Code No: R1632042 **R16** SET - 1

**III B. Tech II Semester Regular Examinations, April/May- 2019**

# 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. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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## PART –A

| | | | |
|---|---|---|---|
| 1. | a) | An air filled waveguide with cross section 2 cm x 1 cm transports $TE_{10}$ mode. Find $\lambda_c$? | [2M] |
| | b) | The wave is travelled in circular wave guide of $V_p$= $5x10^8$ m/sec, find Group velocity? | [2M] |
| | c) | Calculate the velocity of an electron beam if $V_{dc}$=9 V. | [2M] |
| | d) | Define π-mode condition in Magnetron? | [3M] |
| | e) | Find the reflection coefficient if VSWR=3. | [3M] |
| | f) | Draw the graphs of drift velocity versus E-field and J versus E-field. | [2M] |

## PART -B

| | | | |
|---|---|---|---|
| 2. | a) | When the dominant mode is propagated in an air-filled standard rectangular waveguide, the guide wave length at a frequency of 9 GHz is 4 cm. Calculate width of the guide. | [7M] |
| | b) | Derive TE Wave field equations. | [7M] |
| 3. | a) | Give the physical structure and field distribution of microstrip line. Why Can a pure TEM mode not be propagated in a microstrip line? | [7M] |
| | b) | An air-filled circular waveguide of 2 cm inside radius is operated in the $TE_{01}$ mode.<br>i) Compute the cut-off frequency.<br>ii) If the guide is to be filled with a dielectric material of $\varepsilon_r$= 2.25, to what value must its radius be changed in order to maintain the cut-off frequency at its original value? | [7M] |
| 4. | a) | Explain principle of operation, performance characteristics and applications of Two Cavity Klystron. | [7M] |
| | b) | A Reflex Klystron is operated at 9 GHz with DC beam voltage of 600 V and $1\frac{3}{4}$ mode, repeller space length 1 mm. DC beam current 10 mA. The beam coupling coefficient is assumed to be 1. Calculate the repeller voltage, electronic efficiency and output power. | [7M] |
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5. a) Why Magnetron is also called "Extended Interaction tube"? Derive the expression for Hull cut-off magnetic flux density in cylindrical Magnetron. [7M]

   b) A Travelling Wave Tube has the following parameters: [7M]
   Beam current, $I_o$=50 mA; Beam voltage, $V_o$=2.5 kV;
   Characteristic impedance of helix, $Z_o$=6.75Ω; Circuit length N=45;
   Frequency f= 8 GHz. Determine
   i) Gain parameter C
   ii) Output power gain in db
   iii) All four propagation constants
   iv) The wave equations for all four modes in exponential form.

6. a) What is Magic Tee? Why it is called so? Explain the characteristics of the tee considering various input/output conditions? [7M]

   b) What is a precision rotary attenuator? Explain its operation. [7M]

7. a) How is slotted line used for measurement of impedance of an unknown load? Explain. [7M]

   b) Draw the band diagram of GaAs and explain the Gunn effect, where by negative resistances and therefore oscillations are obtained under certain conditions from bulk gallium arsenide. [7M]

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Code No: R1632042 **R16** SET - 2

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(Electronics and Communication Engineering)

Time: 3 hours Max. Marks: 70

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## PART –A

1. a) An air-filled waveguide with dimensions 5 cm x 2 cm transports $TE_{01}$ mode. Find $\lambda_c$? [2M]
   b) The radius of a circular waveguide with air filled is 3 cm. Find the radius if guide is filled with $\varepsilon_r = 4$. [2M]
   c) Calculate the transit angle of a beam passing through the gap of 1 mm with frequency 3 GHz and uniform velocity $2 \times 10^7$ m/sec. [2M]
   d) Calculate angular frequency of a magnetron if $B_0 = 2m/e$? [3M]
   e) Calculate coupling factor of a directional coupler, if $P_{in}$ = 100 mW and Coupling power is 10 mW. [3M]
   f) Estimate the $f_r$ of an IMPATT diode whose drift velocity is $10^5$ m/sec and Drift space is 22 μm. [2M]

## PART -B

2. a) What is the maximum power that can be transmitted by rectangular guide 1.5 cm x 0.75 cm at 45 GHz? [7M]
   b) Prove that $TM_{11}$ is the lowest TM wave mode in a rectangular WG. [7M]

3. a) Explain the function of a Rectangular Resonator Cavity? [7M]
   b) A $TE_{11}$ wave is propagating through a circular waveguide. The diameter of the guide is 10 cm and waveguide is air filled. [7M]
   i) Find the cutoff frequency.
   ii) Find the Wavelength $\lambda_g$ in the guide for a frequency of 3 GHz.
   iii) Determine the wave impedance in the guide.

4. a) For a Two Cavity Klystron, the voltage applied to cathode is 900 V. The gap in input cavity is 1.5 mm and spacing between cavities is 4 cm. The voltage across the cavity gap is 10 V peak to peak. Calculate the value of bunching parameter for a beam frequency of 9 GHz. [7M]
   b) Derive the expression for electron admittance of a Reflex Klystron Oscillator. [7M]

5. a) What are π-mode oscillations? Explain how oscillations are sustained in the Cavity Magnetron with suitable sketches, assuming that π-mode oscillations already exist? [7M]
   b) A helical TWT has a diameter of 2 mm with 50 turns per cm. Calculate axial phase velocity and the anode voltage at which the TWT can operate in useful gain. [7M]

6. a) Explain the construction and working of Directional Coupler. Under what conditions does the coupler give maximum directivity? [7M]
   b) Discuss various types of Waveguide attenuators. [7M]
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7. a) How VSWR of unknown load is measured with the help of Slotted Wave Carriage using microwave bench setup? Draw the block diagram of the setup. [7M]
   b) 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? [7M]

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Code No: R1632042 **R16** SET - 3

**III B. Tech II Semester Regular Examinations, April/May- 2019**

# 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. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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## PART –A

| | | | |
|---|---|---|---|
| 1. | a) | The wave is travelled in a rectangular wave guide with $\lambda_c$ is $3\lambda_0$. Find Group velocity? | [2M] |
| | b) | List out the losses in microstrip lines. | [2M] |
| | c) | Define velocity modulation. | [2M] |
| | d) | Write the applications of Travelling wave tubes. | [3M] |
| | e) | Draw the structure of capacitive Iris and resonant Iris? | [3M] |
| | f) | By using reflectometer, the measured incident power is 9 times of reflected Power. What is the reflection coefficient? | [2M] |

## PART -B

| | | | |
|---|---|---|---|
| 2. | a) | Prove that $TE_{10}$ is the dominant mode in rectangular wave guide. | [7M] |
| | b) | Explain the concept of phase velocity and group velocity. | [7M] |
| 3. | a) | Explain the following about microstrip line:<br>i) Characteristic impedance<br>ii) The effective microstrip permittivity and effective relative permittivity. | [7M] |
| | b) | Estimate the quality factor of a cavity resonator at different load conditions. | [7M] |
| 4. | a) | How bunch formation takes place in drift region in Two Cavity Klystron? Explain? | [7M] |
| | b) | What are the Re-entrant Cavities? Why these are different from Resonant cavities? Explain? | [7M] |
| 5. | a) | Define mode jumping? Explain the techniques to eliminate mode jumping? | [7M] |
| | b) | A helix travelling wave tube operates at 4 GHz under a beam voltage $V_o$=6 kV and beam current $I_o$=30mA. If the helix impedance $Z_o$ is 100 ohm and circuit length N=30, find the output power gain. | [7M] |
| 6. | a) | Derive the S-Matrix of E-plane tee when power is fed from auxiliary port. Consider other ports in the matched condition. | [7M] |
| | b) | What is Circulator? Explain the various applications of Circulator. | [7M] |
| 7. | a) | Show how to measure the frequency of the source without using a wave meter in the microwave test bench? Explain. | [7M] |
| | b) | How avalanche effect is utilized to generate microwave signals? Explain The operation of IMPATT diode. | [7M] |

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Code No: R1632042 **R16** SET - 4

**III B. Tech II Semester Regular Examinations, April/May- 2019**

# 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. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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## PART –A

| | | | |
|---|---|---|---|
| 1. | a) | The wave is travelled in a rectangular wave guide with $\lambda_c$ is $2\lambda_o$. Find Phase velocity? | [2M] |
| | b) | Calculate the resonant frequency of a Rectangular Cavity Resonator with dimensions 2 cm x 1 cm x 3 cm with $TE_{100}$ wave? | [2M] |
| | c) | Define beam coupling coefficient and draw the graph between angle and beam efficiency? | [2M] |
| | d) | Draw the types of slow wave structures used in HTWT? | [3M] |
| | e) | Estimate the reflected power due to load mismatch with $\acute{\Gamma}$=0.1 and $P_i$= 200W? | [3M] |
| | f) | Using double minima method, find SWR for $\lambda_g = \pi$ cm and distance between the positions of twice minimum power is 0.5 cm. | [2M] |

## PART -B

| | | | |
|---|---|---|---|
| 2. | a) | A rectangular air filled copper waveguide with dimension 2.28 cm and 1.01 cm is operated at 9.2 GHz with dominant mode. Find the cut-off frequency, guide wave length, phase shift, phase velocity and characteristic impedance. | [7M] |
| | b) | Discuss the types of losses exist in Rectangular Wave Guide. | [7M] |
| 3. | a) | Compute the lowest resonant frequency of a Rectangular Cavity Resonator having following dimensions: width=2 cm, height=1cm , length=3 cm. | [7M] |
| | b) | Derive TE mode in a Circular Waveguide? | [7M] |
| 4. | a) | Derive the velocity modulation equation of Two Cavity Klystron amplifier? | [7M] |
| | b) | Prove that the efficiency of a Reflex Klystron Oscillator is only 22%? | [7M] |
| 5. | a) | With the support of a diagram, explain the operation of Eight Cavity Magnetron. | [7M] |
| | b) | An X-band pulsed Cylindrical Magnetron has $V_o$=30 kV, $I_o$=80 A, $B_o$=0.01 Wb/m$^2$, a=4 cm, b=8 cm. Calculate<br>i) Cyclotron angular frequency<br>ii) Cutoff voltage<br>iii) Cutoff magnetic flux density | [7M] |
| 6. | a) | Explain the working and applications of two types of Waveguide discontinuity. | [7M] |
| | b) | An Isolator has an insertion loss of 0.5 dB and isolation of 30 dB. Determine the scattering matrix of the Isolator if the isolated ports are perfectly matched to junction. | [7M] |
| 7. | a) | What is Reflection meter? How it is used to measure the reflection coefficient and VSWR of any unknown load? | [7M] |
| | b) | How avalanche effect is utilized to generate microwave signals? Explain the operation of TRAPATT diode. | [7M] |

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