AMIETE – ET (OLD SCHEME)

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

JUNE 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. The skin depth at 1000 MHz, in comparison with that at 500 MHz is

(A) 2. **(B)** $\sqrt{2}$.
(C) $1/\sqrt{2}$. **(D)** $1/2$.

b. Which of the following modes will not be supported by a rectangular waveguide?

(A) TE_{10} **(B)** TE_{11}
(C) TM_{10} **(D)** TM_{11}

c. The semiconductor diode which can be used in switching circuit of microwave range is

(A) PIN diode. **(B)** Varactor diode.
(C) Tunnel diode. **(D)** Gunn diode.

d. A full duplex round trip delay through geostationary synchronous satellite is approximately

(A) 300 ms. **(B)** 500 ms.
(C) 600 ms. **(D)** 800 ms.

e. A plane electromagnetic wave is travelling in an unbounded loss-less dielectric medium having $\mu_r = 1$ and $\varepsilon_r = 4$. The time averaged Poynting vector of the wave is 5 W/m^3. The phase velocity V_p (assuming velocity of light as 3×10^8 m/s) is:

(A) 1.5×10^8 m/s. **(B)** 3.0×10^8 m/s.
(C) 0.5×10^8 m/s. **(D)** 2.5×10^8 m/s.

f. If the peak transmitted power of radar is increased by a factor of 81, then maximum range will be increased by a factor

(A) 3. **(B)** 9.
(C) 27. **(D)** 81.

g. A microwave junction is supposed to be matched at all ports, if in the S matrix

(A) All diagonal elements are zero.
(B) All diagonal elements are equal but not zero.
(C) All diagonal elements are complex.
(D) Is Hermitian.

h. Ferrite phase shifters utilise faraday rotation for providing the necessary phase shift in case of Gyrator.

(A) True **(B)** False.

i. A monolithic circuit is fully integrated chip incorporating both passive and active elements on it and it does require wire bonding to its surrounding.

(A) True **(B)** False

j. In a vertically polarised wave electric field components are always and everywhere in horizontal direction.

(A) True **(B)** False

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

Q.2 a. Why TEM waves do not exist in rectangular waveguide? Which is the dominant mode of propagation in rectangular waveguide and why? **(6)**

b. Prove that $\frac{1}{\lambda_g^2}+\frac{1}{\lambda_c^2}=\frac{1}{\lambda_o^2}$ where λ_g, λ_c and λ_o are guided wavelength, cut-off wavelength and free-space wavelength respectively. **(6)**

c. What is impedance matching? Briefly explain various methods of achieving impedance. **(4)**

Q.3 a. Describe using diagram the operating principle and working of PIN diode and explain two of its application in details. **(8)**

b. Write in brief, what is transferred electron effect? In which type of material it is present? What are the typical characteristics of Gunn diode and explain its working as oscillator. **(8)**

Q.4 a. How are microwave measurement techniques different from low frequency measurement techniques? List techniques for measuring microwave power. Describe in detail measurement of medium microwave power? **(8)**

b. Two identical 30 dB directional couplers are used to sample incident and reflected power in a waveguide. Measured VSWR is 2 and back power is 0.5 mW. What is the value of incident power? **(4)**

c. In a microwave power measurement set up, the Average Pulse power is 250 W and duration of pulse is 5 μ sec. If the time interval between the pulses is measured as 2 m sec, determine the value of peak pulse power. **(4)**

Q.5 a. Define a re-entrant cavity and give at least two examples. Where are these used? **(6)**

b. A lossless parallel strip line has a conducting strip width w. The substrate dielectric separating the two conducting

strips has a relative dielectric constant ε_{rd} of 6 (BeO) and thickness d of 4 mm. Calculate

(i) The required width w of the conducting strip in order to have characteristic impedance of 50 Ω.
(ii) The strip line capacitance.
(iii) The strip line inductance.
(iv) The phase velocity of the wave in the parallel strip line. **(10)**

Q.6 a. Explain the construction and working of directional coupler. Derive expression for coupling factor and directivity. Compare single hole and double hole directional coupler. **(6)**

b. What is Magic Tee? Why is it called so? Explain the characteristics of the Tee considering various input/output conditions. **(6)**

c. What is circulator? Describe construction and working of a four port Faraday rotation circulator. **(4)**

Q.7 a. What are degenerate modes? Explain with illustration that degenerate modes do not have same field pattern. **(4)**

b. What is a micro strip line? How does its characteristic impedance change with change in width to height ratio? Give a reason for using lower dielectric constant substrate in place of alumina at higher microwave frequencies. **(6)**

c. A rectangular cavity resonates in the TM_{111} mode at 5 GHz. Given a = 8.0 cm and b = 6.0 cm, calculate the resonant frequencies for TE_{101}, TE_{102} and TE_{111} modes. Assume cavity is air filled. **(6)**

Q.8 a. What are microwaves? Enumerate the basic advantages and some typical applications of microwaves. **(4)**

b. Draw the schematic diagram of TWT amplifier and describe its principle of operation. Give the propagation characteristics of different waves generated in the amplifier. Explain how r.f. power output and gain vary with the change in r.f. power input. **(12)**

Q.9 a. Explain the basic principles of a radar system. Give the limitation and application of radars. **(8)**

b. Explain the following:

(i) CW Doppler Radar.
(ii) FMCW Doppler Radar. **(8)**