Ref No. Ex/ ET/PC/B/T/412/2024

B. ETCE 4TH YEAR 1ST SEMESTER EXAMINATION, 2024

MICROWAVE ENGINEERING

Time: 3 Hours **Full Marks: 100**

Use separate Answer - Script for each Part

50 marks for each part

PART - I

Answer any **Five (5)** Questions from the followings: 10×5

1. A two port network is known to have the following scattering matrix

$$[S] = \begin{bmatrix} 0.15\angle 0^{O} & 0.85\angle -45^{O} \\ 0.85\angle 45^{O} & 0.2\angle 0^{0} \end{bmatrix}$$

i) Determine if the network is reciprocal, and loss less, ii) If port two is terminated with matched load, what is the return loss seen at port 1? And iii) If port two is terminated with a short circuit, what is the return loss seen at port 1?

3+4+3

2. A magic T is terminated at collinear ports 1 and 2 and difference port 4 by impedances of reflection coefficients $\Gamma_1 = 0.5$, $\Gamma_2 = 0.6$ and $\Gamma_4 = 0.8$ respectively. If 1 W power is fed at the sum port 3, calculate the power reflected at the port 3 and power transmitted to the other three ports.

10

3. What is directional coupler? Define directivity, coupling factor, insertion loss and isolation of a 4-port directional coupler. Derive the expression for scattering matrix of a 4-port directional coupler.

2+3+5

4. What do you meant by waveguide discontinuity? How this discontinuity related with the change of height and width of waveguide? How the resonant frequency of resonant Iris is determined?

2+5+3

5. What are Ferrites? What properties do they have? Explain the operation of Faraday Rotation Isolator and give its application.

2+2+6

6. Discuss the construction and working of a hybrid rings (Rare-Race circuit). Derive the scattering matrix for the same. Mention the areas of application for this microwave junction.

4+4+2

7. What is the function of metallic cavity? Explain how Q is affected by the metallic cavity? Find the resonant frequencies of the five lowest modes of an air-filled cylindrical cavity of radius 1.905 cm and length 2.54 cm. List them in ascending order. Derived the expression for Q of a rectangular cavity.

2+3+5

8. Write short notes (any two from the followings): 2×5

   A. Wave guide bend and twists

   B. Phase shifter

   C. Four port circulator

   D. Equivalent transmission line circuit for TM and TE waves

[Turn over

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B.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING
FOURTH YEAR
FIRST SEMESTER EXAM 2024

MICROWAVE ENGINEERING

Time (Full Paper): Three hours | Full Marks of (Part II): 50

Use separate answer scripts for each half.

PART II

Answer **Q.1** and ***any three*** questions from the rest.

1. a) How will you measure impedance using slotted line? [5]

   b) Discuss on low, medium and high microwave power detection techniques. [5]

   c) Explain high VSWR (>10) measurement technique. [5]

   d) How will you measure gain and bandwidth of antenna. [5]

2. Draw a neat diagram of two cavity klystron amplifier and explain velocity modulation. [10]

3. A silicon bipolar junction transistor has the following scattering parameters at 1.0 GHz, with a 50 Ohm reference impedance: $S_{11} = 0.61\angle -170°$, $S_{21} = 2.3\angle 80°$, $S_{12} = 0.06\angle 70°$, $S_{22} = 0.72\angle -25°$. The source impedance is $Z_s = 25$ Ohm and the load impedance is $Z_L = 100$ Ohm. Compute the power gain, the available power gain, and the transducer power gain. [10]

4. A typical *n*-type Gunn diode has the following parameters: Threshold field $E_{th} = 2500$ V/cm, Applied field $E = 3000$ V/cm, Device length $L = 10$ μm, Doping concentration $n_0 = 2\text{x}10^{14}$ cm^{-3}, Operating frequency $f = 10$ GHz. Compute the electron drift velocity. Calculate the current density. Estimate the negative electron mobility. [10]

5. A single-pole switch is to be constructed using a PIN diode with following parameters: $C_j = 0.2$ pF, $R_r = 2$ Ohm, $R_f = 5$ Ohm, $L_i = 0.4$ nH. If the operating frequency is 5 GHz, and $Z_0 = 50$ Ohm, what circuit (series or shunt) should be used to obtain the greatest ratio of off-to-on attenuation? [10]

6. Write short notes on: [2x5 = 10]
   a) IMPATT diode
   b) Use of PIN diode