INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	MICROWAVE ENGINEERING
Course Code	:	A70442 – JNTUH - R15
Class	:	IV B. Tech I Semester
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OBJECTIVES

The subject microwave engineering may be also referred to as applied electromagnetic. The importance of microwaves started way back in World War II period and later expanded its ways out to domestic (microwave oven), military, commercial, satellite and etc. This subject starts with the definition of microwave frequency range, its applications and its importance in modern era. The microwave transmission lines like waveguides (rectangular, circular), micro-strips etc. and the various microwave components like T-junctions, circulator, isolator etc. are discussed in detail to enable the student to design microwave systems and sub- systems.

UNIT-I
MICROWAVE TRANSMISSION LINES-I

PART-A (SHORT ANSWER QUESTIONS)

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	List the typical applications of microwaves.	Remember	1
2.	Define the dominant mode of a waveguide?	Understand	1
3.	What are microwaves? Why they are so called?	Understand	1
4.	Define waveguide? Mention some of its features?	Remember	1
5.	What is TE, TM & TEM modes?	Understand	1
6.	Define dominant mode and degenerate mode?	Remember	1
7.	Define cutoff frequency of a waveguide.	Understand	1
8.	What is dominant mode of a rectangular waveguide for TE and TM modes and why?	Remember	1
9.	Find the cut–off frequency of the dominant mode for an air filled rectangular waveguide when a = 6cm and b = 2 cm for TE wave?	Understand	1
10.	Name the microwave frequency bands and spectrums.	Understand	1
11.	Define phase velocity.	Understand	1
12.	What is meant by group velocity?	Understand	1

13.	What is the relation between phase and group velocities in terms of light velocity?	Understand	1
14.	Define guide wavelength.	Understand	1
15.	Summarize the advantages of microwaves.	Understand	1
16.	What are the advantages of dominant mode propagation?	Understand	1
17.	What are the advantages and disadvantages of micro strip lines?	Understand	1
18.	Explain briefly about impossibility of TEM Modes.	Understand	1

PART-B (LONG ANSWER QUESTIONS)

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	Derive the TMmn mode field equation in rectangular waveguide.	Remember	1
2.	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.	Remember	1
3.	A rectangular waveguide has dimensions 2.5 X 5 cms. Determine the guide wavelength, phase constant and phase velocity at a wavelength of 4.5 cms for dominant mode.	Understand	1
4.	What is a Microwave spectrum bands? Explain briefly the applications of microwaves at various frequency bands.	Remember	1
5.	Explain the TE and TM modes of propagation in waveguides. Why TEM wave does not exist in a rectangular wave guide.	Understand	1
6.	Explain the wave impedance of a rectangular waveguide and derive the expression for the wave impedance of TE and TM modes.	Understand	1
7.	A rectangular wave guide with dimension of 3 x 2 cm operates in the TM11 mode at 10 GHz. Determine the characteristic wave impedance.	Understand	1
8.	A Rectangular wave guide is filled by dielectric material of $\varepsilon r = 9$ and has dimensions of 7 × 3.5 cm. It operates in the dominant TE mode. i. Determine the cut off frequency. ii. Find the phase velocity in the guide at a frequency of 2 GHz. iii. Find the guided wave length at 2GHz.	Understand	1
9.	Derive the expression for cutoff frequency of TEmn mode in rectangular wave guide.	Remember	1
10.	Obtain an expression for microwave impedance for TE waves in rectangular wave guide.	Understand	1
11.	Derive an expression for microwave impedance for TM waves in rectangular wave guide.	Understand	1
12.	Obtain the expression for power transmission in waveguide	Remember	1

PART-C (ANALYTICAL QUESTIONS)

1.	Can a waveguide have more than one cut-off frequency? On what factors does the cut-off frequency of a wave guide depend?	Understand	1
2.	When the dominant mode is propagated through a waveguide at a frequency of 9GHz, the guide wavelength is found to be 4cms. Find the breadth of the waveguide.	Remember	1

UNIT-II
CAVITY RESONATORS &WAVEGUIDE COMPONENTS AND APPLICATIONS

PART-A (SHORT ANSWER QUESTIONS)

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	Define the attenuation constant.	Remember	2

2.	What is meant by cavity resonator?	Understand	2
3.	Define resonant frequency and give its expression.	Understand	2
4.	Derive the resonant frequency for TE101 mode.	Understand	2
5.	What are the applications of cavity resonator?	Understand	2
6.	Define quality factor of a cavity resonator	Understand	2
7.	Explain the waveguide discontinuities?	Remember	2
8.	Describe the characteristic features of resonant windows?	Understand	2
9.	Mention the applications of Hybrid Tee junction?	Remember	2
10.	Mention the applications of resonant Iris?	Understand	2
11.	Mention the applications of capacitive and Inductive Iris?	Understand	2
12.	What is directional coupler?	Understand	2
13.	Describe the principle of working of a wave guide attenuator, with neat schematics?	Understand	2
14.	List out the different types of waveguide Irises?	Understand	2
15.	Give the properties of S-matrix.	Understand	2
16.	What is Isolator?	Understand	2
17.	What is Gyrator?	Understand	2
PART-B(LONG ANSWER QUESTIONS)			
1.	Derive the cut-off frequency expression for Rectangular cavity resonator.	Understand	2
2.	Prove that a cavity resonator is nothing but an LC circuit.	Understand	2
3.	Discuss about E-H plane Tee junction. Why a hybrid E-H plane Tee referred to as Magic Tee. Derive the scattering matrix for E-H plane Tee junction.	Understand	2
4.	Explain the applications of Directional Couplers and obtain scattering matrix.	Understand	2
5.	What is the application of Circulator? Derive the S matrix for Circulator with neat diagram?	Remember	2
6.	Write about quality factor of a cavity resonator.	Understand	2
7.	Discuss the principle of working an H-plane Tee junction with neat schematics.	Understand	2
8.	Discuss in detail about the principle of working an E-plane Tee junction with neat schematics?	Understand	2
9.	Explain the principle of working a Magic Tee junction with neat schematics?	Understand	2
10.	Discuss in detail about the principle of working of two-hole Directional coupler with neat schematics?	Understand	2
11.	Explain the two-hole Directional coupler and write applications of directional couplers?	Understand	2
12.	Discuss the following characteristics related to Directional coupler i)Coupling factor ii)Directivity iii) Isolation	Remember	2
PART-C (ANALYTICAL QUESTIONS)			
1.	Prove that it is impossible to construct a perfectly matched, loss less, reciprocal three port junction.	Remember	2
2.	A wave length termination having VSWR of 1.1 is used to dissipate 100 W of power. Find received power	Remember	2
3.	An attenuator of 20dB is fed with 100w input. Find the output power of the attenuator.	Understand	2

UNIT-III MICROWAVE TUBES			
PART-A (SHORT ANSWER QUESTIONS)			
S.No	**Question**	**Blooms Taxonomy Level**	**Course Outcome**
1.	State the limitations of conventional tubes at microwave frequencies.	Remember	3
2.	What is the principle of two cavity Klystron amplifier?	Remember	3
3.	What are the applications of reflex klystron?	Understand	3
4.	State the characteristics of the two-cavity klystron amplifier.	Remember	3
5.	Compare TWT& Klystron amplifier.	Understand	3
6.	Draw the schematic diagram of helix travelling wave tube?	Understand	3
7.	What is meant by reflex klystron?	Remember	3
8.	What are the performance characteristics of klystron amplifier?	Remember	3
9.	Differentiate between klystrons and TWT.	Understand	3
10.	State the applications of the two-cavity klystron amplifier.	Remember	3
11.	Why multi-cavity klystrons are preferred?	Remember	3
12.	How are oscillations avoided in travelling wave tube?	Remember	3
13.	Discuss in detail about lead inductance and inter electrode capacitance effects of conventional tubes at microwave frequencies.	Understand	3
14.	Differentiate between O – type tubes and M – type tubes.	Understand	3
15.	What is the condition for obtaining the power output in reflex klystron?	Understand	3
16.	What is transit time?	Understand	3
17.	What is the operating principle of reflex klystron?	Remember	3
18.	What is velocity and current modulation in a reflex klystron?	Remember	3
19.	How does bunching occur in a reflex klystron?	Remember	3
20.	Explain clearly the classification of microwave sources.	Understand	3
21.	What is the operating frequency, power output and efficiency of a reflex klystron?	Remember	3
22.	What are the devices used as a microwave signal sources?	Remember	3
23.	Write the classification of microwave tubes.	Understand	3
24.	What is TWTA?	Remember	3
MID-II			
25.	What is the need of slow – wave structures?	Remember	3
26.	What are the assumptions for calculation of RF Power in Reflex Klystron?	Remember	3
27.	What is the effect of transit time?	Remember	3
28.	List the applications of TWT.	Remember	3
29.	What do you mean by O-type tubes? Name some O-type tubes.	Understand	3
30.	List the parameters on which bunching depend on?	Remember	3
31.	Compare between two cavity klystron and reflex klystron?	Understand	3
32.	State the advantages of TWT.	Remember	3
33.	State the effects of frequency rise in conventional tubes.	Remember	3
34.	Explain briefly about linear beam tubes and crossed field tubes	Understand	3
35.	Sketch the functional diagram of two-cavity amplifier.	Understand	3
36.	Compare “Drift space bunching” and “Reflector bunching”.	Understand	3
37.	Compare magnetron and reflex klystron.	Understand	3
38.	List the drawbacks of klystron amplifiers.	Remember	3
39.	What is the condition for oscillation in Reflex klystron?	Understand	3

40.	List out different types of magnetrons?	Remember	3
41.	What are the performance characteristics of TWT?	Understand	3
42.	What are the desirable properties of slow wave structures to be used in TWT amplifiers?	Understand	3
43.	What do you mean by M-type tubes? Name some M-type tubes.	Understand	3
44.	Draw the schematic diagram of two cavity klystron amplifier?	Understand	3
45.	What is the need of slow wave structures in TWT?	Understand	3
46.	Write the basic modes of operation in magnetron?	Understand	3
47.	What is klystron tube?	Remember	3
48.	What is reflex klystron oscillator?	Remember	3
PART-B (LONG ANSWER QUESTIONS)			
1.	What is Gunn effect? Explain the operation of Gunn diode.	Remember	3
2.	Explain is the principle of working for Two – Cavity Klystron with velocity diagram.	Understand	3
3.	Derive the expression for output power & Efficiency of a 2 cavity klystron.	Understand	3
4.	Explain in detail bunching process & obtain expression for bunching parameter in a two cavity klystron amplifier.	Understand	3
5.	What are the limitations of conventional tubes at microwave frequencies? Explain how these limitations can be overcome.	Understand	3
6.	A reflex klystron having an accelerated field of 300v oscillates at a frequency of 10GHZ with a retarding field of 500v. If its cavity is returned to 9GHZ. What must be the new value of retarding field fro oscillations in the same mode to take place?	Understand	3
7.	Name different methods of generating microwave power. Describe the necessary theory & Working of reflex klystron.	Understand	3
8.	Explain in detail bunching process & obtain expression for bunching parameter in a two cavity klystron amplifier.	Understand	3
9.	Explain the principle of operation of a reflex Klystron oscillator and derive an expression for the bunching parameter.	Understand	3
10.	Explain the construction & working of two cavity klystron amplifier.	Remember	3
PART-C (ANALYTICAL QUESTIONS)			
1.	Formulate the expression for optimum drift space distance L optimum in a Two Cavity Klystron Amplifier.	Understand	3
2.	A reflex klystron operates at 8 GHz with dc beam voltage 300 V, repeller space=1mm for 1 mode. Calculate PRFmax	Remember	3
3.	Determine the gain parameter C for a TWTA with Beam current 30mA, characteristic impedance 10Ω, and Beam voltage 3KV.	Understand	3

UNIT-IV
M-TYPE TUBES & MICROWAVE SOLID STATE DEVICES

PART-A (SHORT ANSWER QUESTIONS)

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	What is transferred electron effect?	Remember	4
2.	What is negative resistance in Gunn diode?	Remember	4
3.	What are the applications of Microwave Solid-State Devices?	Understand	4
4.	What are the elements that exhibit Gunn Effect?	Remember	4
5.	Mention the applications of Gunn diode amplifier.	Remember	4

6.	Why magnetron is called as cross field devices?	Understand	4
7.	What are the types of magnetrons?	Remember	4
8.	Write short notes on negative resistance magnetron.	Understand	4
9.	State the power output and efficiency of magnetron.	Understand	4
10.	Write the applications of magnetron.	Understand	4
11.	What is GUNN effect?	Understand	4
12.	Explain transferred electron effect.	Understand	4
13.	What is the principle of TRAPATT diode?	Remember	4
14.	What is the principle of IMPATT diode?	Remember	4
15.	What is the principle of BARITT diode?	Remember	4
PART-B (LONG ANSWER QUESTIONS)			
1.	Explain the working Magnetron with π mode oscillation.	Understand	4
2.	What is meant by Avalanche Transit Time Devices? Explain the operation, construction and applications of IMPATT.	Remember	4
3.	Explain avalanche transit time devices.	Understand	4
4.	Write short notes on "8 cavity magnetron".	Understand	4
5.	Explain Gunn effect using the two valley theory.	Understand	4
6.	Derive the criterion for classifying the modes of operation for Gunn effect diodes.	Understand	4
7.	Describe the operation of IMPATT diode.	Remember	4
8.	Explain the physical structure and construction of IMPATT diodes.	Remember	4
9.	Write short notes on "LSA mode in GUNN diode".	Understand	4
10.	Derive the criterion for classifying the modes of operation for Gunn effect diodes.	Understand	4
11.	Describe the operation of TRAPATT diode.	Remember	4
12.	Describe the operation of BARITT diode.	Remember	4
PART-C (ANALYTICAL 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	Understand	4
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.	Understand	4
3.	Determine the hull cutoff voltage for a given anode voltage of 26kv. Assume radii of cathode and anode cylinders as 5cm and 10cm respectively.	Understand	4

UNIT-V
MICROWAVE MEASUREMENTS

PART-A (SHORT ANSWER QUESTIONS)

S.No	Question	Blooms Taxonomy Level	Course Outcome
1.	Define the method for measuring VSWR<10?	Remember	5
2.	What is the principle of microwave frequency measurement?	Remember	5
3.	State various methods for measuring attenuation?	Understand	5
4.	Write the S-matrix for Isolator and Gyrator?	Understand	5

5.	Discuss the S-matrix for E-Plane and H-Plane tee.	Understand	5
6.	Write the s-matrix for directional coupler.	Understand	5
7.	Define i) Voltage standing wave ratio. ii) Reflection coefficient.	Remember	5
8.	List the methods used for measuring the low and high VSWR?	Remember	
9.	Write a short notes on power ratio method.	Understand	5
10.	Discuss about the RF substitution method.	Understand	5
11.	Write short notes on measurement of phase shift.	Understand	
12.	List the devices used in microwave bench setup.	Remember	5
PART-B (LONG ANSWER QUESTIONS)			
1.	Explain the measurement of attenuation using power ratio method with neat block diagram?	Understand	5
2.	Write about the Slotted line method for impedance measurement.	Understand	5
3.	Draw a neat diagram of microwave test bench and explain about each block along with its features.	Understand	5
4.	Explain the measurement of microwave power using bolometer method.	Remember	5
5.	Discuss the measurement of phase shift.	Remember	5
6.	Explain the method of measurement of high VSWR.	Understand	5
7.	Explain the RF substitution method of measurement of attenuation.	Understand	5
8.	Write about the measurement of Q of a cavity resonator.	Understand	5
9.	Explain the frequency measurement techniques.	Understand	5
10.	What are the different techniques employed in measuring impedance? Explain any one method.	Remember	5
11.	Discuss the measurement of frequency using wave meter method.	Understand	5
12.	Explain the high power measurements using calorimetric method.	Understand	5
PART-C (ANALYTICAL QUESTIONS)			
1.	In a microwave measurement it is observed that $\lambda 0=3$ cm and $\lambda c=4$cm. Find λG.	Remember	5
2.	The peak power is 1KW. The duty cycle is 10-3. Find the average power.	Remember	5
3.	Convert -30 dBm and 0 dBW into absolute power.	Understand	5
4.	The reflection coefficient of a given microwave component is 0.5. Find its VSWR.	Remember	5
5.	Find the Q of a cavity resonator, if its resonating frequency and bandwidth are 9 GHz and 1MHz respectively	Understand	5
6.	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.	Remember	5

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