

**N.B. :** (1) Question No. 1 is compulsory.

(2) Attempt any four questions out of the remaining six questions,

(3) Assume any suitable data wherever required justify the same

1. (a) A rectangular cavity resonator has dimensions of  $a = 5$  cm,  $b = 2$  cm, and  $d = 15$  cm. 20  
Compute :

(i) the resonant frequency of the dominant mode for an air-filled cavity.

(ii) the resonant frequency of the dominant mode for a dielectric filled cavity of

$$\epsilon_r = 2.56.$$

(b) Compare IMPATT and TRAPTT diodes.

(c) What are slow-wave structures ? For what purpose are the, slow-wave structures used in microwave devices ?

(d) Explain the following terms for waveguides :

(i) Dominant mode

(ii) Degenerate modes

(iii) Group velocity

(iv) Phase velocity

(v) Cutoff frequency.

2. (a) Derive the field equations for TE modes in circular waveguides. 10

(b) Can TEM mode exist in hollow waveguides ? Justify your answer. 5

(c) An air-filled waveguide with cross-section  $2 \times 1$  cm transports energy in the  $TE_{10}$  mode at a rate of 0.5 hp. The impressed frequency is 30 GHz. What is the peak value of the electric field occurring in the guide ? 5

3. (a) Explain the construction and working of a two-hole directional coupler. Define coupling coefficient and directivity of a directional coupler. 10

(b) Show that the scattering matrix for a series T-junction matched at arm 3 is given by— 10

$$[S] = \begin{bmatrix} \frac{1}{2} & \frac{1}{2} & \frac{1}{\sqrt{2}} \\ \frac{1}{2} & \frac{1}{2} & -\frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} & 0 \end{bmatrix}$$

4. (a) Explain velocity modulation in Reflex Klystron. How does it help in bunching the electrons ? Obtain an expression for the bunching parameter of the Reflex Klystron oscillator. 15

(b) A Reflex Klystron operates under the following conditions :

$$V_0 = 500 \text{ V}$$

$$R_{sh} = 20 \text{ k}\Omega$$

$$f_r = 8 \text{ GHz}$$

$$L = 1 \text{ mm is the spacing between repeller and cavity.}$$

The tube is oscillating at  $f_r$  at the peak of the  $n = 2$  mode or  $1\frac{3}{4}$  mode. Assume that the transit time through the gap and the beam loading effect can be neglected.

- (i) Find the value of the repeller voltage,  $V_r$ .
- (ii) Calculate the electronic efficiency.

5. (a) Draw a neat labelled diagram of a four port circulator. Explain how the flow of power is maintained only in one direction in the circulator. 12  
Design the same circulator using two magic tees and a phase shifter.
- (b) Compare Klystron amplifier and a TWT based on their operation, efficiency, output power, applications, bunching process of electrons and operating frequencies. 8
6. (a) Explain the working of a Faraday Rotation Isolator. 6
- (b) A matched isolator has insertion loss of 0.5 dB and an isolation of 25 dB. Find the scattering coefficients for the isolator. 4
- (c) Explain Gunn effect with the two-valley model of Gunn diode. What are the criteria that the semiconductor must satisfy in order to exhibit negative resistance? 10
7. Write short notes on :
  - (a) Striplines 6
  - (b)  $\pi$ -mode of operation of a cavity magnetron. 8
  - (c) Wavemeter method of frequency measurement. 6