Code No: R1632042 **R16** SET - 1

III B. Tech II Semester Regular Examinations, April/May- 2019

MICROWAVE ENGINEERING

(Electronics and Communication Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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PART –A

1.	a)	An air filled waveguide with cross section 2 cm x 1 cm transports TE_{10} mode. Find λ_c?	[2M]
	b)	The wave is travelled in circular wave guide of $V_p = 5x10^8$ m/sec, find Group velocity?	[2M]
	c)	Calculate the velocity of an electron beam if V_{dc}=9 V.	[2M]
	d)	Define π-mode condition in Magnetron?	[3M]
	e)	Find the reflection coefficient if VSWR=3.	[3M]
	f)	Draw the graphs of drift velocity versus E-field and J versus E-field.	[2M]

PART -B

2.	a)	When the dominant mode is propagated in an air-filled standard rectangular waveguide, the guide wave length at a frequency of 9 GHz is 4 cm. Calculate width of the guide.	[7M]
	b)	Derive TE Wave field equations.	[7M]
3.	a)	Give the physical structure and field distribution of microstrip line. Why Can a pure TEM mode not be propagated in a microstrip line?	[7M]
	b)	An air-filled circular waveguide of 2 cm inside radius is operated in the TE_{01} mode. i) Compute the cut-off frequency. ii) If the guide is to be filled with a dielectric material of ε_r= 2.25, to what value must its radius be changed in order to maintain the cut-off frequency at its original value?	[7M]
4.	a)	Explain principle of operation, performance characteristics and applications of Two Cavity Klystron.	[7M]
	b)	A Reflex Klystron is operated at 9 GHz with DC beam voltage of 600 V and $1\frac{3}{4}$ mode, repeller space length 1 mm. DC beam current 10 mA. The beam coupling coefficient is assumed to be 1. Calculate the repeller voltage, electronic efficiency and output power.	[7M]
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5. a) Why Magnetron is also called "Extended Interaction tube"? Derive the expression for Hull cut-off magnetic flux density in cylindrical Magnetron. [7M]

   b) A Travelling Wave Tube has the following parameters: [7M]
   Beam current, I_o=50 mA; Beam voltage, V_o=2.5 kV;
   Characteristic impedance of helix, Z_o=6.75Ω; Circuit length N=45;
   Frequency f= 8 GHz. Determine
   i) Gain parameter C
   ii) Output power gain in db
   iii) All four propagation constants
   iv) The wave equations for all four modes in exponential form.

6. a) What is Magic Tee? Why it is called so? Explain the characteristics of the tee considering various input/output conditions? [7M]

   b) What is a precision rotary attenuator? Explain its operation. [7M]

7. a) How is slotted line used for measurement of impedance of an unknown load? Explain. [7M]

   b) Draw the band diagram of GaAs and explain the Gunn effect, where by negative resistances and therefore oscillations are obtained under certain conditions from bulk gallium arsenide. [7M]

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Code No: R1632042 **R16** SET - 2

III B. Tech II Semester Regular Examinations, April/May- 2019

MICROWAVE ENGINEERING

(Electronics and Communication Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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PART –A

1. a) An air-filled waveguide with dimensions 5 cm x 2 cm transports TE_{01} mode. Find λ_c? [2M]
   b) The radius of a circular waveguide with air filled is 3 cm. Find the radius if guide is filled with $\varepsilon_r = 4$. [2M]
   c) Calculate the transit angle of a beam passing through the gap of 1 mm with frequency 3 GHz and uniform velocity 2×10^7 m/sec. [2M]
   d) Calculate angular frequency of a magnetron if $B_0 = 2m/e$? [3M]
   e) Calculate coupling factor of a directional coupler, if P_{in} = 100 mW and Coupling power is 10 mW. [3M]
   f) Estimate the f_r of an IMPATT diode whose drift velocity is 10^5 m/sec and Drift space is 22 μm. [2M]

PART -B

2. a) What is the maximum power that can be transmitted by rectangular guide 1.5 cm x 0.75 cm at 45 GHz? [7M]
   b) Prove that TM_{11} is the lowest TM wave mode in a rectangular WG. [7M]

3. a) Explain the function of a Rectangular Resonator Cavity? [7M]
   b) A TE_{11} wave is propagating through a circular waveguide. The diameter of the guide is 10 cm and waveguide is air filled. [7M]
   i) Find the cutoff frequency.
   ii) Find the Wavelength λ_g in the guide for a frequency of 3 GHz.
   iii) Determine the wave impedance in the guide.

4. a) For a Two Cavity Klystron, the voltage applied to cathode is 900 V. The gap in input cavity is 1.5 mm and spacing between cavities is 4 cm. The voltage across the cavity gap is 10 V peak to peak. Calculate the value of bunching parameter for a beam frequency of 9 GHz. [7M]
   b) Derive the expression for electron admittance of a Reflex Klystron Oscillator. [7M]

5. a) What are π-mode oscillations? Explain how oscillations are sustained in the Cavity Magnetron with suitable sketches, assuming that π-mode oscillations already exist? [7M]
   b) A helical TWT has a diameter of 2 mm with 50 turns per cm. Calculate axial phase velocity and the anode voltage at which the TWT can operate in useful gain. [7M]

6. a) Explain the construction and working of Directional Coupler. Under what conditions does the coupler give maximum directivity? [7M]
   b) Discuss various types of Waveguide attenuators. [7M]
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7. a) How VSWR of unknown load is measured with the help of Slotted Wave Carriage using microwave bench setup? Draw the block diagram of the setup. [7M]
   b) What is transferred electron effect? In which type of material it is present. How the domain formation is taking place in Gunn devices and what are its various modes of operation? [7M]

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Code No: R1632042 **R16** SET - 3

III B. Tech II Semester Regular Examinations, April/May- 2019

MICROWAVE ENGINEERING

(Electronics and Communication Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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PART –A

1.	a)	The wave is travelled in a rectangular wave guide with λ_c is $3\lambda_0$. Find Group velocity?	[2M]
	b)	List out the losses in microstrip lines.	[2M]
	c)	Define velocity modulation.	[2M]
	d)	Write the applications of Travelling wave tubes.	[3M]
	e)	Draw the structure of capacitive Iris and resonant Iris?	[3M]
	f)	By using reflectometer, the measured incident power is 9 times of reflected Power. What is the reflection coefficient?	[2M]

PART -B

2.	a)	Prove that TE_{10} is the dominant mode in rectangular wave guide.	[7M]
	b)	Explain the concept of phase velocity and group velocity.	[7M]
3.	a)	Explain the following about microstrip line: i) Characteristic impedance ii) The effective microstrip permittivity and effective relative permittivity.	[7M]
	b)	Estimate the quality factor of a cavity resonator at different load conditions.	[7M]
4.	a)	How bunch formation takes place in drift region in Two Cavity Klystron? Explain?	[7M]
	b)	What are the Re-entrant Cavities? Why these are different from Resonant cavities? Explain?	[7M]
5.	a)	Define mode jumping? Explain the techniques to eliminate mode jumping?	[7M]
	b)	A helix travelling wave tube operates at 4 GHz under a beam voltage V_o=6 kV and beam current I_o=30mA. If the helix impedance Z_o is 100 ohm and circuit length N=30, find the output power gain.	[7M]
6.	a)	Derive the S-Matrix of E-plane tee when power is fed from auxiliary port. Consider other ports in the matched condition.	[7M]
	b)	What is Circulator? Explain the various applications of Circulator.	[7M]
7.	a)	Show how to measure the frequency of the source without using a wave meter in the microwave test bench? Explain.	[7M]
	b)	How avalanche effect is utilized to generate microwave signals? Explain The operation of IMPATT diode.	[7M]

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Code No: R1632042 **R16** SET - 4

III B. Tech II Semester Regular Examinations, April/May- 2019

MICROWAVE ENGINEERING

(Electronics and Communication Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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PART –A

1.	a)	The wave is travelled in a rectangular wave guide with λ_c is $2\lambda_o$. Find Phase velocity?	[2M]
	b)	Calculate the resonant frequency of a Rectangular Cavity Resonator with dimensions 2 cm x 1 cm x 3 cm with TE_{100} wave?	[2M]
	c)	Define beam coupling coefficient and draw the graph between angle and beam efficiency?	[2M]
	d)	Draw the types of slow wave structures used in HTWT?	[3M]
	e)	Estimate the reflected power due to load mismatch with $\acute{\Gamma}$=0.1 and P_i= 200W?	[3M]
	f)	Using double minima method, find SWR for $\lambda_g = \pi$ cm and distance between the positions of twice minimum power is 0.5 cm.	[2M]

PART -B

2.	a)	A rectangular air filled copper waveguide with dimension 2.28 cm and 1.01 cm is operated at 9.2 GHz with dominant mode. Find the cut-off frequency, guide wave length, phase shift, phase velocity and characteristic impedance.	[7M]
	b)	Discuss the types of losses exist in Rectangular Wave Guide.	[7M]
3.	a)	Compute the lowest resonant frequency of a Rectangular Cavity Resonator having following dimensions: width=2 cm, height=1cm , length=3 cm.	[7M]
	b)	Derive TE mode in a Circular Waveguide?	[7M]
4.	a)	Derive the velocity modulation equation of Two Cavity Klystron amplifier?	[7M]
	b)	Prove that the efficiency of a Reflex Klystron Oscillator is only 22%?	[7M]
5.	a)	With the support of a diagram, explain the operation of Eight Cavity Magnetron.	[7M]
	b)	An X-band pulsed Cylindrical Magnetron has V_o=30 kV, I_o=80 A, B_o=0.01 Wb/m^2, a=4 cm, b=8 cm. Calculate i) Cyclotron angular frequency ii) Cutoff voltage iii) Cutoff magnetic flux density	[7M]
6.	a)	Explain the working and applications of two types of Waveguide discontinuity.	[7M]
	b)	An Isolator has an insertion loss of 0.5 dB and isolation of 30 dB. Determine the scattering matrix of the Isolator if the isolated ports are perfectly matched to junction.	[7M]
7.	a)	What is Reflection meter? How it is used to measure the reflection coefficient and VSWR of any unknown load?	[7M]
	b)	How avalanche effect is utilized to generate microwave signals? Explain the operation of TRAPATT diode.	[7M]

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Code No: R1632042 **R16** SET - 1

III B. Tech II Semester Regular/Supplementary Examinations, October/November - 2020

MICROWAVE ENGINEERING

(Electronics and Communication Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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PART –A (14 Marks)

1. a) What is Degenerate Mode? [2M]
   b) Define the Quality factor in waveguides. [2M]
   c) What is the avalanche transit time? [2M]
   d) Define the slow wave structure of TWT using any three structures. [3M]
   e) How the microwave power can be trapped from the waveguide for coupling using a directional coupler? [3M]
   f) List out the applications of the TRAPATT device. [2M]

PART –B (56 Marks)

2. a) Enumerate the basic advantages and applications of microwaves. [7M]
   b) The Dimensions of the Waveguide are 2.5 cm x 1 cm. The Frequency is 8.6 GHz. Find the (i) Possible Modes (ii) Cut off Frequency and (iii) Guide Wavelength. [7M]

3. a) Compare: (i) Transmission Line and Wave Guide
   (ii) Rectangular Wave Guide and Circular Wave Guide
   (iii) Waveguide and microstrip line. [7M]
   b) Explain the mathematical analysis of the rectangular cavity resonator. [7M]

4. a) Explain Working of the reflex klystron. Compare it with two-cavity klystron. [7M]
   b) Explain how the klystron amplifier can act as a klystron oscillator? Discuss the performance specifications of Reflex klystron. [7M]

5. a) With a neat diagram explain the operation of helix TWT. [7M]
   b) An X-band pulsed conventional magnetron has the following parameters: Anode voltage, V_o=5.5 KV, Beam current, I_0=4.5 A, Operating frequency, f=9×10^9 Hz, Resonant conductance, $G_r=2\times10^{-4}$ mho, Loaded conductance, $G_l=2.5\times10^{-5}$ mho, Vane capacitance, C=2.5 PF. Compute: (i) Angular resonant frequency, (ii) Unloaded quality factor, and (iii) Loaded quality factor. [7M]

6. a) Using S parameters, explain the properties of a magic tee. [7M]
   b) Explain the coupling mechanism through probe and aperture. [7M]

7. a) Draw the basic block diagram of the microwave test bench setup and explain each part. [7M]
   b) Give at least three differences between microwave transistors and TEDs (i.e. transfer electron devices). Write the statement of the Gunn effect and explain the GaAs diode. [7M]

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Code No: R1632042 **R16** SET - 1

III B. Tech II Semester Supplementary Examinations, November – 2019

MICROWAVE ENGINEERING

(Electronics and Communication Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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PART –A (14 Marks)

1.	a)	Define cut-off frequency of a waveguide and write its significance.	[2M]
	b)	Draw the schematic diagram of a microstrip line.	[2M]
	c)	Define reentrant cavity.	[2M]
	d)	Write the applications of magnetron.	[3M]
	e)	Write short notes on waveguide irises.	[3M]
	f)	Write the performance characteristics of TRAPATT diode.	[2M]

PART –B (56 Marks)

2.	a)	What are the characteristics and advantages of microwaves? Explain.	[7M]
	b)	What are the various power losses in waveguides? Explain.	[7M]
3.		Discuss about TE modes in circular waveguides.	[14M]
4.	a)	Draw the diagram of two-cavity klystron amplifier and explain its working.	[7M]
	b)	Explain about limitations of conventional tubes at microwave frequencies.	[7M]
5.	a)	What is meant by slow wave structure? List out the various slow wave structures. Discuss the properties of Helical slow wave structure.	[7M]
	b)	Discuss about power output and efficiency of cylindrical magnetron.	[7M]
6.	a)	What is S-matrix? Explain its significance and write the properties of S-matrix.	[7M]
	b)	Explain the operation of circulator and write its applications.	[7M]
7.	a)	Explain about RWH theory for Gunn effect.	[7M]
	b)	Explain the procedure of measurement of low VSWR.	[7M]

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Code No: **RT4104A** **R13** **Set No. 1**

IV B.Tech I Semester Supplementary Examinations, February/March - 2018

OPTICAL COMMUNICATION

(Electronics and Communication Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B
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PART–A *(22 Marks)*

1. a) Mention the four advantages of OFC. [4]
   b) Write about micro bending and macro bending losses. [4]
   c) Differentiate the splicer and connector. [3]
   d) Discuss the concept of spontaneous emission in LED. [3]
   e) Write a brief notes on equilibrium numerical aperture. [4]
   f) What is WDM and explain its significance. [4]

PART–B *(3x16 = 48 Marks)*

2. a) A multimode step index fiber has a relative refractive index difference of 1% and core refractive index of 1.5. The number of modes operating at a wavelengthof1.3μmeteris 1100. Estimate the diameter of the fiber core. [8]
   b) Explain group delay and mode delay factor with reference to single mode fibers showing the relevant graph. [8]

3. a) Explain the scattering and bending losses in optical fibers. [8]
   b) Give an account of cut off wavelength for single mode and multi mode fibers and discuss its dependence on fiber length. [8]

4. a) Describe the connector return loss in an optical fiber. [8]
   b) Explain the following briefly (i) Single mode fiber joint (ii) Multimode fiber joint [8]

5. a) Sketch and explain the fabry-petrot resonator cavity of a laser diode. [8]
   b) A GaAs laser operating at 850 nm and 450μm length and refractive index $\eta = 3.5$. What are the frequency and wavelength spacing? If the half power point, $\lambda - \lambda o = 2.5$nm, what is the spectral width σ of the gain? [8]

6. a) With a schematic diagram explain the working of optical receiver. [8]
   b) Discuss the possible sources of noise in optical receivers. [8]

7. a) Explain the significance of power budget and system margin. [8]
   b) Following are the parameters of a point-to-point optical link: (i) Optical power launched: + 5dBm (ii) sensitivity of detector : -30dBm (iii) Source/detector connector loss : 1dB (iv) Length of optical cable : 55km (v) Cable attenuation : 0.3 dB/km (vi) Jumper cable loss : 2.5 dB (vii) Connector loss at each fiber joint : 1dB Assume two jumper cables and two cable joints. Compute the power margin of the line [8]

Code No: **RT4104A** **R13** **Set No. 1**

IV B.Tech I Semester Supplementary Examinations, February - 2019

OPTICAL COMMUNICATION

(Electronics and Communication Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B
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PART–A *(22 Marks)*

1.	a)	Define and explain mode coupling.	[3]
	b)	Write a short note on Halide Glass fibers.	[3]
	c)	Define fiber splicing? Explain fusion splicing of optical fiber.	[4]
	d)	Define spontaneous emission.	[4]
	e)	Write a short note on error source.	[4]
	f)	Write a short note on chromatic dispersion.	[4]

PART–B *(3x16 = 48 Marks)*

2.	a)	Write about the historical development of optical fiber communication.	[8]
	b)	Explain briefly about Skew rays.	[8]
3.	a)	Write a short note on Scattering Losses.	[8]
	b)	Discuss briefly about Polarization-Mode dispersion.	[8]
4.	a)	Write a note on single-mode fiber connectors.	[8]
	b)	Draw and explain V-groove and Elastic-tube fiber splicing technique.	[8]
5.	a)	Explain internal and external quantum efficiency.	[8]
	b)	Write a note on external quantum efficiency.	[8]
6.	a)	Explain briefly about laser diode –to-fiber coupling.	[8]
	b)	Explain briefly about analog receivers.	[8]
7.	a)	Discuss briefly about Rise-Time budget.	[8]
	b)	Discuss briefly about Time-Domain Intermodal Dispersion measurements.	[8]

Code No: **RT4104A** **R13** **Set No. 1**

IV B.Tech I Semester Regular Examinations, November - 2016

OPTICAL COMMUNICATION

(Electronics and Communication Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B
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PART–A *(22 Marks)*

1. a) List out the differences between skew ray and meridional ray? [4]
   b) List out the types of dispersion? [4]
   c) List out the salient features of expanded beam connector? [4]
   d) Define electrical and optical 3-dB bandwidth? [4]
   e) Estimate the receiver front-end rise time if the 3-dB electrical bandwidth is 5MHz? [3]
   f) Define a term Timing jitter? [3]

PART–B *(3x16 = 48 Marks)*

2. a) Calculate the number of modes at 820nm and 1.3μm in a graded- index fiber having a parabolic-index profile (α=2), a 25μm core radius n_1 =1.48 and n_2=1.46. How does this compare to a step-index fiber? [8]
   b) A step-index multimode fiber with a numerical aperture of 0.20 supports approximately 1000 modes at an 850nm wavelength.
      i) What is the diameter of its core?
      ii) How many modes does the fiber supports at 1320nm?
      iii) How many modes does the fiber supports at 1550nm? [8]

3. a) Write a note on glass fibers? [8]
   b) An optical signal at a specific wavelength has lost 55% of its power after traversing 3.5km of fiber. What is the attenuation in dB/km of this fiber? [8]

4. a) With neat sketch, explain the splicing techniques used in optical fiber. [8]
   b) Explain about connecter loss when two optical fibers are connected. [8]

5. a) Explain the working principle of surface emitting LED. [8]
   b) Explain types of noise sources in optical fiber system. [8]

6. a) Explain about digital signal transmission system. [8]
   b) Explain the power launching techniques in optical fiber. [8]

7. a) List out the each component choice and their features in a point-to-point link. [8]
   b) Explain how to measure attenuation in optical fiber system. [8]

Code No: **RT4104A** **R13** **Set No. 2**

IV B.Tech I Semester Regular Examinations, November - 2016

OPTICAL COMMUNICATION

(Electronics and Communication Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B

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PART–A (22 Marks)

1. a) Define total internal reflection? [4]
   b) Define mode –field diameter? [4]
   c) Define the phenomenon of Fresnel reflection? [4]
   d) Define double hetero structure and show the cross sectional view? [4]
   e) Draw the waveforms of given data 010110 in NRZ and Manchester coding? [3]
   f) Define the term edge jitter? [3]

PART–B (3x16 = 48 Marks)

2. a) Calculate the numerical apertures of
      i) a plastic step-index fiber having a core refractive index of n_1=1.60 and a cladding index of n_2=1.49.
      ii) a step-index fiber having a silica core (n_1=1.458) and the silicone resin cladding (n_2=1.405). [8]
   b) Calculate the numerical apertures of step-index fiber having n_1=1.48, and n_2=1.46. What is the maximum entrance angle $\theta_{0,max}$ for this fiber if the outer medium is air. [8]

3. a) Explain any three mechanisms of absorption in optical fiber? [8]
   b) Consider an optical link consisting of a 5km long step-index fiber with core index n_1=1.49 and relative index difference Δ=1%.
      i) Find the delay difference at the fiber end between the slowest and fastest modes.
      ii) Find the RMS pulse broadening caused by inter model dispersion. [8]

4. a) Explain the affect of misalignment if two optical fibers are aligned? [8]
   b) An optical fiber has a core refractive index of 1.5. Two lengths of the fiber with smooth and perpendicular (to the core axes) end faces are butted together. Assuming the fiber axes are perfectly aligned, calculate the optical loss in decibels at the joint (due to Fresnel reflection) when there is a small air gap between the fiber end faces. [8]

5. a) Explain the working principle of edge-emitting double hetero junction LED. [8]
   b) Explain the photodiode pulse responses under various detector parameters. [8]

6. a) Explain types of error sources in detection mechanism. [8]
   b) Explain equilibrium numerical aperture. [8]

7. a) Briefly explain the link power budget. [8]
   b) List out the techniques to measure dispersion in optical fiber. Explain any one of the technique. [8]

Code No: **RT4104A** **R13** **Set No. 3**

IV B.Tech I Semester Regular Examinations, November - 2016

OPTICAL COMMUNICATION

(Electronics and Communication Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B

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PART–A (22 Marks)

1. a) Define numerical aperture? Generally what is the range of NA? [4]
   b) When the mean optical power launched into an 8km length of fiber is 120μw, the mean optical power at the fiber output is 3μw then determine the overall signal attenuation or loss in decibels through the fiber assuming there are no connectors or splices? [4]
   c) If Fresnel reflection is 4% calculate the loss (dB) due to reflection? [4]
   d) Draw the lambertian pattern and mention the HPBW? [4]
   e) Define a quantum limit? [3]
   f) Draw the eye diagram with their parts? [3]

PART–B (3x16 = 48 Marks)

2. a) A silica tube with inside and outside radii of 3 and 4mm, respectively, is to have a certain thickness of glass deposited on the inner surface. What should be the thickness of the glass deposition be if a fiber having a core diameter of 50μm and an outer cladding diameter of 125μm is to be drawn from this perform? [8]
   b) A wave is specified by $y=8\cos 2\pi(2t-0.8z)$, where y is expressed in micrometers and the propagation constant is given in μm^{-1}. Find i) the amplitude ii) the wavelength. [8]

3. a) Explain about bending losses in optical fiber and how they can minimize? [8]
   b) When the mean optical power launched into an 8km length of fiber is 120μw, the mean optical power at the fiber output is 3μw. Determine
   i) The overall signal attenuation or loss in decibels through the fiber assuming there are no connectors or splices;
   ii) The signal attenuation per kilometer for the fiber. [8]

4. a) Explain the working principle of expanded beam connecters? [8]
   b) Two single –mode fibers with mode-field diameters of 9.2 μm and 8.4μm are to be connected together. Assuming no extrinsic losses, determine the loss at the connection due to the mode-field diameter mismatch. [8]

5. a) Explain the temperature effect on avalanche gain. [8]
   b) Explain the internal quantum efficiency. [8]

6. a) Explain the principle of analog receiver. [8]
   b) Calculate the power coupling in $P_{LED,STEP}$. [8]

7. a) Explain the advantage with line coding and also explain any one of the coding technique with suitable diagram. [8]
   b) Explain the intermodal dispersion measurement technique in time domain. [8]

Code No: **RT4104A** **R13** **Set No. 4**

IV B.Tech I Semester Regular Examinations, November - 2016

OPTICAL COMMUNICATION

(Electronics and Communication Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B

Answer ALL sub questions from Part-A

Answer any THREE questions from Part-B

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PART–A (22 Marks)

1. a) Define birefringence and fiber beat length? [4]
   b) A multimode graded index fiber exhibits total pulse broadening of 0.1μs over a distance of 15kms, estimate the maximum possible bandwidth on the link assuming no inter symbol interference? [4]
   c) If two optical fibers of core reflective index 1.5 are joined with a small air gap. Calculate the Fresnel reflection? [4]
   d) Define internal and external quantum efficiency? [4]
   e) Define relative intensity noise (RIN)? [3]
   f) Define total distance accuracy? [3]

PART–B (3x16 = 48 Marks)

2. a) Find the core radius necessary for single mode operation at 1320nm of a step-index fiber with n_1=1.480 and n_2=1.478. What are the numerical aperture and maximum acceptance angle of this fiber? [8]
   b) A manufacturer wishes to make a silica-core, step-index fiber with V=75 and a numerical aperture NA=0.30 to be used at 820nm. If n_1=1.458, what should the core size and cladding index be? [8]

3. a) Define signal dispersion in optical fiber and explain any one of the dispersion? [8]
   b) A multimode fiber with a core refractive index of 1.50, a relative refractive index difference of 3% and an operating wavelength of 0.8μm. Estimate the critical radius of curvature at which large bending losses occur? [8]

4. a) Explain the principle of multimode fiber joints? [8]
   b) Explain the need of connecter in optical fiber and list out the types of connectors? [8]

5. a) Explain the working principle of distributed feedback laser diode. [8]
   b) Draw and explain the structure of InGaAs APD (avalanche photo diode). [8]

6. a) What is radiation pattern? Explain how to represent radiation pattern. [8]
   b) Explain the quantum limit in optical fiber system. [8]

7. a) Explain the intermodal dispersion measurement technique in frequency domain. [8]
   b) What is WDM? Explain the principle of WDM. [8]

Code No: **RT4104A** **R13** **Set No. 1**

IV B.Tech I Semester Regular/Supplementary Examinations, Oct/Nov - 2018

OPTICAL COMMUNICATION

(Electronics and Communication Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B

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PART–A *(22 Marks)*

1. a) Explain the terms : (i) Cut off wave length (ii) Mode field diameter [4]
   b) What are the requirements of optical fiber? Explain glass and plastic materials in detail. [4]
   c) What is the difference between fusion splicing and mechanical splicing? [4]
   d) What is the importance of double hetero junction in LED structures? [4]
   e) What is called equilibrium numerical aperture? [3]
   f) What is WDM? [3]

PART–B *(3x16 = 48 Marks)*

2. a) Explain about the light guidance in a optical fiber with figures and explain the total internal reflection and numerical aperture with diagrams. [8]
   b) What is normalized frequency? A step index fiber in air has a numerical aperture of 0.16, core refractive index 1.45, and core diameter 60 micro meters. Assume that wavelength is 0.1 micrometer. Determine normalized frequency for fiber. [8]

3. a) Explain the different types of methods to minimize signal distortion in optical fibers. [8]
   b) How does material dispersion occur in an optical fiber? Obtain the expression for group delay τ_{mat} resulting from the material dispersion and from this, deduce the relation for the pulses spread σ_{mat} in terms of material dispersion D_{mat} (λ). [8]

4. a) Explain the losses in end separator connecting different fibers when joining two fibers. [8]
   b) Write a short note on different types of fiber connectors? [8]

5. a) Derive the expressions for quantum efficiency and LED power. [8]
   b) The Radiative and non radiative recombination life times of minority carriers in the active region of a double heterojunction LED are 60 sec and 90 sec respectively. Determine the total carrier recombination life time and optical power generated internally if the peak emission wave length is 870 nm and the drive current is 40 mA. [8]

6. a) Derive an expression for power coupled power from an LED into a relatively smaller step index fiber with equal numerical aperture. [8]
   b) Discuss the dependence of equilibrium numerical aperture and power coupling from a source into a fiber. [8]

7. a) Discuss key system features of WDM. Draw diagram of a typical WDM link containing various components and explain it in brief. [8]
   b) Describe graphical representation of link loss budget with a set of assumed values. [8]

Code No: **RT4104A** **R13** **Set No. 2**

IV B.Tech I Semester Regular/Supplementary Examinations, Oct/Nov - 2018

OPTICAL COMMUNICATION

(Electronics and Communication Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B

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PART–A *(22 Marks)*

1. a) A light ray is incident from medium-1 to medium-2, if the refractive indices of medium-1 and medium -2 are 1.5 and 1.36 respectively then determine the angle of refraction for an angle of incidence of 30^0. [4]
   b) What are the mechanical properties of optical fibers? Explain. [4]
   c) What is meant by splicing? What are the advantages of splicing? [4]
   d) What are the different types of light source materials? [4]
   e) "The optical power launched into a fiber does not depend on the wavelength of the source but only on its brightness". Explain. [3]
   f) What are the line coding techniques in optical communication? [3]

PART–B *(3x16 = 48 Marks)*

2. a) For a multimode step index optical fiber of glass core of refractive index 1.5 and quartz cladding of refractive index 1.46 , determine:
   (i) critical angle (ii) Acceptance angle (iii) Numerical aperture [8]
   b) Explain the basic principal of Optical Fiber. Compare Optical Fiber with Co-axial cable as a communication channel. [8]

3. a) For a 30 km long fiber attenuation 0.8 db/km at 1300 nm. If a 200 µW is launched into the fiber, find the output power. [8]
   b) Differentiate between graded index and step index also define birefringence and V number [8]

4. a) What are the different types of alignments in optical fibers? [8]
   b) Compare multi mode fiber joints and single mode fiber joints? [8]

5. a) Explain the different types of photo detector used in optical system and explain structure and operating principle of any one in detail. [8]
   b) An LED with a circular emitting area of radius 20 µm has a lambertian emission pattern with 100 w/cm2 .sr. axial radiance at 100 mA drive current. How much optical power can be coupled in to a step index fiber having a 100 µm core diameter and numerical aperture of 0.22? How much optical power can be coupled from this source in to a 50 µm core diameter graded index fiber having $\alpha = 2.0$ $n1=1.48$ and $\Delta=0.01$? [8]

6. a) Derive the equation for the power launched from LED Source in to a Graded Index fiber. [8]
   b) Explain the fundamental receiver operation in optical fiber communication. [8]

7. a) State the probable basic requirements of an optical communication system. [8]
   b) Enlist the major design considerations in an optical system. [8]

Code No: **RT4104A** **R13** **Set No. 3**

IV B.Tech I Semester Regular/Supplementary Examinations, Oct/Nov - 2018

OPTICAL COMMUNICATION

(Electronics and Communication Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B
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PART–A *(22 Marks)*

1. a) Explain the following terms : (i) Meridional rays (ii) Skew rays [4]
   b) Explain scattering losses in optical fibers. [4]
   c) Explain the requirements of a good connector design. [4]
   d) Explain population inversion mechanism in optical fibers. [4]
   e) Calculate the optical power coupled into the fiber by an optical source with a bias current of 20mA and a forward voltage of 1.5V.Assume an internal efficiency of the source as 2% and the coupling efficiency of 30%. 0 [3]
   f) Briefly explain TDM, FDM, WDM and SDM used in optical communication system. [3]

PART–B *(3x16 = 48 Marks)*

2. a) Explain electromagnetic mode theory in optical fiber in detail. [8]
   b) Explain the importance of cladding in optical fiber communication. Justify the statement: "Light travels faster in cladding than core". [8]

3. a) Explain in detail the transmission losses due to absorption mechanism in an optical fiber with necessary equations and prove that this loss is a function of wavelength using graphical analysis. [8]
   b) Derive the equation for intermodal dispersion. [8]

4. a) Explain Butt joint connectors with neat circuit diagrams. [8]
   b) Explain the connector return losses in optical fibers. [8]

5. a) A Laser diode has lateral $\emptyset$ =0°and transverse $\emptyset$ =90° half power beam widths of 2θ=60°and 30° respectively what are transverse and lateral power distribution coefficients for this device? [8]
   b) Derive the equation of power coupling from LED source to step index fiber: (i) when source radius is less than fiber radius (ii) when source radius is greater than the fiber radius. [8]

6. a) A continuous 12 km long optical fiber link has a loss of 1.5 dB/km: (i) What is the minimum optical power level that must be launched into the fiber to maintain an optical level of 0.3 μW at the receiving end? (ii) What is the required input power if the fiber has a loss of 2.5 dB/km? [8]
   b) Differentiate between power coupled to step index fiber and graded index fiber? [8]

7. a) Discuss all the criteria to select the set of components sufficing design of a fiber fiber optical link. [8]
   b) What are the differences in specifications, selection of components, performance merit parameters of digital and analog fiber optic receiver? [8]

Code No: **RT4104A** **R13** **Set No. 4**

IV B.Tech I Semester Regular/Supplementary Examinations, Oct/Nov - 2018

OPTICAL COMMUNICATION

(Electronics and Communication Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B

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PART–A *(22 Marks)*

1. a) Explain the terms: (i) Group velocity (ii) Phase velocity [4]
   b) Explain in detail intrinsic absorption losses and extrinsic absorption losses. [4]
   c) Explain (i) V-grove splicing and (ii) elastic tube techniques for fiber splicing. [4]
   d) A GaAs laser operating at 850nm and has a length of 500µm. refractive index n=3.7.Calculate frequency and wave length. [4]
   e) Derive the relation for the optical power launched from a surface emitting LED into a graded index fiber. [3]
   f) Write short notes on multiplexing in fiber optic receivers. [3]

PART–B *(3x16 = 48 Marks)*

2. a) Compare the fiber structure and NA in step index and graded index fibers. [8]
   b) The refractive index of the core of step index fiber is 1.46 and the relative refractive index difference between core and cladding of the fiber is 2%. Estimate (i) Numerical Aperture (ii) Critical angle at the core cladding interface within the fiber. [8]

3. a) Explain core and cladding losses. Explain losses due to bending. [8]
   b) An optical signal at a specific wavelength has lost 55% of its power after traversing 3.5 Km of fiber. What is the attenuation in dB/km of this fiber? [8]

4. a) Explain the procedure of installing fiber connectors in optical fibers. [8]
   b) A step index fiber has a core refractive index of 1.5 and a core diameter of 50µm.Esimate the insertion loss at the joint due o the lateral misalignment assuming a uniform distribution of power between all guided modes when: (i) There is a small air gap at the joint (ii) the joint s considered index matched. [8]

5. a) Draw the light output versus current curve and explain the operation of LASER. [8]
   b) Explain the semiconductor injection laser diode resonating mode. [8]

6. a) Calculate the optical power coupled into the fiber by an optical source with a bias current of 20mA and a forward voltage of 1.5V.Assume an internal efficiency of the source as 2% and the coupling efficiency of 30%. [8]
   b) Estimate the losses encountered while coupling power from a source to a fiber due to mismatch in their numerical apertures and surface areas. [8]

7. a) Discuss the system criteria for design of a point-to-point fiber optic link. [8]
   b) Design of an optical fiber link for transmitting 15 Mb/Sec of data for a distance of 4 Km with BER of 10^{-9}. [8]