

Code No: RT32044

R13

SET - 1

III B. Tech II Semester Regular/Supplementary Examinations, April - 2017

MICROWAVE ENGINEERING

(Electronics and Communication Engineering)

Time: 3 hours

Max. Marks: 70

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

PART -A

- 1 a) Derive the expression for cutoff frequency in a rectangular waveguide. [3M]
b) Explain about dominant and degenerate modes in circular waveguide. [4M]
c) Explain about the significance and properties of scattering matrix. [4M]
d) Derive expression for output power in a Two-cavity klystron? [4M]
e) Explain the types of slow wave structures in TWT. [4M]
f) List out the different components used in a microwave bench. [3M]

PART -B

- 2 a) Derive the field expression for TE & TM modes in rectangular waveguide? [12M]
b) Briefly explain the applications of microwave signal. [4M]
- 3 a) Explain about the effective dielectric constants, losses & Q-factor of microstrip lines? [8M]
b) Explain in detail about rectangular and circular cavity resonator? [8M]
- 4 a) Explain the operation of magic tee with neat diagram and derive it's S- matrix? [6M]
b) Explain in detail about waveguide irises, tuning screws and posts, waveguide attenuators with neat diagram? [10M]
- 5 a) Derive the expression for bunching process, output power and efficiency of reflex klystron? [8M]
b) Explain the limitations and losses of conventional tubes at microwave frequencies? [8M]
- 6 a) Explain how oscillations are suppressed in TWT? [5M]
b) Explain the nature of four propagation constants? [5M]
c) Explain the operation of 8-cavity cylindrical travelling wave magnetron and derive it's hull cutoff voltage? [6M]
- 7 a) Explain RWH- theory in GUNN diode? [5M]
b) Explain various modes of operation in GUNN diode? [5M]
c) Explain different methods of measuring VSWR and explain any one method with neat diagrams. [6M]

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2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

PART -A

- 1 a) Derive the expressions for phase and group velocities in a rectangular waveguide? [4M]
- b) Explain about effective dielectric constants in micro strip line. [3M]
- c) Derive S-matrix of an E-plane Tee? [4M]
- d) Explain in detail about electronic and mechanical tuning? [4M]
- e) Explain about a characteristics of slow wave structure? [4M]
- f) Explain about the classifications and applications of microwave solid state devices? [3M]

PART -B

- 2 a) Explain about the Power transmission and power losses in rectangular waveguide? [5M]
- b) Explain why the propagation of TEM mode is impossible in wave guides? [5M]
- c) Derive the expression for various fields in rectangular guides? [6M]
- 3 a) Explain about the dominant modes and derive expressions for resonant frequency in a cylindrical cavity resonator? [8M]
- b) Explain the different excitations techniques used in rectangular and circular wave guides. [8M]
- 4 a) Explain different types of directional couplers with neat sketches and derive the S- matrix for directional coupler? [8M]
- b) Explain the operation of Four-port circulator with suitable diagrams? [8M]
- 5 a) Derive the expression for bunching process, output power and efficiency of Two- cavity klystron? [8M]
- b) Explain the bunching process in reflex klystron oscillator round trip. [8M]
- 6 a) Explain about modes of operation and PI-mode in magnetrons? [6M]
- b) Explain about different types of magnetrons. [4M]
- c) Explain the operation of TWT with neat sketches. [6M]
- 7 a) Explain the operation, basic modes of operation and oscillating modes in a GUNN diode? [8M]
- b) Explain different methods of measurement of impedance using microwave bench? [8M]

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PART -A

- 1 a) Explain the applications of microwaves in detail? [3M]
 b) Derive the expression for cutoff frequency in a circular waveguides. [4M]
 c) Explain about the waveguide phase shifters? [3M]
 d) Differentiate between 2-cavity klystron and reflex klystron? [4M]
 e) What are the advantages of magnetrons over TWT? [4M]
 f) Explain the operation of TRAPATT diode with suitable diagram? [4M]

PART -B

- 2 a) Analyze, derive and draw the fields for TE and TM modes in a rectangular waveguide. [10M]
 b) A rectangular waveguide with dimensions $a=4\text{cm}$ and $b=1\text{cm}$ operates in TE_{10} mode at 10GHz. The waveguide is perfectly matched and maximum E field existing everywhere in the guide is 10^3 V/m. Determine the wave impedance and maximum average power that can be carried by the guide? [6M]
- 3 a) Explain about dominant and degenerate modes in circular waveguide and derive the expressions for TE wave. [8M]
 b) A TE_{11} mode is propagating through a circular waveguide, the diameter of the guide is 10cm and the guide is air-filled, relative di-electric constant is $\epsilon_n = 4$. [8M]
 Find :
 a) cut-off frequency b) wavelength in the guide for a frequency of 3 GHz
 c) wave impedance of the guide d) mode diameter for a di-electric filled guide
- 4 a) Derive the expressions for Directivity, Coupling factor and S-matrix for a directional coupler. [8M]
 b) Derive the S-parameters for 10dB directional coupler, Directivity $D=30\text{dB}$. Assume that it is lossless and VSWR at each port is 1.0 under matched conditions. Designate the ports in main guide as 1 and 2, in the auxiliary guide as 3 and 4. [8M]
- 5 a) Explain the operation of Reflex klystron with neat sketches and derive it's output power and efficiency? [8M]
 b) A reflex klystron operates under the following conditions [8M]
 $V_0=500\text{V}$, $R_{sh}=30\text{K}\Omega$, $f_r=8\text{GHz}$, $L=1\text{mm}$ is the spacing between repeller and cavity. The tube is oscillating at f_r at peak $n=2$ mode. Transit time across the gap and beam loading is neglected. Find a) the repeller voltage V_R b) find the d.c necessary to give the microwave gap of voltage 200V c) Efficiency?

- 6 a) Explain the operation of 8-cavity magnetron? [5M]
b) Explain modes of resonance and pi-mode in magnetron? [5M]
c) A normal cylindrical magnetron has inner radius $R_i=0.15\text{m}$, outer radius $R_o=0.45\text{m}$. magnetic flux density $\beta_0 = 1.2\text{m Wb/m}^2$ [6M]
Determine a) Hull Cut-off voltage, b) cyclotron frequency in GHz?
- 7 a) Explain the principle of operation and characteristics of IMPATT diode. [8M]
b) Explain the process of Frequency measurement using microwave bench? [8M]

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Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)

2. Answering the question in **Part-A** is compulsory

3. Answer any **THREE** Questions from **Part-B**

PART -A

- 1 a) Explain about the filter characteristics in a rectangular waveguides. [4M]
- b) Explain the construction of micro strip line and working. [4M]
- c) Explain about the Hybrid rings in detail. [3M]
- d) What are the special characteristics of reflex klystron compared to 2-cavity klystron? [3M]
- e) Derive the expression for Hull cut-off voltage in magnetrons. [4M]
- f) Explain the importance of negative resistance region in Gunn diode with neat waveforms. [4M]

PART -B

- 2 a) Explain and derive the expressions for dominant and degenerate modes in a rectangular waveguides. [10M]
- b) A rectangular waveguide is designed to propagate the dominant mode TE_{10} at a frequency of 5 GHz. Cut-off frequency is 0.8 of the signal frequency. The ratio of guide height to width is 2. The time-average power flowing through the guide is 1KW. Determine the magnitudes of Electric and Magnetic intensities in the guide and indicate where these will occur in the guide? [6M]
- 3 a) Explain and derive the expressions for Z_0 relations in a circular waveguides. [8M]
- b) Derive the expressions for Q- factor and coupling co-efficients in cylindrical cavity resonators? [8M]
- 4 a) What is the significance of S-matrix? Derive S-matrix for H-plane Tee? [8M]
- b) Explain the operation of Gyrator and isolator. [8M]
- 5 a) Explain about the structure, re-entrant cavities and velocity modulation process in a 2-cavity klystron? [8M]
- b) A 2-cavity klystron is operated at 10GHz with $V_0=1200V, I_0=30mA, d=1mm, L=4cm, R_{sh}=40K\Omega$, neglecting the beam loading. Calculate a) input RF voltage V_0 for maximum output voltage, b) voltage gain, c) Efficiency. [8M]
- 6 a) Explain about the modes of resonance, pi-mode operation and separation of pi-mode in magnetrons. [8M]
- b) An X-band pulsed cylindrical magnetron has $V_0=30KV, I_0=80A, B_0=0.01Wb/Sq.m, a=4cm, b=8cm$. Calculate a) cyclotron angular frequency b) Cut-off voltage c) Cut-off magnetic flux density? [8M]
- 7 a) What are Avalanche transit time devices? Explain the principle of operation and characteristics of IMPATT diode with neat sketches? [6M]
- b) Explain Bolometer method for power measurement using microwave bench. [4M]
- c) Explain the procedure for measurement of cavity Q. [6M]

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III B. Tech II Semester Supplementary Examinations, November/December - 2016

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. Answering the question in **Part-A** is compulsory

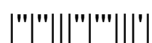
3. Answer any **THREE** Questions from **Part-B**

PART -A

- 1 a) Derive the expression for cut-off frequency of a rectangular wave guide. [4M]
- b) What are the design considerations for a micro strip line? [3M]
- c) Explain scattering parameters in microwave components. [4M]
- d) Explain the bunching process in reflex klystron. [4M]
- e) Explain any two applications of magnetron. [3M]
- f) Explain RWH theory. [4M]

PART -B

- 2 a) Derive the wave equation for a TE wave and obtain all the field components in a rectangular waveguides. [8M]
- b) A hollow rectangular waveguide has dimensions $a=1.5$ cm, calculate the amount of attenuation if the frequency of the signal is 6GHz. [8M]
- 3 a) A rectangular-cavity resonator has dimensions of $a=5$ cm, $b=2$ cm and $d=15$ cm, compute. i)the resonant frequency of the dominant mode for an air-filled cavity. [10M]
ii)the resonant frequency of the dominant mode for a dielectric-filled cavity of $\epsilon_r=2.56$
- b) Define a reentrant cavity and give at least two examples. Where are these used? [6M]
- 4 a) Explain briefly about circulators and isolators. [8M]
- b) Find the Hybrid ring S-parameters and explain with neat sketch. [8M]
- 5 a) A two-cavity amplifier klystron has the following parameters beam voltage $V_0=900$ V, beam current $I_0=30$ mA, frequency $f=8$ GHz, gap spacing in either cavity $d=1$ mm, spacing between centers of cavities $L=4$ cm, effective shunt impedance $R_{sh}=40$ K Ω , determine [10M]
i)The electron velocity ii)The dc electron transit time iii)The input voltage for maximum output voltage iv)The voltage gain in decibels.
- b) Derive the output power of Two-cavity klystron amplifier. [6M]
- 6 a) Explain the modes of resonance and PI mode operation. [8M]
- b) Explain 8-cavity cylindrical travelling wave. [8M]
- 7 a) Draw and explain in detail about IMPATT diode. [8M]
- b) Draw a neat diagram of a microwave bench setup and explain in detail about all the components. [8M]



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 3. Answer any **THREE** Questions from **Part-B**

PART -A

- 1 a) What are the various applications of Microwaves? [4M]
- b) How to find Q of resonant rectangular cavity? [4M]
- c) How to use matched load in microwaves? [3M]
- d) What are the limitations of conventional tubes? [4M]
- e) How separate the π mode in Magnetron? [4M]
- f) Why isolator is used in microwave bench set up? [3M]

PART -B

- 2 a) Derive the field equations of rectangular waveguide in TM mode, starting from Maxwell's equations. [10M]
- b) Calculate the guide wavelength (in cm) at 7 and 12GHz for an air filled waveguide with $a=2.54$ cm , $b=1.5$ cm . [6M]
- 3 a) Explain how TEM propagate in circular waveguides. [8M]
- b) A cubic shaped cavity is required to resonate at 7500MHz in the TE_{101} mode. Calculate its dimensions and unloaded Q if the cavity is air filled. [4M]
- c) Determine the strip width of a Teflon filled balanced strip line for $Z_0 = 50\Omega$ if the ground plane spacing is 0.25 inch and the strip thickness is 4 mils. [4M]
- 4 a) What are the different types of attenuators? Explain them with neat diagrams [8M]
- b) Derive S-matrix of Magic Tree and also draw its structure. [8M]
- 5 a) Explain the bunching process of two cavity klystron and how to convert velocity modulation into current modulation and also derive the equation for efficiency? [12M]
- b) How to change the frequency of oscillations in reflex klystron? [4M]
- 6 a) What are the different propagation constants TWT? How to calculate them? [8M]
- b) What is Hartree condition in Magnetron? Derive the equation for Hartree voltage of it. [8M]
- 7 a) Draw the characteristics of Gunndiode and explain how negative region is obtained in it? [8M]
- b) What is bolometer? How it is used for microwave measurements? [8M]

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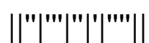
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 3. Answer any **THREE** Questions from **Part-B**

PART -A

- 1 a) What are the advantages waveguides have compared to coaxial transmission lines? [3M]
- b) What are the applications of Microstrip line? [4M]
- c) How to use tuning screws and posts in microwaves? [4M]
- d) How to tune the reflex klystron oscillator? [3M]
- e) What the effects are of cross field in Magnetron? [4M]
- f) What is mean by transferred electron devices? Give some examples [4M]

PART -B

- 2 a) Derive the field equations of rectangular waveguide in TE mode, starting from Maxwell's equations. [10M]
- b) Prove that the cutoff frequency is same for both TE and TM modes. [6M]
- 3 a) Calculate the cutoff frequency of the dominant mode in a 1 inch diameter, Teflon filled circular waveguide. What is its maximum operating frequency if the possibility of higher mode propagation is to be avoided? Include a 5 percent safety factor, what would be the value of f_{max} if the possibility of TM_{01} propagation was excluded? [10M]
- b) Compare rectangular and circular waveguides [6M]
- 4 a) Explain the working of Rotary Vane type phase shifter with neat diagram. [8M]
- b) What are the properties of S-matrix? Derive the S-matrix of Circulator. [8M]
- 5 a) Derive the equation of optimum output power of two cavity Klystron amplifier. [8M]
- b) Draw and explain the mode characteristics of Reflex Klystron. [8M]
- 6 a) Draw the structure of TWT and explain its amplification process. [8M]
- b) What is Hull cut off condition? Derive the equation for Hull cut off voltage. [8M]
- 7 a) Explain how Gunn diode is used as an oscillator? Explain with the help of circuit diagram. [8M]
- b) Explain the method of measurement of low and high VSWR with neat diagrams. [8M]



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PART -A

- 1 a) Draw the field patterns of rectangular waveguide in TE_{10} and TM_{11} modes. [4M]
- b) Define effective dielectric constant of micro strip line and derive its equation. [4M]
- c) What is waveguide Iris? Where it is used? [4M]
- d) What are reentrant cavities? How these are used? [3M]
- e) Draw the different types of slow wave structures. [4M]
- f) Explain the function of slotted section in microwave measurements? [3M]

PART -B

- 2 a) Why the TEM wave is not possible in rectangular waveguide? [6M]
- b) A rectangular waveguide has the following characteristics: [10M]
 $b=1.5\text{cm}$, $a=3.0\text{cm}$, $\mu_g = 1$, and $\epsilon_g=2.25$
 Calculate cutoff wavelength, frequency, λ_g , Z_0 and attenuation constant at 3.0 GHz.
- 3 a) What is meant by degenerative modes? [4M]
- b) Derive the field equation for rectangular cavity resonator in TM_{mnp} mode, starting from wave equation. [12M]
- 4 a) What are the different types of Directional couplers? Explain the working of two hole directional coupler. [8M]
- b) Derive the S-matrix of E plane Tee and also write its characteristics. [8M]
- 5 a) Explain the bunching process of reflex klystron and also derive the equation for efficiency? [10M]
- b) Why multi cavities are used in Klystron amplifiers? [6M]
- 6 a) Derive the equation for gain of TWT amplifier. [8M]
- b) Draw the structure of 8 cavity magnetron and explain its bunching process [8M]
- 7 a) Explain the principle of working of IMPATT diode with suitable structure and characteristics. [8M]
- b) What are the different precautions have to be made while measuring parameters at Microwave range? [8M]

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PART -A

- 1 a) Define and derive the equation for guide wave length of rectangular waveguide. [4M]
- b) How to find the Z_0 of Micro strip line? [4M]
- c) Compare coupling mechanisms using loop and probe in all aspects. [4M]
- d) Classify the microwave tubes. [3M]
- e) Why slow wave structures are used in TWT? [3M]
- f) What are different methods of measurement of microwave frequency? [4M]

PART -B

- 2 a) Calculate the cutoff frequencies of air-filled wave guide with $a=3.24\text{cm}$ and $b=2.2\text{cm}$, for the TE_{10} , TE_{20} , TE_{01} , and TM_{11} modes. [8M]
- b) Determine the power loss in rectangular waveguide. [8M]
- 3 a) Derive the characteristic equation of circular waveguide. [6M]
- b) Derive the field equation for rectangular cavity resonator in TE_{mnp} mode, starting from wave equation. [10M]
- 4 a) What is the principle of Faraday's rotation? How this is used in isolator? [8M]
- b) Derive the s-matrix of Hybrid ring. [8M]
- 5 a) Explain the bunching process in two cavity klystron amplifier with Apple gate diagram. [6M]
- b) Explain how oscillations are generated in reflex klystron? How to calculate its electronic admittance? [10M]
- 6 a) Explain how gain of TWT amplifier is more compared to Klystron amplifiers? [8M]
- b) Explain how cross field is used to generate oscillations in Magnetron? [8M]
- 7 a) Explain the principle of working of TRAPATT diode with suitable characteristics. [8M]
- b) Explain the method of measurement of impedance at microwave frequencies with suitable block diagram. [8M]
