53 (EC 601) MWEN

2017

MICROWAVE ENGINEERING

Paper : EC 601

Full Marks : 100

Time : Three hours

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

Answer ***any four*** *questions :* 4×25=100

1. *(a)* What is Smith chart ?

   (b) Deriving the necessary equations clearly explain the different circles present in Smith chart.

   (c) What does impedance matching mean ? Why is it so important in transmission line ?

(d) What are the different types of impedance matching techniques which are used commonly in transmission line? Explain each of them qualitatively. 2+8+(3+3)+9

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

(b) Deduce the expression of the cut-off 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.

(d) Explain qualitatively why TEM mode is not supported in a hollow waveguide. 10+4+6+5

3. (a) Show that a rectangular cavity is a waveguide version of short circuited $\lambda/4$ transmission line resonator.

(b) 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.

(c) Define 'Q-factor' of a cavity. Distinguish between 'loaded-Q' and 'unloaded-Q' of the cavity.

(d) Describe critical coupling, over coupling and under coupling. Draw the variation of VSWR with coupling coefficient.

5+7+6+7

4. (a) Explain why 'Scattering Matrix' representation of a microwave network is preferred over Z-matrix or Y-matrix representation.

(b) What are the different properties of S matrix ?

(c) Deducing the necessary equation prove the unitary properties of the S-matrix for a lossless junction.

(d) With the neat sketch describe the working principle of precision type attenuator and write down its scattering matrix.

5+4+8+8

5. *(a)* What does a Tee junction mean ?

(b) Explain clearly the operating principle of E-plane Tee and H-plane Tee and write down their scattering matrices.

(c) A $20mW$ signal is fed into one collinear port-1 of a lossless H-plane tee junction. Calculate the power delivered through each port when other ports are terminated with matched load.

(d) Describe the principle of Hybrid Rings (Rat-Race Circuits) and write down its scattering matrix. 2+(6+6)+4+7

6. *(a)* Describe the phenomenon of bunching with the help of Applegate diagram.

(b) Explain the working principle of a reflex Klystron oscillator.

(c) Explain what is meant by 'Velocity modulation' and how this phenomenon is used in the operation of a Klystron tube.

(d) Draw the power *Vs* repeller voltage and frequency *Vs* repeller voltage characteristics of a reflex Klystron. Explain qualitatively. 6+7+6+6

7. *(a)* Explain the slotted line method for the measurement of unknown impedance.

(b) Describe the principle of operation of "Absorption type wave meter" and how it can be used to measure the microwave frequency in a standard microwave bench.

(c) Describe the procedure for measuring *(i)* VSWR < 10 and *(ii)* VSWR > 10 using a VSWR meter in a microwave test bench. 9+6+10