MICROWAVE ENGINEERING
(ECE3102)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) A waveguide is a
(a) band pass filter (b) high pass filter
(c) band stop filter (d) low pass filter

(ii) The modes of propagation supported by a rectangular wave guide is:
(a) TM, TEM, TE modes (b) TM, TE
(c) TM, TEM (d) TE, TEM

(iii) A quarter-wave transformer matching a 75Ω source with a 300 Ω load should have a characteristic impedance of
(a) 50Ω (b) 100Ω
(c) 150Ω (d) 200Ω

(iv) If the reflection coefficient of a 2 port network is 0.5 then the return network loss in the network is:
(a) 6.5 Db (b) 0.15 dB
(c) 6.020 dB (d) 10 dB

(v) For lossless network which of the followings is correct?
(a) $[S]^t [S]^* = 1$ (b) $[S]^t [S]^* = 0$
(c) $[S]^t [S]^* = [I]$ (d) None of the above

(vi) A Travelling Wave Tube is basically
(a) An oscillator (b) Tuned Amplifier
(c) Wideband Amplifier (d) both amplifier and oscillator

(vii) In a two-cavity klystron, velocity modulation occurs in the:
(a) Output cavity (b) Drift space
(c) Buncher cavity (d) Collector

(viii) For a two-port network the voltage reflection coefficient seen looking towards the load, ΓS is:

(a) $(Z_S - Z_0)/(Z_S + Z_0)$ (b) $(Z_S + Z_0)/(Z_s - Z_0)$

(c) $Z_S/(Z_S - Z_0)$ (d) $Z_0/(Z_S - Z_0)$

(ix) When both input and output of an amplifier are matched to zero reflection (in contrast to conjugate matching), the transducer power gain is:

(a) $|S_{21}|^2$ (b) $|S_{22}|^2$

(c) $|S_{12}|^2$ (d) $|S_{11}|^2$

(x) What does a noise figure (NF) close to 1 indicate in a microwave amplifier?

(a) High noise (b) High gain

(c) Low noise (d) High bandwidth

Fill in the blanks with the correct word

(xi) Ferrite isolators are ___ port microwave devices

(xii) In a _____ oscillator, the RF wave travels along the helix from the collector towards the electron gun.

(xiii) _____ condition, if met then the transistor can be impedance matched for any load.

(xiv) The scattering parameter $\mathbf{S_{21}}$ represents the _____ coefficient from port 1 to port 2.

(xv) A directional coupler allows a known portion of a signal to be coupled from one transmission line to another while maintaining _____.

Group - B

2. (a) Draw the field patterns for TE_{10} mode. *[(CO1, CO2) (Understand/LOCQ)]*

(b) A waveguide having dimensions a = 5 cm, b = 2 cm. The signal applied to waveguide is10 GHz. Determine the modes that are propagating in the waveguide. *[(CO1) (Analyse/IOCQ)]*

(c) Explain following terms (b) Phase Velocity (c) Group Velocity. *[(CO1) (Remember/IOCQ)]*

3 + 5 + 4 = 12

3. (a) Discuss in detail about Q factor of cavity Resonator. *[(CO2) (Remember/LOCQ)]*

(b) Calculate resonant frequency of rectangular cavity filled with dielectric with €r=4 and having dimensions a=5cm, b=4cm, and d=15cm. *[(CO2) (Analyse/IOCQ)]*

(c) Design an air-filled cubical cavity to have its dominant resonant frequency at 3 GHz. *[(CO1, CO2) (Apply/HOCQ)]*

4 + 4 + 4 = 12

Group - C

4. (a) Explain that a three-port network cannot be simultaneously reciprocal, lossless and matched at all ports. *[(CO3) (Understand/LOCQ)]*

(b) A two-port network has the following S-Matrix

$$\begin{bmatrix} 0.1\angle 0^0 & 0.8\angle -45^0 \\ 0.8\angle 45^0 & 0.2\angle 0^0 \end{bmatrix}$$

(i) Determine whether the network is reciprocal or not?
(ii) Determine whether the network is lossless or not?
(iii) If port 1 is terminated with an open load calculate the return loss at the port 2.
(iv) If the port 2 is terminated with matched load calculate the return loss at port 1?

[(CO3) (Analyse/IOCQ)]

6 + 6 = 12

5. (a) What is the principle of phase shifter? Draw the diagram of dielectric phase shifter and discuss the working mechanism. *[(CO3) (Remember/LOCQ)]*

(b) A 25db directional coupler gives 4dbm in output power through coupled port. If the Isolation specified as 55 dB, find the power available at the Isolated Port. *[(CO3) (Analyse/IOCQ)]*

7 + 5 = 12

Group - D

6. (a) Describe with a neat sketch the constructional details and principle of operation of a reflex klystron tube. *[(CO4) (Remember/LOCQ)]*

(b) Explain velocity modulation principle. *[(CO4) (Remember/LOCQ)]*

8 + 4 = 12

7. (a) Explain in detail about PIN diodes, control circuits and its applications. *[(CO4) (Understand/LOCQ)]*

(b) Explain clearly how a GUNN diode is different from a tunnel Diode in view of both being a negative resistance device. *[(CO4)(Remember/LOCQ)]*

7 + 5 = 12

Group - E

8. (a) Design a low pass filter with cut off frequency of 200 MHz and attenuation of 50 dB at 250 MHz. The flatness of the filter response is not a design consideration. Design a filter thatrequires the least number of components. *[(CO6) (Create/HOCQ)]*

(b) Differentiate between Butterworth filter and Chebyshev filter. *[(CO5) (Analyse/IOCQ)]*

9 + 3 = 12

9. (a) Design a maximally flat low pass filter with a cut off frequency of 4GHz, impedance of 50Ω andat least 20dB insertion loss at 5GHz.g_1=0.195 g_2=0.7797, g_3=2, g_4=1.4029. *[(CO6) (Create/HOCQ)]*

(b) Differentiate between power gain, available power gain and transducer power gain in a two-port microwave amplifier? *[(CO5) (Remember/LOCQ)]*

7 + 5 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	51.04	28.13	20.83