

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

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**

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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

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|---|--|-------|
| 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 its 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 its 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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SET - 3

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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) 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 $\epsilon_r = 4$. [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 its 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?

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- 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 $R_a=0.15\text{m}$, 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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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]

