INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**MICROWAVE ENGINEERING**				
Course Code	**AEC015**				
Programme	B.Tech				
Semester	VII	ECE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Dr. V Siva Nagaraju, Professor				
Course Faculty	Mrs. S Annapurna, Asst. Professor Mrs. P Saritha, Asst. Professor Mr. U Somanaidu, Asst. Professor				

COURSE OBJECTIVES:

The course should enable the students to:	
I	Develop the knowledge on transmission lines for microwaves, cavity resonators and Wave guide components and applications.
II	Enable the students to understand and analyze the operation of microwave tubes like klystron, magnetron, travelling wave tube, etc.,
III	Familiarize with microwave solid state devices
IV	Introduce the student the microwave test bench for measure different parameters like attenuation, VSWR, impedance etc.

COURSE OUTCOME (COs):

CO 1	Describe the types of waveguides, rectangular waveguides and field equations.
CO 2	Understand the coupling mechanisms in waveguides and analyze the waveguide multiport junctions
CO 3	Explore the microwave linear tubes and analyze with microwave cross field tubes
CO 4	Demonstrate the microwave bench set up and conducting measurements of different parameters
CO 5	Demonstrate the microwave bench set up and conducting measurements of different parameters

COURSE LEARNING OUTCOMES (CLOs):

AEC015.01	Understand the microwave spectrum and applications of microwaves
AEC015.02	Analyze the types of waveguides, rectangular waveguides and field equations in rectangular waveguide.
AEC015.03	Determine the wave impedance for a TM and TE wave in rectangular waveguide
AEC015.04	Understand the types of cavity resonators and determine the dominant mode.
AEC015.05	Explore the coupling mechanisms for a cavity resonator
AEC015.06	Understand the waveguide discontinuities: waveguide irises, tuning screws, posts and matched loads
AEC015.07	Understand the operation of multiport junctions and its applications
AEC015.08	Understand the Faraday rotation principle and analyze the different ferrite devices.
AEC015.09	Understand the limitations of conventional vacuum tubes at microwave frequencies and Understand the velocity modulation process and bunching process in microwave linear beam tubes
AEC015.10	Determine the beam current density in Multi cavity Klystron amplifiers
AEC015.11	Understand the velocity modulation process and power output in Reflex Klystron
AEC015.12	Determine the amplification process in helix Traveling wave tube (TWT)
AEC015.13	Describe the 8-cavity cylindrical travelling wave Magnetron
AEC015.14	Analyze the Hull cut-off and Hartree conditions in Magnetron
AEC015.15	Illustrate the microwave solid-state devices: microwave tunnel diode and transferred electron devices
AEC015.16	Determine the RWH theory and modes of operations in Gunn diodes
AEC015.17	Understand the Avalanche transit time devices: IMPATT diode, TRAPATT diode and BARITT diode
AEC015.18	Describe the microwave bench set-up with different blocks and their features
AEC015.19	Determine the measurements of microwave power, attenuation, frequency, VSWR and impedance
AEC015.20	Apply the concept of microwave engineering to understand and analyze real time applications.

TUTORIAL QUESTION BANK

S. No	QUESTION	Blooms Taxonomy Level	Course Outcomes	Course learning Outcome
UNIT-I				
PART-A (SHORT ANSWER QUESTIONS)				
1	List the typical applications of microwaves.	Remember	CO 1	AEC015.01
2	Define the dominant mode of a waveguide?	Remember	CO 1	AEC015.01
3	What are microwaves? Why they are so called?	Remember	CO 1	AEC015.01
4	Define waveguide? Mention some of its features?	Remember	CO 1	AEC015.01
5	What is TE, TM & TEM modes?	Remember	CO 1	AEC015.01
6	Define dominant mode and degenerate mode?	Remember	CO 1	AEC015.02
7	Define cutoff frequency of a waveguide.	Remember	CO 1	AEC015.02
8	What is dominant mode of a rectangular waveguide for TE and TM modes and why?	Remember	CO 1	AEC015.02
9	Explain briefly about impossibility of TEM Modes.	Understand	CO 1	AEC015.02
10	Name the microwave frequency bands and spectrums.	Remember	CO 1	AEC015.01
11	Define phase velocity.	Remember	CO 1	AEC015.03
12	What is meant by group velocity?	Remember	CO 1	AEC015.03
13	What is the relation between phase and group velocities in terms of light velocity?	Understand	CO 1	AEC015.03
14	Define guide wavelength.	Remember	CO 1	AEC015.03
15	Summarize the advantages of microwaves.	Understand	CO 1	AEC015.01
16	Define wave impedance?	Remember	CO 1	AEC015.03
17	Define cavity resonator?	Remember	CO 1	AEC015.04
18	What are different types of cavity resonators are there?	Remember	CO 1	AEC015.04
19	Define Rectangular cavity resonator?	Remember	CO 1	AEC015.04
20	Discuss about resonant frequencies?	Understand	CO 1	AEC015.05
PART-B (LONG ANSWER QUESTIONS)				
1	Derive the TMmn mode field equation in rectangular waveguide.	Create	CO 1	AEC015.02
2	Derive the TEmn mode field equation in rectangular waveguide	Create	CO 1	AEC015.02
3	What are the dominated and degenerate modes? What is the significance of dominant modes? Indicate the dominant mode in rectangular wave guide and calculate fc for the same.	Understand	CO 1	AEC015.02
4	Formulate the expressions for cut off frequency, phase constant, in a rectangular wave guide.	Apply	CO 1	AEC015.03
5	What is a Microwave spectrum bands? Explain briefly the applications of microwaves at various frequency bands.	Understand	CO 1	AEC015.01
6	Explain the wave impedance of a rectangular waveguide and derive the expression for the wave impedance of TE mode.	Understand	CO 1	AEC015.03
7	Derive the expression for cutoff frequency of TEmn mode in rectangular wave guide.	Create	CO 1	AEC015.02
8	Derive the TMmnp mode field equation in rectangular cavity resonator	Create	CO 1	AEC015.04
9	Derive the TEmnp mode field equation in rectangular cavity resonator	Create	CO 1	AEC015.04
10	Derive the cut-off frequency expression for Rectangular cavity resonator	Create	CO 1	AEC015.04

S. No	QUESTION	Blooms Taxonomy Level	Course Outcomes	Course learning Outcome
11	Formulate the expressions group velocity, Phase velocity and wave impedance in A rectangular wave guide	Apply	CO 1	AEC015.03
12	Derive the expression for cutoff frequency of TMmn mode in rectangular wave guide.	Create	CO 1	AEC015.02
13	List the advantages of microwaves briefly.	Remember	CO 1	AEC015.01
14	Explain the wave impedance of a rectangular waveguide and derive the expression for the wave impedance of TM mode.	Understand	CO 1	AEC015.03
15	Derive the field components of TE Waves in Rectangular waveguide?	Create	CO 1	AEC015.02
16	Derive the field components of TE Waves in Rectangular waveguide?	Create	CO 1	AEC015.02
17	How many types of waveguides are there? Explain them briefly?	Understand	CO 1	AEC015.01
18	Draw the field patterns for any three modes in TE Mode for a rectangular waveguide?	Apply	CO 1	AEC015.03
19	Draw the field patterns for any three modes in TM Mode for a rectangular waveguide?	Apply	CO 1	AEC015.03
20	Explain about different coupling mechanisms in Rectangular cavity resonator?	Understand	CO 1	AEC015.04
PART-C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	Show that the TM01 and TM10 modes in rectangular waveguide do not exist.	Apply	CO 1	AEC015.02
2	An air-filled rectangular waveguide has dimensions of a = 6 cm and b = 4 cm. The signal frequency is 3 GHz. Compute the following for the TE10 and TM11 modes: (a) Cut-off frequency (b) Wavelength in the waveguide (c) Phase constant and phase velocity (d) Group velocity in the waveguide.	Apply	CO 1	AEC015.02
3	The dimensions of a rectangular waveguide are a = 2.5 cm and b = 1 em. The signal frequency is 8.6 GHz. The determine the following: (a) Possible modes (b) Cut-off frequencies.	Apply	CO 1	AEC015.02
4	A rectangular waveguide has a = 4 cm and b = 3 cm. Find all the possible modes of propagation at signal frequency of 5 GHz.	Apply	CO 1	AEC015.02
5	For a dominant mode in an air filled rectangular waveguide, for a signal frequency of 9 GHz and guide wavelength is 4 cm. Determine the dimension of the waveguide.	Apply	CO 1	AEC015.02
6	A rectangular waveguide is filled by dielectric material of E r = 9 and has inside dimensions of 7 x 3.5 cm. It operates in the dominant TE10 mode. Then determine (a) Cut-off frequency (b) Phase velocity in the guide at frequency of 2 GHz (c) Guide wavelength A.9 at the same frequency.	Apply	CO 1	AEC015.03
7	A rectangular waveguide operating in dominant mode having breath 10 cm for 2.5 GHz signal propagated in this waveguide. Determine the group, phase velocities and guide wavelength	Apply	CO 1	AEC015.03
8	Calculate the cut-off frequency of the following modes	Apply	CO 1	AEC015.03

S. No	QUESTION	Blooms Taxonomy Level	Course Outcomes	Course learning Outcome
	in a square waveguide 4 cm × 4 cm (i) TE10 (ii) TE11 (iii) TE22			
9	(a) A common air filled rectangular X band waveguide has the interior dimensions a = 2.29 cm and b = 1.0 cm. Find the cut-off frequency of the lower order, nontrival TM mode. (b) If a source frequency which is twice the cut-off value found in (a), determine the propagating constant for the mode. Also obtain the wavelength in the guide, phase velocity and intrinsic wave impedance.	Apply	CO 1	AEC015.03
10	A 6 GHz signal is to be propagated in the dominant mode in a rectangular waveguide. If group velocity is to be 90% of the free space velocity of light. What must be the breath of the waveguide? What impedance will be offer to this signal, if it is correctly matched?	Apply	CO 1	AEC015.03
UNIT-II				
PART-A(SHORT ANSWER QUESTIONS)				
1	Explain the waveguide discontinuities?	Remember	CO 2	AEC015.06
2	Mention the applications of Hybrid Tee junction?	Remember	CO 2	AEC015.07
3	What is meant by Isolator?	Remember	CO 2	AEC015.08
4	What is meant Gyrator?	Remember	CO 2	AEC015.08
5	Describe the principle of working of a wave guide attenuator, with neat schematics?	Understand	CO 2	AEC015.08
6	List out the different types of waveguide Irises?	Remember	CO 2	AEC015.06
7	Write short notes on Ferrite Devices?	Understand	CO 2	AEC015.08
8	How many types of microwave junctions are there?	Apply	CO 2	AEC015.07
9	Distinguish between an isolator and a gyrator	understand	CO 2	AEC015.08
10	What is the need of S-Matrix	Understand	CO 2	AEC015.07
11	Describe about probe and loop coupling mechanisms in rectangular cavity resonator?	Understand	CO 2	AEC015.07
12	What is meant circulator?	Understand	CO 2	AEC015.08
13	Write the applications of circulator?	Understand	CO 2	AEC015.08
14	Explain faraday rotation principle?	Understand	CO 2	AEC015.08
15	Define attenuator?	Remember	CO 2	AEC015.08
16	Define phase shifter?	Remember	CO 2	AEC015.08
17	How many types of attenuators are there in rectangular waveguide?	Remember	CO 2	AEC015.08
18	How many types of phase shifters are there in rectangular waveguide?	Remember	CO 2	AEC015.07
19	What are the applications of magic tee?	Understand	CO 2	AEC015.07
20	Why E-H Plane tee junction is called as magic tee?	Understand	CO 2	AEC015.07
PART-B (LONG ANSWER QUESTIONS)				
1	Write about quality factor of a cavity resonator.	Understand	CO 2	AEC015.06
2	Discuss the principle of working an H-plane Tee junction with neat schematics.	Understand	CO 2	AEC015.07
3	Discuss in detail about the principle of working an E-plane Tee junction with neat schematics?	Understand	CO 2	AEC015.07
4	Explain the principle of working a Magic Tee junction with neat schematics?	Understand	CO 2	AEC015.07
5	Discuss about E-H plane Tee junction. Why a hybrid E-H plane Tee referred to as Magic Tee. Derive the	Understand	CO 2	AEC015.07

S. No	QUESTION	Blooms Taxonomy Level	Course Outcomes	Course learning Outcome
	scattering matrix for E-H plane Tee junction.			
6	Write short notes on: Wave guide Irises	Understand	CO 2	AEC015.06
7	Discuss about tuning screws and posts	Understand	CO 2	AEC015.06
8	Describe about various types of Attenuators?	Understand	CO 2	AEC015.06
9	Describe about various types of Phase shifters?	Understand	CO 2	AEC015.06
10	Discuss the principle of working a Hybrid ring with neat schematics.	Understand	CO 2	AEC015.07
11	Discuss about gyrator with neat diagrams?	Understand	CO 2	AEC015.08
12	Discuss about circulator with neat diagrams?	Understand	CO 2	AEC015.08
13	Discuss about isolator with neat diagrams?	Understand	CO 2	AEC015.08
14	Explain about Ferrite components and faraday rotation principle?	Understand	CO 2	AEC015.08
15	Explain about Rotatory vane type of phase shifters	Understand	CO 2	AEC015.08
16	Explain about Rotatory vane type of phase shifters	Understand	CO 2	AEC015.08
17	Explain in detail about wave guide discontinuities?	Understand	CO 2	AEC015.06
18	With the help of block diagrams explain about the applications of magic tee?	Understand	CO 2	AEC015.07
19	What is the need of microwave junction and derive s-matrix with the help of two port network?	Understand	CO 2	AEC015.07
20	What is the need of attenuators and phase shifters in rectangular waveguide?	Understand	CO 2	AEC015.08
PART-C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	Prove that it is impossible to construct a perfectly matched lossless, reciprocal three-port junction	Apply	CO 2	AEC015.07
2	An isolator has an insertion loss of 0.5 dB and an isolation of 30 dB. Determine the scattering matrix of the isolator if the isolated ports are perfectly matched to junction	Apply	CO 2	AEC015.08
3	A three-port circulator has an insertion loss of 1 dB, isolation 30 dB and VSWR is 1.5. Find the S-matrix.	Apply	CO 2	AEC015.08
4	Show that E-plane acts as a 3 dB splitter	Apply	CO 2	AEC015.07
5	The collinear ports (1) and (2) of magic tee are terminated by impedances of reflection coefficients $\rho 1 = 0.5$ and $\rho 2 = 0.6$. The difference port (4) is terminated by an impedance with reflection coefficient of 0.8. If 1 watt power is fed at sum port (3), calculate the power reflected at port (3) and power divisions at the other ports	Apply	CO 2	AEC015.07
6	Show that H-plane acts as a 3 dB splitter	Apply	CO 2	AEC015.07
7	A three-port circulator has an insertion loss of 10 dB, isolation 30 dB and VSWR is 1.5. Find the S-matrix.	Apply	CO 2	AEC015.08
8	An isolator has an insertion loss of 0.8 dB and an isolation of 40 dB. Determine the scattering matrix of the isolator if the isolated ports are perfectly matched to junction	Apply	CO 2	AEC015.08
9	An attenuator of 20dB is fed with 100w input. Find the output power of the attenuator.	Apply	CO 2	AEC015.06
10	An attenuator of 40dB is fed with 100w input. Find the output power of the attenuator.	Apply	CO 2	AEC015.06
UNIT-III				
PART-A(SHORT ANSWER QUESTIONS)				
1	State the limitations of conventional tubes at microwave	Remember	CO 3	AEC015.09

S. No	QUESTION	Blooms Taxonomy Level	Course Outcomes	Course learning Outcome
	frequencies.			
2	What is the principle of two cavity Klystron amplifier?	Remember	CO 3	AEC015.10
3	What are the applications of reflex klystron?	Remember	CO 3	AEC015.11
4	State the characteristics of the two-cavity klystron amplifier.	Remember	CO 3	AEC015.10
5	Compare TWT& Klystron amplifier.	Understand	CO 3	AEC015.12
6	Draw the schematic diagram of helix travelling wave tube?	Understand	CO 3	AEC015.12
7	What is meant by reflex klystron?	Remember	CO 3	AEC015.11
8	What are the performance characteristics of klystron amplifier?	Remember	CO 3	AEC015.10
9	Differentiate between klystrons and TWT.	Understand	CO 3	AEC015.12
10	State the applications of the two-cavity klystron amplifier.	Remember	CO 3	AEC015.10
11	Why multi-cavity klystrons are preferred?	Remember	CO 3	AEC015.10
12	How are oscillations avoided in travelling wave tube?	Remember	CO 3	AEC015.08
13	Discuss in detail about lead inductance and inter electrode capacitance effects of conventional tubes at microwave frequencies.	Remember	CO 3	AEC015.08
14	Differentiate between O – type tubes and M – type tubes.	Understand	CO 3	AEC015.12
15	What is the condition for obtaining the power output in reflex klystron?	Understand	CO 3	AEC015.11
16	Explain mechanical tuning of reflex klystron?	Understand	CO 3	AEC015.11
17	Explain electronic tuning of reflex klystron	Understand	CO 3	AEC015.11
18	Explain the operating principle of reflex klystron?	Understand	CO 3	AEC015.11
19	Derive the power output of a reflex klystron	Understand	CO 3	AEC015.11
20	Explain frequency pushing in magnetron	Remember	CO 3	AEC015.14
	PART-B (LONG ANSWER QUESTIONS)			
1	Explain is the principle of working for Two – Cavity Klystron with velocity diagram.	Understand	CO 3	AEC015.10
2	Derive the expression for output power & Efficiency of a Two cavity klystron.	Analyze	CO 3	AEC015.10
3	Explain in detail bunching process & obtain expression for bunching parameter in a two cavity klystron amplifier.	Apply	CO 3	AEC015.10
4	What are the limitations of conventional tubes at microwave frequencies? Explain how these limitations can be overcome.	Analyze	CO 3	AEC015.09
5	Explain the construction & working of 8-Cavity magnetron and also explain hull cut off and hartree conditions	Understand	CO 3	AEC015.14
6	Name different methods of generating microwave power. Describe the necessary theory & Working of reflex klystron.	Apply	CO 3	AEC015.11
7	Explain the operation of TWT With the help of constructional diagram.	Analyze	CO 3	AEC015.12
8	Explain the principle of operation of a reflex Klystron oscillator and derive an expression for the bunching parameter.	Analyze	CO 3	AEC015.11
9	Explain the construction & working of two cavity klystron amplifier.	Understand	CO 3	AEC015.10
10	Explain the construction & working of Magnetron.	Understand	CO 3	AEC015.13

S. No	QUESTION	Blooms Taxonomy Level	Course Outcomes	Course learning Outcome
11	Explain mathematical analysis of two cavity klystron amplifier in detail.	Understand	CO 3	AEC015.10
12	Derive the equation for beam coupling coefficient of the input cavity in two cavity klystron.	Analyze	CO 3	AEC015.10
13	Derive the equation for depth of velocity modulation in two cavity klystron.	Analyze	CO 3	AEC015.10
14	Explain the bunching parameter of klystron	Understand	CO 3	AEC015.10
15	Derive the output power of klystron with equivalent circuit of catcher cavity	Analyze	CO 3	AEC015.10
16	Derive the expression for efficiency of reflex klystron and compare with two cavity klystron	Analyze	CO 3	AEC015.11
17	Derive a relationship between accelerating voltage and repeller voltage in reflex klystron	Analyze	CO 3	AEC015.11
18	Explain the purpose of attenuator in travelling wave tube amplifier	Understand	CO 3	AEC015.12
19	Explain the efficiency improvement methods in travelling wave tube amplifier	Understand	CO 3	AEC015.12
20	Compare travelling wave tube amplifier with two cavity klystron amplifier	Understand	CO 3	AEC015.12
PART-C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	A reflex klystron is operating at 100 GHz. If the mode operating in the tube corresponds to integer n = 3, determine the transit time of the electron in the repeller space	Apply	CO 3	AEC015.11
2	The operating frequency of reflex klystron is 2 GHz. Calculate the change in frequency for a 2% change in the repeller voltage given that; Repeller voltage = 2000 V Accelerating voltage = 500 V Space between exit of the gap and repeller electrode = 2 cm (Assume that the operation is for n = 1)	Apply	CO 3	AEC015.11
3	A reflex klystron operates at the peak of the n = 1 or 3/4 mode. The DC power input is 40 mW and the ratio of V1 over V0 is 0.278 (a) Determine the efficiency of the reflex klystron. (b) Find the total output power in mW. (c) If 20% of the power delivered by the electron beam is dissipated in the cavity walls, find the power delivered to the load.	Apply	CO 3	AEC015.11
4	A reflex klystron operates at the peak of the n = 1 or 3/4 mode. The DC power input is 40 mW and the ratio of V1 over V0 is 0.278 (a) Determine the efficiency of the reflex klystron. (b) Find the total output power in mW. (c) If 20% of the power delivered by the electron beam is dissipated in the cavity walls, find the power delivered to the load.	Apply	CO 3	AEC015.11
5	A reflex klystron operates at the peak mode n = 2 with Beam voltage V0 = 300 V Beam current I0 = 20 mA Signal voltage V1 = 40 V Determine: (a) The input power (b) The output power (c) The efficiency.	Apply	CO 3	AEC015.12
6	A helical TWT has a circumference (of helix) to pitch ratio of 10. Determine the anode voltage for which the TWT can be operated for any useful gain.	Apply	CO 3	AEC015.12
7	A helix travelling wave tube operates at 4 GHz under a beam voltage V0 = 6 kV and beam current I0 = 30 mA.	Apply	CO 3	AEC015.12

S. No	QUESTION	Blooms Taxonomy Level	Course Outcomes	Course learning Outcome
	If the helix impedance Z0 is 100 ohm and circuit length N = 30, find the output power gain.			
8	An O-type travelling wave tube operates at 2 GHz. The slow wave structure has pitch angle of 5.7°. Determine the propagation constant of the travelling wave in the tube. It is assumed that the tube is lossless.	Apply	CO 3	AEC015.12
9	Determine the following in case of an 8 resonator travelling wave magnetron. (a) Phase difference between adjacent resonators in general. (b) Number of possible modes of resonance. (c) Number of useful modes of resonance. (d) Value of integer (n) for the most dominant mode	Apply	CO 3	AEC015.13
10	An X-band pulsed cylindrical magnetron has V0 = 30 kV, I0 = 80 A, B0 = 0.01 wb/m2 , a = 4 cm, b = 8 cm. Calculate: (i) Cyclotron angular frequency (ii) Cut-off voltage (iii) Cut-off magnetic flux density.	Apply	CO 3	AEC015.14
UNIT-IV				
PART-A(SHORT ANSWER QUESTIONS)				
1	What is transferred electron effect?	Remember	CO 4	AEC015.15
2	What is negative resistance in Gunn diode?	Remember	CO 4	AEC015.16
3	What are the applications of Microwave Solid-State Devices?	Understand	CO 4	AEC015.15
4	What are the elements that exhibit Gunn Effect?	Understand	CO 4	AEC015.16
5	Mention the applications of Gunn diode amplifier.	Remember	CO 4	AEC015.16
6	What is GUNN effect?	Remember	CO 4	AEC015.16
7	Explain transferred electron effect.	Understand	CO 4	AEC015.15
8	What is the principle of TRAPATT diode?	Understand	CO 4	AEC015.17
9	What is the principle of IMPATT diode?	Remember	CO 4	AEC015.17
10	What is the principle of BARITT diode?	Remember	CO 4	AEC015.17
11	Write short notes on “LSA mode in GUNN diode”.	Understand	CO 4	AEC015.16
12	What are the limitations of LSA modes of Gunn diodes?	Remember	CO 4	AEC015.17
13	Compare IMPATT and TRAPATT diodes.	Understand	CO 4	AEC015.17
14	Differentiate between transferred electron devices and transistors.	Understand	CO 4	AEC015.16
15	What are the Applications of MESFET?	Remember	CO 4	AEC015.17
16	What are the applications and advantages of various solid state devices?	Understand	CO 4	AEC015.16
17	Explain working of varactor diode.	Remember	CO 4	AEC015.17
18	Explain the working of IMPATT.	Understand	CO 4	AEC015.17
19	Explain the working of PIN diode.	Understand	CO 4	AEC015.16
20	What is the advantage of double drift region over single drift region?	Understand	CO 4	AEC015.15
PART-B (LONG ANSWER QUESTIONS)				
1	What is meant by Avalanche Transit Time Devices? Explain the Operation, construction and Applications of IMPATT.	Understand	CO 4	AEC015.17
2	Explain avalanche transit time devices.	Remember	CO 4	AEC015.16
3	Explain Gunn effect using the two valley theory.	Understand	CO 4	AEC015.15
4	Derive the criterion for classifying the modes of operation for Gunn effect diodes.	Remember	CO 4	AEC015.15
5	Describe the operation of IMPATT diode.	Understand	CO 4	AEC015.17

S. No	QUESTION	Blooms Taxonomy Level	Course Outcomes	Course learning Outcome
6	Explain the physical structure and construction of IMPATT diodes.	Understand	CO 4	AEC015.17
7	Write short notes on “LSA mode in GUNN diode”.	Remember	CO 4	AEC015.16
8	Derive the criterion for classifying the modes of operation for Gunn effect diodes.	Remember	CO 4	AEC015.16
9	Describe the operation of TRAPATT diode.	Remember	CO 4	AEC015.17
10	Describe the operation of BARITT diode.	Understand	CO 4	AEC015.17
11	Explain the working of any two of the following: (i) IMPATT (ii) Varactor diode. (iii) PIN diode.	Understand	CO 4	AEC015.17
12	What is the relevance of different modes of operation in Gunn diode?	Remember	CO 4	AEC015.16
13	What is varactor diode? Discuss its two applications. How TRAPATT can be designed using IMPATT and how it is important?	Understand	CO 4	AEC015.15
14	How avalanche effect is utilized to generate microwave signals? Explain the operation of TRAPATT.	Understand	CO 4	AEC015.17
15	What is an IMPATT diode? Draw the schematic diagram and equivalent circuit of the IMPATT diode?	Remember	CO 4	AEC015.16
16	Describe the basic operating mechanism of TRAPATT diode using a suitable sketch. Why is drift through this diode much slower than through a comparable IMPATT diode?	Understand	CO 4	AEC015.15
17	What does acronym IMPATT stand for? Why does the device show a differential negative resistance? Give the physical structure, doping profile and electric field distribution of a double drift region IMPATT diode.	Understand	CO 4	AEC015.17
18	How avalanche effect is utilized to generate microwave signals? Explain the operation of IMPATT.	Remember	CO 4	AEC015.16
19	Draw the band diagram of Ga As and explain the Gunn effect, where by negative resistances and therefore oscillations are obtained under certain conditions from bulk gallium arsenide.	Understand	CO 4	AEC015.15
20	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?	Understand	CO 4	AEC015.15
PART-C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	A Gunn device operates in the transit time mode of 20 GHz. If it is fabricated from gallium arsenide, find length of device. Consider that Vs=10cm/s	Remember	CO 4	AEC015.16
2	An IMPATT diode has a drift length of 2μm. Determine the operating frequency of the IMPATT diode, if the drift velocity for Si is 107 cms/sec.	Remember	CO 4	AEC015.17
3	Determine the hull cutoff voltage for a given anode voltage of 26kv. Assume radiiof cathode and anode cylinders as 5cm and10cm respectively.	Understand	CO 4	AEC015.17
4	The drift velocity of electron is 2 107 cm/s, through the active region of length 10 □ 10−4 cm. Calculate the natural frequency of the diode and the critical voltage.	Understand	CO 4	AEC015.17
5	An n-type GaAs Gunn diode has Electron velocity vd = 3 105 m/s Negative electron mobility |μn| = 0.16 m2 /Vs	Remember	CO 4	AEC015.16

S. No	QUESTION	Blooms Taxonomy Level	Course Outcomes	Course learning Outcome
	Relative dielectric constant εr = 12.9 Determine the criterion for classifying the modes of operation.			
6	Determine conductivity of an n-type GaAs Gunn diode if Electron density n = 1016 cm−3 Electron density at lower valley nl = 1010 cm−3 Electron density at upper valley nu = 108 cm−3 Temperature T = 400 K	Understand	CO 4	AEC015.16
7	In Gunn diode's transit domain mode, the domain velocity is equal to the carrier drift velocity and is about 107 cm/sec. Determine the drift length of a diode at a frequency of 8 GHz.	Remember	CO 4	AEC015.16
8	Calculate the dielectric relaxation time of GaAs Gunn diode has the following parameter: Relative dielectric constant εr = 13 Doping concentration n0 = 1015 cm−3 Mobility μn = 8500 cm2 /Vs.	Remember	CO 4	AEC015.16
9	A tunnel diode amplifier has the negative resistance of 26 Ω. Now a load of 24 Ω is to be connected to draw the amplified output. Suggest whether the load is to be connected in series or in parallel to make the gain maximum.	Remember	CO 4	AEC015.16
10	A tunnel diode has the following parameters: Negative resistance = 26 Ω Series resistance = 1 Ω Junction capacitance = 5 pF Series inductance = 1 mH Calculate the resistive and reactive cut-off frequencies.	Remember	CO 4	AEC015.16
UNIT-V				
PART-A(SHORT ANSWER QUESTIONS)				
1	Define the method for measuring VSWR<10?	Understand	CO 5	AEC015.19
2	What is the principle of microwave frequency measurement?	Understand	CO 5	AEC015.19
3	State various methods for measuring attenuation?	Understand	CO 5	AEC015.19
4	Define Voltage standing wave ratio.	Remember	CO 5	AEC015.19
5	Define Reflection coefficient.	Remember	CO 5	AEC015.19
6	List the methods used for measuring the low and high VSWR?	Understand	CO 5	AEC015.19
7	Write a short notes on power ratio method.	Remember	CO 5	AEC015.19
8	Discuss about the RF substitution method.	Understand	CO 5	AEC015.19
9	Write short notes on measurement of phase shift.	Understand	CO 5	AEC015.19
10	List the devices used in microwave bench setup.	Remember	CO 5	AEC015.18
11	Define the method for measuring VSWR<10?	Remember	CO 5	AEC015.19
12	What is the principle of microwave frequency measurement?	Understand	CO 5	AEC015.19
13	Under what conditions double minimum method of VSWR is preferred?	Understand	CO 5	AEC015.19
14	Define Voltage standing wave ratio	Remember	CO 5	AEC015.19
15	Explain in brief about errors in microwave power measurement?	Understand	CO 5	AEC015.19
16	Define Gunn Power Supply ?	Remember	CO 5	AEC015.18
17	What is Gunn Oscillator ?	Understand	CO 5	AEC015.19
18	Define PIN Modulator ?	Understand	CO 5	AEC015.18
19	Define VSWR meter ?	Remember	CO 5	AEC015.19
20	Define reflection coefficient ?	Understand	CO 5	AEC015.18
PART-B (LONG ANSWER QUESTIONS)				
1	Explain the measurement of attenuation using power	Remember	CO 5	AEC015.19

S. No	QUESTION	Blooms Taxonomy Level	Course Outcomes	Course learning Outcome
	ratio method with neat block diagram?			
2	Write about the Slotted line method for impedance measurement.	Remember	CO 5	AEC015.19
3	Draw a neat diagram of microwave test bench and explain about each block along with its features.	Understand	CO 5	AEC015.18
4	Explain the measurement of microwave power using bolometer method.	Apply	CO 5	AEC015.19
5	Discuss the measurement of phase shift using neat block diagram.	Remember	CO 5	AEC015.19
6	Explain the method of measurement of high VSWR.	Understand	CO 5	AEC015.19
7	Explain the RF substitution method of measurement of attenuation.	Understand	CO 5	AEC015.19
8	Write about the measurement of quality factor of a cavity resonator.	Remember	CO 5	AEC015.19
9	Explain the frequency measurement techniques.	Understand	CO 5	AEC015.19
10	Discuss the different techniques employed in measuring impedance?	Remember	CO 5	AEC015.19
11	Explain the operation of isolator, variable attenuator and frequency meter briefly.	Remember	CO 5	AEC015.18
12	Explain the measurement of microwave power using Calorimeter technique.	Understand	CO 5	AEC015.19
13	Discuss the method for measuring low voltage standing wave ratio.	Remember	CO 5	AEC015.18
14	Explain different types of fixed and variable attenuators briefly.	Remember	CO 5	AEC015.18
15	Explain VSWR meter, crystal detector , slotted section and Gunn oscillator.	Remember	CO 5	AEC015.19
16	Discuss the measurement of impedance using reflectometer with block diagram	Understand	CO 5	AEC015.18
17	Discuss the V-I characteristics of Gunn diode using micro wave bench set up.	Remember	CO 5	AEC015.19
18	Discuss the method for measuring high voltage standing wave ratio.	Remember	CO 5	AEC015.18
19	Explain the measurement of impedance using slotted line method.	Understand	CO 5	AEC015.19
20	Explain the construction and operation of slotted line using diagrams.	Remember	CO 5	AEC015.18
PART-C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1.	The reflection coefficient of a given microwave component is 0.5.Find its VSWR.	Remember	CO 5	AEC015.19
2.	Find the Q of a cavity resonator, if its resonating frequency and bandwidth are 9 GHz and 1MHz respectively	Understand	CO 5	AEC015.19
3.	The input power given to an attenuator is 1000 W. The output power produced by the attenuator is 1W. Calculate the value of the attenuator	Understand	CO 5	AEC015.19
4.	Calculate the VSWR of a transmission line operating at 10 GHz. Assume TE10 wave propagating inside of a waveguide of dimensions a = 4 cm, b = 3 cm. The distance between twice minimum power point is 2 mm on a slotted line.	Understand	CO 5	AEC015.19
5.	A slotted line is used to measure VSWR of the load at 8 GHz by double minima method. If the distance between	Understand	CO 5	AEC015.19

S. No	QUESTION	Blooms Taxonomy Level	Course Outcomes	Course learning Outcome
	the positions of twice minimum power is 0.5 cm. Find the value of VSWR on the line and magnitude of the voltage reflection coefficient.			
6.	A slotted line is used to determine the VSWR value of a waveguide. Adjacent null positions are located at 13.31 cm and 15.45 cm on slotted line scale. If the twice minimum power point is 2 mm. What is the value of VSWR?	Understand	CO 5	AEC015.19
7.	Two identical 30 dB directional coupler are used to sample the reflected power in waveguide. If VSWR is 3 and the output of the coupler sampling the incident power is 5.2 mW. What will be the reflected power?	Understand	CO 5	AEC015.19
8.	By using reflectometer measurement set-up, Determine the reflection coefficient and VSWR.	Understand	CO 5	AEC015.19
9.	Two identical 20 dB directional couplers are used in a waveguide to sample the incident and reflected powers. The output of the forward and reverse directional coupler are 3.5 mW and 0.25 mW respectively. Find the VSWR in the waveguide.	Understand	CO 5	AEC015.19
10.	Find the Q of a cavity resonator, if its resonating frequency and bandwidth are 9 MHz and 1MHz respectively	Remember	CO 5	AEC015.19

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