Code: A-20 **Subject: MICROWAVE THEORY & TECHNIQUES**
Time: 3 Hours **Max. Marks: 100**

NOTE: There are 11 Questions in all.

- **Question 1 is compulsory and carries 16 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Answer any THREE Questions each from Part I and Part II. Each of these questions carries 14 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or best alternative in the following: (2x8)

a. A lossless transmission line of $Z_0 = 100\Omega$ is terminated by an unknown impedance. The termination is found to be at a maximum of the voltage standing wave and the VSWR is 5. The value of the terminating impedance is

(A) 500 Ω. **(B)** 50 Ω.
(C) 600 Ω. **(D)** 60 Ω.

b. A transmission line less than $\lambda/4$ long short circuited at the far end acts like a

(A) pure inductance. **(B)** pure capacitance.
(C) series resonant circuit. **(D)** parallel resonant circuit.

c. When a particular mode is excited in a wave guide there appears an extra electric component in the direction of propagation. The resulting move is

(A) Longitudinal electric. **(B)** Transverse electromagnetic.
(C) Transverse electric. **(D)** Transverse magnetic.

d. A cavity resonator simulates

(A) a series resonant circuit. **(B)** a parallel resonant circuit.
(C) an iris inserted in a waveguide. **(D)** a free running osillator.

e. The following solid-state device can operate at high power levels of the order of 100 W

(A) TRAPATT **(B)** IMPATT
(C) GUNN **(D)** PIN

f. A pyramidal horn has an opening of 58 mm in the E-plane and 78 mm in the H-plane and if operates at 10 GHz. The gain of the horn antenna is

(A) 47.7 **(B)** 37.7
(C) 57.7 **(D)** 27.7

g. A loop is used to couple a waveguide and is placed in a location which for the TE_{10} mode occurs close to the end wall of the guide.

(A) Maximum electric field.
(B) Minimum magnetic field.
(C) Maximum magnetic field.
(D) Maximum electric and magnetic fields.

h. Suppose a microwave transmitter and a receiver towers have equal height with respect to Mean Sea Level (MSL), in order to communicate over a distance of 40 km, their MSL height should be

(A) 33.5 m **(B)** 43.5 m
(C) 23.5 m **(D)** 13.5 m

PART I
Answer any THREE Questions. Each question carries 14 marks.

Q.2 a. Distinguish between two wire parallel transmission lines and waveguides. **(4)**

b. Determine the attenuation loss, reflection loss, transmission loss, return loss and insertion loss in dBs given a lossless transmission line with a characteristic impedance of 200 Ω fed by a generator of 1 volt and impedance of 100 Ω. The line is 300 m long and terminated by a resistive load of 300 Ω. **(10)**

Q.3 a. Derive the wave equation for a TM wave and obtain all the field components in a rectangular waveguide. **(10)**

b. A Ku band rectangular waveguide has dimensions of a =1.067 cm, b =0.432 cm. Calculate cut off frequency for the TE_{11} mode if the guide is filled with Teflon $(\epsilon_r = 2.1)$. **(4)**

Q.4 a. What do you understand by the term quality factor of a cavity resonator? Obtain an expression for the Q-factor of a rectangular cavity resonator. **(10)**

b. Write a note on re-entrant cavities. **(4)**

Q.5 a. Obtain the scattering matrix of a Magic Tee. Mention at least three of its applications. **(9)**

b. The collinear ports of a magic tee are terminated by impedances of reflection coefficient $\rho_1 = 0.5$ and $\rho_2 = 0.6$. The difference port is terminated by an impedance with reflection coefficient of 0.8. If 1 watt power is fed at the sum port, calculate the power reflected at the sum port and power division at other ports. **(5)**

Q.6 a. What are ferrites? Why are they useful at microwave frequencies? Mention their properties. **(6)**

b. Explain the action of an isolator using ferrites. **(4)**

c. Distinguish between;
(i) E-bend and H-bend
(ii) E-corner and H-corner **(4)**

PART II
Answer any THREE Questions. Each question carries 14 marks.

Q.7 a. Explain the methods of measuring an unknown impedance at microwave frequencies. **(6)**

b. With reference to a microwave bench, explain briefly the following:

(i) Wavemeters.
(ii) Vector network analyser. **(8)**

Q.8 a. Distinguish between TWT amplifier and Klystron amplifier. **(4)**

b. Explain how amplification is achieved in a TWT amplifier. **(6)**

c. What is frequency pushing and pulling in a magnetron? List the performance characteristics of a magnetron. **(4)**

Q.9 a. Explain the doping profiles of a varactor diode as well as its electrical equivalent circuit. **(6)**

b. With reference to parametric amplifier, explain

(i) Parametric up converter.
(ii) Negative resistance parametric amplifier.
(iii) Degenerate parametric amplifier.
(iv) Broadband parametric amplifier. **(8)**

Q.10 a. Distinguish between
(i) Delayed domain mode and Quenched domain mode in a GUNN device.
(ii) IMPATT and TRAPATT.
(iii) MESFETS and Bipolar microwave transistors. **(9)**

b. Explain the Gunn effect. A Gunn diode-has a drift length of 5 μm . What minimum voltage is required to initiate Gunn effect? **(5)**

Q.11 Write explanatory notes on (Any **FOUR**):-

(i) Microwave antennas.
(ii) Fading.
(iii) Microwave applications.
(iv) Microwave repeaters.
(v) Strip lines.
(vi) Phase shifters. **(3.5 x 4 = 14)**