2022
(MARCH)

MICROWAVE ENGINEERING

Full Marks : 100
Pass Marks : 30
Time : Three hours

The figures in the margin indicate full marks for the questions.
*Answer **any five** questions.*

1. Derive the electromagnetic field equations in rectangular waveguide for TE mode. Hence, obtain the cut-off frequency for TE_{10} mode in terms of waveguide dimension. Explain why TE_{10} is called dominant mode. 14+3+3

2. (a) Define the cutoff frequency and guide wavelength in a rectangular waveguide.
(b)Derive the expression of the guide wavelength in terms of the relevant parameters.
(c) Determine the values of the cut off frequency, characteristic wave impedance and the guide wavelength in a hollow rectangular wave-guide with inside dimensions 2.286 x 1.00 cm at 9GHz for the dominant mode. 6+5+9

3. (a) Derive an expression for the resonant frequency of a rectangular cavity ($a \times b \times l$) with $a > b < l$ and hence obtain the dominant mode of resonance.
(b) Define 'Q-factor' of a cavity. Discuss the steps involved in determining 'Q-factor' of the cavity. Distinguish between 'loaded Q' and 'unloaded-Q' of the cavity. 10+ (2+4+4)

4. (a) Discuss the working principle of a 'Magic-T'
(b) Obtain the scattering matrix equation of a 'Magic-T' by using the necessary properties of the scattering matrix
(c) Explain why 'scattering Matrix' representation of a microwave network is preferred over Z-matrix or Y-matrix representation. 6+8+6

5. (a) Describe an ideal 'Directional coupler' and write its 'Scattering Matrix'. Define 'Coupling' and 'Directivity' in the context of a directional coupler.
(b) Explain the design of a 2-hole directional coupler in rectangular wave-guide version for a given coupling. Mention the principal shortcoming of such a directional coupler. Discuss how this shortcoming can be overcome. 12+8

6. (a) Explain the slotted line method for the measurement of unknown impedance.
(b). Describe the procedure for measuring
(i) VSWR (<10) and (ii) VSWR (>10) using a VSWR meter in a microwave bench. 10+10

7. (a) Explain the working principle of a reflex klystron oscillator
(b) Explain what is meant by 'velocity modulation' and how this phenomenon is used in the operation of a klystron tube.
(c) Draw the power vs repeller voltage and frequency vs repeller voltage characteristics of a reflex klystron. Explain qualitatively. (8+6+6)