SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY
(AUTONOMOUS):: PUTTUR

(Approved by AICTE, New Delhi & Affiliated to JNTUA, Ananthapuramu)
(Accredited by NAAC with "A+" Grade & ISO 9001 : 2008 Certified Institution)

QUESTION BANK (DESCRIPTIVE)

Subject with Code: MICROWAVE AND OPTICAL COMMUNICATIONS **(23EC0420)**
Course & Branch: B. Tech –ECE
Year & Semester: III- B. Tech. & II-Semester **Regulation:** R23

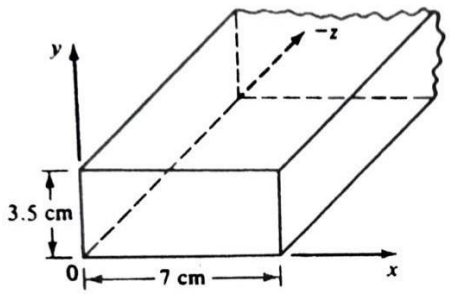
UNIT I

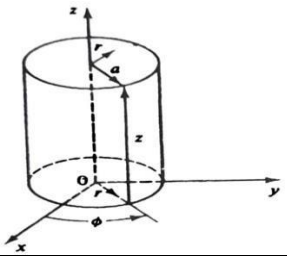
Waveguides

PART-A (2 MARKS)

1.	**(a)**	Define microwave? Mention their frequency range.	**[L1][CO1]**	**[2M]**
	(b)	Write different types of modes in waveguide.	**[L1][CO1]**	**[2M]**
	(c)	State the relationship between phase velocity and group velocity in a waveguide.	**[L1][CO1]**	**[2M]**
	(d)	What is dominant mode in waveguide?	**[L1][CO1]**	**[2M]**
	(e)	What is a cavity resonator?	**[L1][CO1]**	**[2M]**

PART-B (10 MARKS)

2.	**(a)**	Explain the evolution of microwave technology from its origin ?	**[L2][CO1]**	**[5M]**
	(b)	List out i) Microwave frequency bands based on the IEEE standards. ii) Applications of Microwaves.	**[L1][CO1]**	**[5M]**
3.	**(a)**	Derive the equation for the propagation of TE waves in rectangular waveguide.	**[L3][CO1]**	**[5M]**
	(b)	An air filled rectangular waveguide of inside dimensions operates in the dominant TE_{10} mode as shown in following figure. Compute the cutoff frequency and determine the guided wavelength at f = 3.5 GHz.  	**[L3][CO1]**	**[5M]**
4.	**(a)**	Explain the following terms: i) Guide wavelength ii) Phase Velocity iii) Group Velocity iv) Cutoff Frequency.	**[L2][CO1]**	**[5M]**
	(b)	The dimensions of a guide are 2.5x1cms. The frequency is 8.6 GHz. Find the cutoff frequencies for TE_{10} and TE_{01} mode.	**[L3][CO1]**	**[5M]**
5.	**(a)**	Derive the expression for cut off frequency in a waveguide.	**[L3][CO1]**	**[5M]**
	(b)	Derive the expression for group velocity.	**[L3][CO1]**	**[5M]**
6.	**(a)**	Derive the expression for phase velocity.	**[L3][CO1]**	**[5M]**
	(b)	A rectangular waveguide has a=4cms, b=3cms as its sectional dimensions. Predict all the modes which will propagate at 5000MHz.	**[L3][CO1]**	**[5M]**
7.		Define Wave Impedance. Express the equation for wave impedance in TM wave.	**[L1][CO1]**	**[10M]**
8.	**(a)**	Derive the expression for average power transmitted using the Poynting vector for both TEmn and TMmn modes.	**[L3][CO1]**	**[5M]**

	(b)	How to estimate the Power Losses due to attenuation in Rectangular Guide?	**[L3][CO1]**	**[5M]**
9.	**(a)**	Write a short notes on Skin Effect in microwave transmission.	**[L2][CO1]**	**[5M]**
	(b)	Explain mode of excitations in rectangular waveguide.	**[L2][CO1]**	**[5M]**
10.	**(a)**	Describe the circular waveguide and the equation for cut off frequency and its dominant mode.	**[L2][CO1]**	**[5M]**
	(b)	A TE_{11} Mode is propagating through a circular waveguide. The radius of the guide is 5 cm, and the guide contains an air dielectric. Compute the cutoff frequency. 	**[L3][CO1]**	**[5M]**
11.	**(a)**	Explain the working of rectangular and cylindrical cavity resonators with neat diagrams.	**[L2][CO1]**	**[5M]**
	(b)	Derive the cutoff frequency of a rectangular cavity resonator.	**[L3][CO1]**	**[5M]**

UNIT II

Passive Microwave Devices & Microwave amplifiers and Oscillators

PART-A (2 MARKS)

1.	**(a)**	What is waveguide terminator and variable short circuit?	**[L1][CO2]**	**[2M]**
	(b)	What is an isolator?	**[L1][CO2]**	**[2M]**
	(c)	What is velocity modulation?	**[L1][CO2]**	**[2M]**
	(d)	Give two applications of TWT amplifiers.	**[L2][CO2]**	**[2M]**
	(e)	Write the Hartree expression for pi mode operation.	**[L1][CO2]**	**[2M]**

PART-B (10 MARKS)

2.	**(a)**	Explain the significance and formulation of S-matrix in detail.	**[L2][CO2]**	**[5M]**
	(b)	List out the properties of S-matrix.	**[L1][CO2]**	**[5M]**
3.		Describe the following: i) Resistive Card attenuator ii)Rotary Vane Attenuator iii) Phase shifters	**[L2][CO2]**	**[10M]**
4.	**(a)**	Construct the microwave tee, whose rectangular slot is cut along the broader dimension and describe it in detail.	**[L3][CO2]**	**[5M]**
	(b)	Derive the S-matrix for E-Plane Tee.	**[L3][CO2]**	**[5M]**
5.	**(a)**	Construct the microwave tee, whose rectangular slot is cut along the wider dimension and Describe it in detail.	**[L3][CO2]**	**[5M]**
	(b)	Derive the S-matrix for H-Plane Tee.	**[L3][CO2]**	**[5M]**
6.	**(a)**	Construct the microwave tee, whose rectangular slot is cut both along the width and breadth of long waveguide dimension and Describe it in detail.	**[L3][CO2]**	**[5M]**
	(b)	Explain the working of Directional Coupler with suitable diagram & express its Coupling factor and directivity.	**[L2][CO2]**	**[5M]**
7.	**(a)**	What is Gyrator? Explain the working principle of gyrator with a neat sketch.	**[L2][CO2]**	**[5M]**
	(b)	Explain the working principle of Circulator with a neat sketch.	**[L2][CO2]**	**[5M]**
8.	**(a)**	Distinguish between O type Microwave tubes and M type Microwave tubes.	**[L2][CO2]**	**[5M]**
	(b)	Explain the constructional details and principle of operation of two cavity klystron with the neat sketch.	**[L2][CO2]**	**[5M]**
9.	**(a)**	A two cavity klystron amplifier has the following characteristics: Voltage gain = 15 dB, Input Power = 5 mW, R_{sh} of input cavity = 30 k ohm, R_{sh} of output cavity =40 k ohm, load impedance = 40 k ohm. Find input rms	**[L3][CO2]**	**[5M]**

		voltage and the output rms voltage.		
	(b)	Discuss in detail about the working of Reflex Klystron and modes of oscillation with neat applegate diagram.	**[L2][CO2]**	**[5M]**
10.	**(a)**	A reflex klystron operates at the peak mode of n = 2 with V0 = 280 V, I_0 = 22 mA and signal voltage V_1 = 30 V. Determine input & output power and efficiency.	**[L3][CO2]**	**[5M]**
	(b)	Explain the constructional structure of travelling wave tube.	**[L2][CO2]**	**[5M]**
11.	**(a)**	Explain in detail about 8- Cavity magnetron with suitable diagram.	**[L2][CO2]**	**[5M]**
	(b)	Describe the operation of pi-mode of 8-Cavity magnetron with neat sketch.	**[L2][CO2]**	**[5M]**

UNIT III

Microwave Semiconductor Devices

PART-A (2 MARKS)

1.	**(a)**	Mention any two blocks in microwave bench setup with features.	**[L1][CO3]**	**[2M]**
	(b)	List any two common sources of error and precautions to be followed in microwave measurements.	**[L1][CO3]**	**[2M]**
	(c)	Define quality factor of a cavity.	**[L1][CO3]**	**[2M]**
	(d)	What is the relation between VSWR and reflection coefficient?	**[L1][CO3]**	**[2M]**
	(e)	State different frequency measurement methods.	**[L1][CO3]**	**[2M]**

PART-B (10 MARKS)

2.	**(a)**	Explain the operation and characteristics of Gunn diode.	**[L2][CO3]**	**[5M]**
	(b)	Discuss the Two-Valley model in Gunn diodes with suitable diagrams.	**[L2][CO3]**	**[5M]**
3.	**(a)**	Explain the construction and operation of an IMPATT diode.	**[L2[CO3]**	**[5M]**
	(b)	Derive the expression for Power Output and Efficiency of IMPATT diode.	**[L3[CO3]**	**[5M]**
4.	**(a)**	Describe the operation of a TRAPATT diode.	**[L2][CO3]**	**[5M]**
	(b)	Compare Gunn diode, IMPATT diode, and TRAPATT diode.	**[L2][CO3]**	**[5M]**
5.	**(a)**	With the help of a neat sketch, briefly explain the functions of different blocks of a microwave bench.	**[L2][CO3]**	**[5M]**
	(b)	What are the precautions to be taken while setting up microwave bench for measurement of various parameters? Explain.	**[L1][CO3]**	**[5M]**
6.	**(a)**	Discuss in detail about the microwave power measurement using Bolometric technique.	**[L2][CO3]**	**[5M]**
	(b)	Explain about measurement of attenuation using a power ratio method.	**[L2][CO3]**	**[5M]**
7.	**(a)**	Explain briefly Slotted line method of microwave frequency measurement.	**[L2][CO3]**	**[5M]**
	(b)	What is VSWR? How to calculate reflection coefficient from VSWR measurements.	**[L2][CO3]**	**[5M]**
8.	**(a)**	Explain how high values of VSWR(S>10) can be measured directly from the VSWR meter using the experimental set-up.	**[L2][CO3]**	**[5M]**
	(b)	Two identical directional couplers are used in a waveguide to sample the incident and reflected powers. The output of the two couplers is found to be 2.5mw and 0.15mW. Determine the value of VSWR in the waveguide.	**[L3][CO3]**	**[5M]**
9.	**(a)**	Explain the measurement of Quality factor (Q) using Reflectometer method.	**[L2][CO3]**	**[5M]**
	(b)	Estimate the SWR of a transmission system operating at 10GHz. Assume TE_{10} wave transmission inside a waveguide of dimensions a=4cm, b=2.5cm. The distance measured between twice minimum power points = 1 mm on a slotted line.	**[L3][CO3]**	**[5M]**
10.	**(a)**	Sketch the experimental setup necessary for the measurement of impedance using slotted line. Explain it in detail.	**[L3][CO3]**	**[5M]**
	(b)	Assume you have two directional couplers (20 dB) in a guide to sample the incident and reflected powers. The outputs of the two couplers are 3mw	**[L1][CO3]**	**[5M]**

		and 0.1mw respectively. What is the value of VSWR in the main waveguide? What is the value of reflected power?		
11.	**(a)**	Using the Reflectometer method, explain how to measure the impedance with the help a block diagram.	**[L2][CO3]**	**[5M]**
	(b)	In a setup for measuring impedance of a reflectometer, what is the reflection coefficient when the output of two couplers are 2mw and 0.5mw respectively?	**[L3][CO3]**	**[5M]**

UNIT IV
Introduction to Optical Fibers and Transmission Characteristics
PART-A (2 MARKS)

1.	**(a)**	What is meant by optical communication system?	**[L1][CO4]**	**[2M]**
	(b)	Define refractive index of a medium.	**[L1][CO5]**	**[2M]**
	(c)	What is Scattering loss?	**[L1][CO5]**	**[2M]**
	(d)	List any two attenuation mechanisms in optical fibers.	**[L1][CO5]**	**[2M]**
	(e)	Define polarization mode dispersion of a single mode fiber.	**[L1][CO5]**	**[2M]**

PART-B (10 MARKS)

2.		Explain the propagation of light in optical waveguides using ray theory.	**[L2][CO4]**	**[10M]**
3.	**(a)**	Describe different types of optical fibers.	**[L1][CO4]**	**[5M]**
	(b)	Derive the expression for numerical aperture (NA) and acceptance angle.	**[L3][CO4]**	**[5M]**
4.	**(a)**	Consider multimode fiber that has a core refractive index of 1.488 and core cladding index difference of 2.0%. Calculate numerical aperture, critical angle and acceptance angle.	**[L3][CO4]**	**[5M]**
	(b)	Describe the characteristics of Step index & graded index fibers with a neat sketch.	**[L2][CO5]**	**[5M]**
5.		Explain modes in cylindrical optical fibers with neat sketch.	**[L3][CO5]**	**[10M]**
6.	**(a)**	Discuss the formation of Linearly Polarized (LP) modes in weekly guiding fibers with examples.	**[L2][CO5]**	**[5M]**
	(b)	Explain how the attenuation is caused by using absorption losses.	**[L2][CO5]**	**[5M]**
7.	**(a)**	Explain the phenomenon of Rayleigh scattering and Mie scattering losses.	**[L2][CO5]**	**[5M]**
	(b)	Discuss macro bending and micro bending losses. Explain how bending radius affects attenuation.	**[L2][CO5]**	**[5M]**
8.	**(a)**	An optical fiber link of length 8 km is used to transmit optical power. The mean optical power launched into the fiber is 120μW, and the mean optical power measured at the fiber output is 3μW. Determine the following: (a) The total signal attenuation (loss) in decibels (dB) over the 8 km fiber, assuming no connectors or splices are present. (b) The attenuation per kilometer of the optical fiber, expressed in dB/km.	**[L3][CO5]**	**[5M]**

	(b)	Define modal dispersion and chromatic dispersion. Explain how they cause pulse broadening.	**[L2][CO5]**	**[5M]**
9.	**(a)**	Describe the roles of material dispersion and waveguide dispersion in forming total chromatic dispersion.	**[L2][CO5]**	**[5M]**
	(b)	Describe the structure and propagation characteristics of a single-mode fiber (SMF).	**[L2][CO5]**	**[5M]**
10.	**(a)**	Discuss how waveguide dispersion can be engineered to achieve zero-dispersion wavelength.	**[L3][CO5]**	**[5M]**
	(b)	Define Mode Field Diameter & Analyze the role of Mode Field Diameter (MFD) in splice loss.	**[L4][CO5]**	**[5M]**

UNIT V
Optical Transmitters and Receivers

PART-A (2 MARKS)

1.	**(a)**	What are light source materials used in optical transmitters?	**[L1][CO6]**	**[2M]**
	(b)	State any two characteristics of hetero structure LEDs.	**[L1][CO6]**	**[2M]**
	(c)	Write any two differences between PIN diode and APD diode**.**	**[L1][CO6]**	**[2M]**
	(d)	What is a point-to-point optical link**?**	**[L1][CO6]**	**[2M]**
	(e)	List the types of budgets in optical communication system.	**[L1][CO6]**	**[2M]**

PART-B (10 MARKS)

2.	**(a)**	Explain the working principle of an LED and its applications in optical communication.	**[L2][CO6]**	**[5M]**
	(b)	Discuss about homo-junction and hetero-junction LEDs with neat diagrams.	**[L2][CO6]**	**[5M]**
3.	**(a)**	Explain about the surface emitter LED with neat diagram.	**[L2][CO6]**	**[5M]**
	(b)	Illustrate the working principle of an edge emitter LED with neat diagram.	**[L2][CO6]**	**[5M]**
4.		Discuss the advantages of edge-emitting LEDs over surface-emitting LEDs in optical communication systems.	**[L4][CO6]**	**[10M]**
5.	**(a)**	Derive the expressions of quantum efficiency and LED power.	**[L3][CO6]**	**[5M]**
	(b)	Calculate the overall quantum efficiency of an LED with internal quantum efficiency 0.8 and extraction efficiency 0.6.	**[L3][CO6]**	**[5M]**
6.	**(a)**	Explain the structure and working of an Injection Laser Diode (ILD) with neat diagram.	**[L2][CO6]**	**[5M]**
	(b)	Describe the longitudinal and transverse modes of a laser diode.	**[L2][CO6]**	**[5M]**
7.	**(a)**	Explain the threshold condition for lasing and its significance in optical communication systems.	**[L2][CO6]**	**[5M]**
	(b)	Illustrate the laser radiation pattern and explain how it affects fiber coupling efficiency.	**[L3][CO6]**	**[5M]**
8.	**(a)**	Explain the principle behind the operation of an PIN Photo diode with its the energy band diagram.	**[L2][CO6]**	**[5M]**
	(b)	A photo diode has a quantum efficiency of 65% when photons of energy of $1.5x10^{-19}$ J are incident upon it. (i) Find the operating wavelength of the photodiode (ii) Calculate the incident optical power required to obtain a photo current of 2.5 μA when the photodiode is operating as described above.	**[L3][CO6]**	**[5M]**
9.	**(a)**	Explain in detail about the operation of Avalanche Photo Diode using suitable diagram.	**[L2][CO6]**	**[5M]**
	(b)	Summarize the comparisons of photo detectors.	**[L2][CO6]**	**[5M]**
10.	**(a)**	Discuss the different types of noise in photo detectors and their impact.	**[L2][CO6]**	**[5M]**
	(b)	Explain the concept of point-to-point optical links**.**	**[L2][CO6]**	**[5M]**

11.	**(a)**	Illustrate in detail about Link power budget.	**[L3][CO6]**	**[5M]**
	(b)	Explain the Rise Time Budget analysis with basic elements.	**[L3][CO6]**	**[5M]**

Prepared by:

D.Madhu, Associate Professor, Dept. of ECE, SIETK.
B. Ravi Babu, Assistant Professor, Dept. of ECE, SIETK.
G.Priyanka, Assistant Professor, Dept. of ECE, SIETK.