53 (EC 601) MWEN

2018

MICROWAVE ENGINEERING

Paper : EC 601

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1. *(a)* Starting from Maxwell's equation derive the electromagnetic field equation in rectangular waveguide for TE_{mn} mode.

   (b) Deduce the expression of the Cutoff frequency for TE_{10} mode in terms of waveguide dimension.

   (c) Explain why TE_{10} mode is called dominant mode and why wave propagation in a hollow metallic waveguide is preferred in this mode.

   10+4+6

2. (a) Discuss the various considerations in choosing the cross sectional dimensions of a rectangular waveguide.

(b) Given $E_y = A \sin \frac{\pi x}{a} e^{-j\beta z}\ V/m$ to be the electric field in the transverse cross-section of the hollow metallic rectangular waveguide with inside dimensions as "$a \times b$".

Derive the expression for the power transported in the dominant mode.

(c) If $a = 2{\cdot}286cm$, $b = 1{\cdot}0cm$, and $A = 2V/m$, then calculate the power in the dominant mode at $9GHz$.

5+8+7

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. Distinguish between 'loaded Q' and 'unloaded-Q' of the cavity.

(c) Describe critical coupling, over-coupling and under-coupling. Draw the variation of VSWR with coupling co-efficient.

7+6+7

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. 7+8+5

5. *(a)* Describe an ideal 'Directional Coupler'. Define 'Coupling' and 'Directivity' in the context of a directional coupler.

(b) Mention the principal shortcoming of such a directional coupler. Discuss how this shortcoming can be overcome.

(c) Explain with neat sketch the working principle of Faraday Isolator. 6+4+10

6. *(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* voltage characteristics of a Reflex Klystron. Explain qualitatively. 7+6+7

7. (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