.
3. Explain the performance of Front end photo receiver.
4. Explain the noise and bandwidth considerations of photo receiver.
5. Explain the various steps involved in the fabrication of OEIC transmitter and also draw the equivalent circuit of integrated transmitter.
6. Explain in detail about the properties of optical guided wave and couplers.
7. With a necessary diagram, explain the concept of optical control in microwave oscillator.
8. Describe the guided wave mach-Zehnder interferometer and derive the expression for half wave phase shift.
9. Distinguish between hybrid and monolithic integration and discuss the merits and demerits.
10. Explain the different types of integrated transmitter and receivers.

Anna University Question Papers

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 21344

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Eighth Semester

Electronics and Communication Engineering

EC 2047/EC 803/EC 1011– OPTOELECTRONIC DEVICES

(Regulation 2008)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate between Diffraction and Scattering.

2. The average electric field in a particular 2.0 μm GaAs device is 5kV/cm. Calculate the average velocity of Electron, if its mobility value is 8000 cm^2/V-s.

3. Why cathode luminescence is less efficiency than photo luminescence?

4. Find the Q-factor of a laser cavity oscillating at 650nm and having a line width of 1 MHz.

5. What are the advantages of photo conductive detector?

6. Calculate the photo current density in a 1 cm length silicon PIN detector, due to a photon flux of $4.37 \times 10^{18} cm^{-2} s^{-1}$. The absorption coefficient is 700 cm^{-1}.

7. Define Electro optic effect.

8. What is the principle of Quantum confined Stark effect (QCSE) based optical modulation?

9. What are the major differences in characteristic of Opto electronic IC's when compared to conventional electronic IC's?

10. Give the condition for complete power transfer from one guide to another in an optical waveguide directional coupler.

PART B — (5 × 16 = 80 marks)

11. (a) From the Schrödinger equation, explain the formation of energy bands in solids. (16)

Or

(b) Derive the expressions for concentration of electrons and holes in an intrinsic semiconductor, with relevant diagrams. (16)

12. (a) Explain with necessary diagrams the principle, construction and working of a liquid crystal display. (16)

Or

(b) Discuss the theory of population inversion and threshold condition in two level laser system. Also explain with diagram the various transitions involved in a four level system. (16)

13. (a) Compare the principle, construction and working of a thermal detector and a photo conductive detector. (16)

Or

(b) (i) Brief about the various noise sources in a photo multiplier tube. (8)

(ii) With an equivalent circuit, explain the factors affecting the bandwidth of a PIN photo diode. (8)

14. (a) (i) Explain the concept of Birefringence in Uniaxial crystal with necessary diagrams. (8)

(ii) Derive the expression for retardation between two waves due to applied voltage in electro optic material. (8)

Or

(b) (i) Discuss in detail the principle and operation of QCSE based optical switching device. (10)

(ii) Expalin the significance for Multiple Quantum Wells in Opto electronic devices. (6)

15. (a) (i) Explain any two applications of OEIC in detail. (12)

(ii) Write a note on Hybird integration OEIC fabrication. (4)

Or

(b) (i) Draw the diagram of a PIN diode and HBT integrated front end Photo receiver and explain its operation. (8)

(ii) Discuss the noise performance in Integrated Photo receivers. (8)

Reg. No. :

Question Paper Code : 31344

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBE

Eighth Semester

Electronics and Communication Engineering

EC 2047/EC 803/EC 1011/10144 ECE 38 – OPTOELECTRONIC DEVICES

(Regulation 2008 / 2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What do you understand by wave - particle duality of Light?

2. Estimate the energy required to excite electrons from the donor levels to the conduction band in silicon, given that $m_c = 0.26m$ and the relative permittivity of 11.8.

3. What is meant by stokes shift?

4. A typical He-Ne laser operates with a current of 10 mA at a dc voltage of 2500V and gives an output of 5mW. Determine the overall power efficiency.

5. Calculate the maximum frequency of operation of a thermal detector with thermal time constant of 1 mS.

6. What are the limitations of Germanium based photo diodes?

7. Determine the change in refractive index due to Pockel's effect in a 10mm wide KD*P crystal, for an applied voltage of 4kV. The electro optic coefficient and refractive index of the material are 26.4×10^{-12} m/V and 1.51 respectively.

8. What is Quantum confined Stark effect?

9. What are the disadvantages of Hybrid Opto electronic Integration?

10. List the factors that dictate the half wave voltage in an active wave guide device.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Explain the principle of superposition and hence derive an expression for maximum irradiance resulting from four coherent sources. (10)

(ii) With a neat diagram explain the interference effects in a thin film of refractive index "n". (6)

Or

(b) (i) Explain in detail about the excess carriers in semiconductors and hence derive the expression for the variation of excess carriers concentration with distance and time. (12)

(ii) Discuss about Drift and diffusion of carriers with relevant mathematical expressions. (4)

12. (a) Explain the principle, construction and working of an Electro luminescence device with necessary diagrams. (16)

Or

(b) (i) Discuss the theory of mode locking in laser, with neat diagrams and hence derive an expression for irradiance in a mode locked laser. (12)

(ii) Explain active and passive mode locking. (4)

13. (a) (i) Explain the principle, construction and working of a Pyro electric detector. (10)

(ii) Brief about photo emissive devices. (6)

Or

(b) (i) Explain the principle and operation of Photo transistors. (8)

(ii) Discuss the construction and working of a vidicon type imaging tube. (8)

14. (a) (i) Explain the concept of external modulation and compare with direct modulation. (6)

(ii) Explain with a neat diagram, the construction of electro optic effect based external modulator. Also deduce the expression of modulated light. (10)

Or

(b) (i) Discuss in detail the principle and operation of a photonic switch based on Self electro optic Device (SEED). (10)

(ii) Explain the concept of Bipolar Controller Modulator (6)

15. (a) (i) Explain the importance of Opto electronic integration.

(ii) Brief about the principal forms of opto electronic integration with their relative merits and demerits.

Or

(b) Explain the principle and operation of

(i) Waveguide coupler (4)

(ii) Waveguide interferometer (6)

(iii) Active directional coupler switch. (6)

Reg. No. : [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

Question Paper Code : 80327

B.E./B.Tech DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Seventh Semester

Electronics and Communication Engineering

EC 6016 — OPTO ELECTRONIC DEVICES

(Common to Sixth Semester Medical Electronics)

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define diffraction and interference.
2. What are black body sources?
3. Mention some important LED materials.
4. What do you meant by mode locking in lasers?
5. What is a bolometer?
6. What are the various modes involved in charge separation of photo diodes?
7. Define Bragg cell.
8. Compare analog and digital modulation.
9. What is meant by plasma etching?
10. What are the advantages of Monolithic Opto electronic integration?

PART B — (5 × 16 = 80 marks)

11. (a) Derive an expression of wave nature of light starting with the Maxwell's Equation. (16)

Or

(b) (i) Explain the formation of energy bands in various materials. (8)

(ii) Derive an expression for electrical conductivity in solids. (8)

12. (a) Explain the following terms. (16)

(i) Photo luminescence

(ii) Cathode luminescence

(iii) Electro luminescence

(iv) Injection luminescence.

Or

(b) (i) Discuss the theory of laser emission and population inversion. (12)

(ii) Write the applications of laser. (4)

13. (a) Explain the principle construction and operation of various thermal detectors. (16)

Or

(b) Discuss the various parameters used to access the performance of a detector. (16)

14. (a) (i) Explain the operation of a three input threshold logic gate with output characteristic curve. (10)

(ii) Write short notes on optical cross bar switch. (6)

Or

(b) Explain with a neat diagram, the construction of electro optic effect based modulator. (16)

15. (a) (i) What is the need for integration of Opto electronic devices and also draw the block diagram of essential elements of an OEIC. (8)

(ii) Explain the application of Opto electronic integrated circuits. (8)

Or

(b) Explain the principle and operation of wave guides and couplers in detail. (16)

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