Marking Scheme
Microwave Engineering (T) - EC3CO22

Q.1 i) In a rectangular waveguide, the following types of wave can exist **1**
(c) Both TE and TM waves

ii) A transmission line has VSWR of 2, the reflection coefficient is **1**
(a) $\frac{1}{3}$

iii) The mode of propagation in a microstrip line is **1**
(c) Quasi TEM mode

iv) The dielectric constant of a microstrip line **1**
(a) Independent of frequency

v) A magic tee is nothing but a **1**
(d) Combination of E – plane tee and H – plane tee

vi) In a microwave cavity resonator, when the frequency of an impressed signal is equal to a resonant frequency, the peak energies stored in the electric and magnetic fields are **1**
(b) Equal

vii) The number of P-N junctions in the Gunn diode is **1**
(a) 0

viii) Which one of the following is an avalanche and transit time device **1**
(c) IMPATT

ix) The phase velocity of a wave in a periodic structures is **1**
(a) Reduced

x) In insertion loss method the order of the filter is equal to the number of **1**
(b) Reactive elements

Q.2 i. What do you mean by TE and TM modes in a waveguide? **2**
Definition of TE mode - 1 mark
Definition of TM mode - 1 mark

ii. An air filled rectangular waveguide of inside dimensions 7 × 3.5 cm operates in the dominant TE_{10} mode. **3**
(i) Find the cutoff frequency
(ii) Determine the phase velocity of the wave in the guide at a frequency of 3.5 GHz.
(iii) Determine the guided wavelength at the same frequency.
Solution:
Given $a = 7\ cm, b = 3.5\ cm\ and\ f = 3.5\ GHz$
We know that c = 3×10^8 m/s
(i) The cutoff frequency $f_c = \frac{c}{2}\sqrt{(m/a)^2 + (n/b)^2}$ Hz
For TE_{10}, $m = 1, n = 0$
Hence, $f_c = \frac{c}{2a}$ Hz and thus $f_c = 2.14\ GHz$ - 1 mark
(ii) The phase velocity $v_g = \frac{c}{\sqrt{1-(f_c/f)^2}}$ Hz
Hence, $v_g = 3.78 \times 10^8 m/s$ - 1 mark
(iii) The guided wavelength $\lambda_g = \frac{\lambda_o}{\sqrt{1-(f_c/f)^2}}$ Hz
Hence, $\lambda_g = 10.8\ cm$ - 1 mark

iii. What are standing waves? Define VSWR. Express VSWR in terms of reflection coefficient and reflection coefficient in terms of VSWR. **5**
Standing waves definition - 1 mark
VSWR definition - 2 marks
Expression of VSWR in terms of reflection coefficient - 1 mark
Expression of reflection coefficient in terms of VSWR - 1 mark

OR iv. What is a smith chart? Explain how a smith chart works. **5**
Smith chart introduction - 1 mark
Diagram of smith chart - 2 marks
How smith chart works - 2 marks

Q.3 i. What are the basic advantages of planar transmission lines? (any two) **2**
Any two advantages - 2 marks

ii. What do you mean by microstrip lines? Derive the equation of characteristic impedance of microstrip lines. Also explain the losses that occur in microstrip lines. **8**
Definition of microstrip lines - 2 marks
Derivation of the characteristics impedance - 3 marks
Losses in microstrip lines - 3 marks

OR iii. What do you mean by slot lines? Discuss about the effective relative permittivity and characteristic impedance of slot lines. Also explain the excitation process of slot lines. **8**
Definition of slot lines - 2 marks
Discussion about the effective relative permittivity and characteristic impedance of slot lines - 3 marks
the excitation process of slot lines - 3 marks

Q.4 i. Find the resonant frequencies of TE_{101}, TE_{111} and TE_{201} modes of an air-filled rectangular cavity resonator having the dimensions of 5 cm × 4 cm × 2.5 cm **3**

Solution:

Given $a = 5\ cm, b = 4\ cm\ and\ d = 2.5\ cm$

The resonant frequency $f_r = \frac{c}{2}\sqrt{(m/a)^2 + (n/b)^2 + (p/d)^2}$ Hz

Here, c = 3×10^{10} cm/s

For TE_{101}, $m = 1, n = 0\ and\ p = 1$

Hence, $f_r = 6.7082\ GHz$ - 1 mark

For TE_{111}, $m = 1, n = 1\ and\ p = 1$

Hence, $f_r = 7.6852\ GHz$ - 1 mark

For TE_{101}, $m = 2, n = 0\ and\ p = 1$

Hence, $f_r = 8.4853\ GHz$ - 1 mark

ii. Define directivity and coupling factor of a directional coupler. Explain two hole directional coupler with the help of diagram and S – matrix. **7**

Definition of Directivity and coupling factor - 2 marks
Two hole direction coupler diagram - 2 marks
S – matrix of about two hole direction coupler - 1 mark
Explanation about two hole direction coupler - 2 marks

OR iii. Explain Magic Tee with the help of diagram and S- matrix. Also, write its applications. **7**

Magic T diagram - 2 marks
S – Matrix of magic T - 1 mark
Explanation of magic T - 3 marks
Applications of magic T – 1 mark

Q.5 i. Discuss the differences between transferred electron devices and avalanche transit-time devices. **4**

transferred electron devices - 2 marks
avalanche transit-time devices - 2 marks

ii. What are the different modes of operation of a Gunn diode? Explain in details Gunn oscillation mode and LSA oscillation mode. **6**

Classification of modes - 2 marks
Explanation of Gunn mode with diagram – 2 marks
Explanation of LSA mode with diagram – 2 marks

OR iii. Explain the IMPATT diode on the basis of physical structures, negative resistance and the power output and efficiency. **6**

Physical structure - 2 marks
negative resistance - 2 marks
the power output and efficiency - 2 marks

Q.6

i. Write an explanatory note on periodic structure in microwave. **5**

Periodic structures - 1 mark

Diagram - 1 mark
Explanation - 3 marks

ii. What is the image parameter method of filter design? Derive the expressions for the image impedance in terms of ABCD parameters of the network. **5**

Introduction of Image parameter method - 1 mark
Image impedance expressions derivation with diagram - 4 marks

iii. Explain the insertion loss method of filter design. **5**

Introduction of Insertion loss method - 1 mark
Power loss ratio characterization - 1 mark
Discussion on some practical filter responses - 3 marks

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Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering

End Sem Examination May-2024

EC3CO22 Microwave Engineering

Programme: B.Tech. Branch/Specialisation: EC

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. In a rectangular waveguide, the following types of wave can exist- **1**

(a) TE only (b) TM only

(c) Both (a) and (b) (d) TEM only

ii. A transmission line has VSWR of 2, the reflection coefficient is- **1**

(a) $\frac{1}{3}$ (b) 0 (c) $\frac{1}{4}$ (d) $\frac{1}{2}$

iii. The mode of propagation in a microstrip line is- **1**

(a) TE mode (b) TM mode

(c) Quasi TEM mode (d) TEM mode

iv. The dielectric constant of a microstrip line- **1**

(a) Independent of frequency

(b) Depends on the frequency

(c) It is a constant parameter for certain material

(d) Depends on the type of material used

v. A magic tee is nothing but a- **1**

(a) Modification of H – plane tee

(b) Modification of E – plane tee

(c) Combination of two E – plane tees

(d) Combination of E – plane tee and H – plane tee

vi. In a microwave cavity resonator, when the frequency of an impressed signal is equal to a resonant frequency, the peak energies stored in the electric and magnetic fields are- **1**

(a) Zero (b) Equal (c) Infinite (d) None of these

vii. The number of P-N junctions in the Gunn diode is- **1**

(a) 0 (b) 1 (c) 2 (d) 3

P.T.O.

viii. Which one of the following is an avalanche and transit time device? **1**
(a) Gunn (b) Tunnel (c) IMPATT (d) LSA diode

ix. The phase velocity of a wave in a periodic structures is- **1**
(a) Reduced (b) Increased
(c) Remains constant (d) None of these

x. In insertion loss method the order of the filter is equal to the number of- **1**
(a) Passive elements (b) Reactive elements
(c) Lossy elements (d) Lossless elements

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OR iii. Explain the IMPATT diode on the basis of physical structures, negative resistance and the power output and efficiency. **6**

Q.6 Attempt any two:

i. Write an explanatory note on periodic structure in microwave. **5**

ii. What is the image parameter method of filter design? Derive the expressions for the image impedance in terms of ABCD parameters of the network. **5**

iii. Explain the insertion loss method of filter design. **5**

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