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. In a rectangular cavity resonator having a = width, b = height and d = length for a> b<d, the dominant mode is

(A) TE_{101}. **(B)** TM_{101}.
(C) TE_{010}. **(D)** TM_{110}.

b. High frequency inductors and capacitors are commonly plated with sliver. The main purpose of this is to

(A) reduce their dc resistance. **(B)** reduce their ac resistance.
(C) increase their ac resistance. **(D)** decrease their dc resistance.

c. The Dominant mode in a waveguide is characterised by

(A) longest cut off wavelength. **(B)** shortest cut off wavelength.
(C) infinite attenuation. **(D)** zero attenuation.

d. To couple a coaxial line to a parallel wire line, it is best to use a

(A) slotted line. **(B)** balun.
(C) directional coupler. **(D)** $\lambda/4$ transformer.

e. Two matched hybrid-T's are connected through two H-plane arms to form a 6-port device as shown in Fig.1 below. If 4 mw of power is fed into port 1, the output power (in mw) in the other five ports, namely, $1', 2, 2', 4, 4'$ will be respectively.

(A) 0, 4, 0, 0, 0 **(B)** 1, 0, 1, 0, 2
(C) 1, 0, 1, 2, 0 **(D)** 0, 2, 1, 1, 0

f. In a TWT, the phase velocity of axi ıve structure is kept

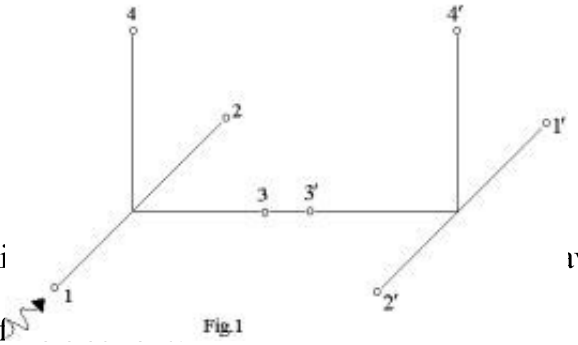

Fig.1

(A) equal to the velocity of
(B) slightly less than the velocity of electrons.
(C) slightly more than the velocity of electrons.
(D) equal to the velocity of light in free space.

g. A disadvantage of micro-strips with respect to strip line circuits in that the former

(A) do not lend themselves to printed circuit techniques.
(B) are more likely to radiate.
(C) are bulkier.
(D) are more expensive and complex to manufacture.

h. Which one of the following is a transformed electron device?

(A) BARITT diode. **(B)** IMPATT diode.
(C) Gunn diode. **(D)** Step recovery diode.

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

Q.2 a. What are multi-conductor, single conductor, open boundary transmission lines? Give examples. **(4)**

b. Show that a TEM wave cannot propagate in a waveguide. **(5)**

c. The dominant mode TE_{10} is propagated in a rectangular waveguide of dimensions a=2.25 cm and b=1 cm. Assume an air dielectric with a break-down gradient of 30 kV/cm and a frequency of 10 GHz. There are no standing waves in the guide. Determine the maximum average power that can be carried by the guide. **(5)**

Q.3 a. Derive the wave equations for a TE wave propagating in a circular waveguide and obtain all the field components. **(9)**

b. An air filled circular waveguide is to be operated at a frequency of 10 GHz and is to have dimensions such that $f_c = 0.9$ f for TE_{11} mode. Determine the diameter of the waveguide and guide wavelength. **(5)**

Q.4 a. Explain the operation of a 2-hole directional coupler and obtain its scattering matrix. **(7)**

b. A symmetric directional coupler has an infinite directivity and a forward attenuation of 20 dB. The coupler is used to monitor the power delivered to a load Z_L as shown in Fig.2 below. Bolometer 1 introduces a VSWR of 2.0 on arm1; Bolometer 2 is matched to arm 2. If bolometer 1 reads 9 mW and bolometer 2 reads 3 mW

(i) Find the amount of power dissipated in the load Z_L.

(ii) Determine the VSWR on arm 3. **(7)**

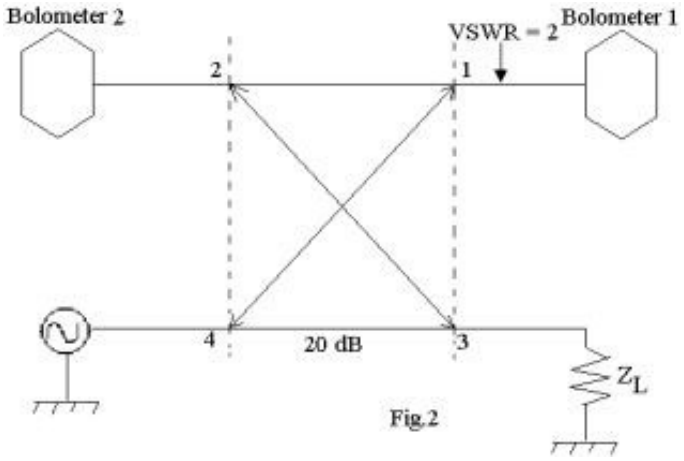

Fig.2

Q.5 a. Explain the action of a four port circulator based on ferrites. What are the applications of a circulator? **(6)**

b. Determine the scattering matrix of a 3-port circulator which has an insertion loss of 0.4 dB, an isolation of 20dB and a VSWR of 1.5. **(5)**

c. Write a note on waveguide irises. **(3)**

Q.6 a. Explain the self balancing bridge technique of measuring microwave power. How can the range of power measurement be increased? **(7)**

b. How are microwave measurements different from low frequency measurements? **(4)**

c. What is a Network Analyser? Explain briefly its operation. **(3)**

PART II

Answer any THREE Questions. Each question carries 14 marks.

Q.7 a. How are high frequency limitations of conventional tubes overcome? Explain. **(5)**

b. Explain the construction and operation of a Travelling Wave Tube. (TWT) **(5)**

c. A TWT operates under the following parameters.

Beam Current	:	I_0 = 50mA
Beam voltage	:	V_0 = 2.5KV
Char. Impedance	:	Z_0 = 6.75Ω
Circuit length	:	N = 45
Frequency	:	f = 8 GHz

Determine

(i) The gain parameter 'C'.

(ii) The output power gain A_p in dB. **(4)**

Q.8 a. Explain the working principle and applications of a reflex Klystron oscillator. **(7)**

b. A reflex Klystron operates at the peak mode of n = 2 with

Beam voltage V_0 = 300V

Beam Current I_0 = 20mA

Signal Voltage V_1 = 40V

Determine

(i) the input power in watts.

(ii) the output power in watts.

(iii) the efficiency of operation of the system. **(4)**

c. How is tuning achieved in a reflex klystron. **(3)**

Q.9 a. Distinguish between Avalanche transit time devices and transferred electron devices. **(3)**

b. Explain the operation of an IMPATT diode and state its applications. **(7)**

c. If the drift length of an IMPATT diode is 1.5 μm determine

(i) drift time of the carrier.

(ii) operating frequency of the diode. **(4)**

Q.10 a. Explain the following :

(i) Microwave Repeater with IF amplification.

(ii) Fading.

(iii) Microwave Antennas. **(6)**

b. A microwave line of sight link operates at a frequency of 8 GHz with a repeater spacing of 50 Km and requires 50 dBm carrier power at the receiver input to avoid deterioration due to fading and noise. Calculate the transmitter carrier power required if the antenna gain is 40 dB and Coupling and waveguide loss is 9 dB. **(5)**

c. What do you understand by the term Over The Horizon (OTH) microwave system? Explain in

brief. **(3)**

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

(i) Parametric amplifiers.
(ii) MASERS.
(iii) Pulsed Radar.
(iv) Stub Matching.
(v) Phase Shifters.
(vi) MESFETs. **(3.5 x 4 = 14)**