AMIETE – ET (OLD SCHEME)

Code: AE20 **Subject: MICROWAVE THEORY & TECHNIQUES**
Time: 3 Hours **Max. Marks: 100**

DECEMBER 2009

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or the best alternative in the following: **(2×10)**

a. In a circular waveguide with radius 'r', the dominant mode is

(A) TE_{01} **(B)** TM_{01}
(C) TE_{11} **(D)** TM_{11}

b. The propagation constant is

(A) Real quantity **(B)** Complex quantity
(C) Both **(A)** & **(B)** **(D)** None of these

c. TE and TM waves have an axial component of the

(A) Circuit **(B)** Field
(C) Circuit and Field **(D)** None of the above

d. There is a rectangular waveguide whose breadth is 10 cm. For a 2.5 GHz signal propagated in this waveguide in the dominant mode. The cut off wavelength is

(A) 10 cm **(B)** 15 cm
(C) 25 cm **(D)** 20 cm

e. The main disadvantage of the two-hole directional coupler is

(A) narrow bandwidth **(B)** low directional coupling
(C) poor directivity **(D)** high standing wave ratio

f. In transmission line, at a point exactly a quarter wavelength from the load, the current is

(A) maximum. **(B)** permanently zero
(C) infinite **(D)** none of these.

g. A short-circuited line less than $\lambda/4$ long behaves as a

(A) pure capacitance. **(B)** pure inductance.

(C) both (A) and (B) **(D)** None of the above.

h. For transmission line load matching over a range of frequencies, it is best to use a

(A) balance-to-unbalance transformer or balun
(B) broadband directional coupler
(C) double stub
(D) single stub of adjustable position

i. A transmission time terminated with open circuit having input impedance

(A) 0 **(B)** jZo tan $\beta\ell$
(C) - jZo cot $\beta\ell$ **(D)** 1

j. A ferrite is

(A) a non conductor with magnetic properties
(B) An inter metallic compound with particularly good conductivity
(C) An insulator which heavily attenuates magnetic fields
(D) A microwave semiconductor invented by Faraday

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. Derive the transmission line equations. **(8)**

b. The terminating impedance $Z_L = (100 + j100)\ \Omega$ and the characteristic impedance Z_O of the line and stub is 50 Ω. The first stub is placed at 0.4λ away from the load. The spacing between the 2 stubs is $3/8\lambda$. Determine the length of the short-circuited stubs where the match is achieved. What terminations are forbidden for matching the line by the double stub device? Use Smith chart. Why is double stub matching preferred over single stub matching? **(8)**

Q.3 a. Derive the wave equation for a TM wave and obtain all the field components in a rectangular waveguide. **(8)**

b. A rectangular waveguide with cross-sectional dimensions 5 cm by 3 cm is filled with a dielectric of relative permittivity 3. (i) Determine the cut off frequency of the TE_{11} mode. (ii) Determine the frequency at which this mode has an attenuation of 3π nepers/m. **(8)**

Q.4 a. Derive an expression for resonant frequency f_O in a rectangular cavity resonator. **(6)**

b. What is the power passing through a rectangular waveguide propagating in the TE_{10} mode when the maximum signal strength is 100×10^{-3} V/m ? The dimensions of the waveguide are 3 cm × 1.5 cm and the frequency is 10 GHz. **(6)**

c. Briefly discuss loop coupling and aperture coupling. **(4)**

Q.5 a. In an H plane Tee junction, 20mW power is applied to the main arm that is perfectly matched to the junction. Calculate the power delivered to the load 60Ω and 75Ω connected to port (1) and port (2) of collinear arms

respectively. **(8)**

b. Explain how amplification is achieved in a Magnetron with neat sketch. **(8)**

Q.6 a. Explain the operation of two-cavity klystron amplifier with neat sketch. **(8)**

b. Obtain the scattering matrix of a Eplane Tee. **(8)**

Q.7 a. Describe the method for microwave frequency and Noise Factor measurement. **(8)**

b. Mention the chief advantages and disadvantages of microwave communication systems. **(8)**

Q.8 a. Explain in detail the operation of PIN diode. **(6)**

b. Compare stripline and micro strip lines. **(4)**

c. What are the limitations of conventional tubes at microwave frequencies? **(6)**

Q.9 Write short notes on the following (Any **TWO**).

(i) Varactor diode-operation in detail
(ii) Microwave Antennas
(iii) IMPATT diode
(iv) Measurement of high VSWR. **(8 × 2)**