

AMIETE – ET (OLD SCHEME)

Code: AE20
Time: 3 Hours

Subject: MICROWAVE THEORY & TECHNIQUES
Max. Marks: 100

JUNE 2011

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.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 Minutes of the commencement of the examination.**
- **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 semiconductor diode which can be used in switching circuits at microwave range is
- (A) PIN diode (B) Varactor diode
(C) Tunnel diode (D) Gunn diode
- b. Which one of the following modes of transmission will not be supported by a rectangular waveguide?
- (A) TE₁₀ (B) TE₁₁
(C) TM₁₁ (D) TM₁₀
- c. 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
- d. In a TWT, the tube velocity of the axial component of the RF field on the slow-wave structure is kept
- (A) Equal to the velocity of the electrons.
(B) Slightly less than the velocity of electrons.
(C) Slightly more than the velocity of electrons.
(D) Equal to the velocity of light in free space.
- e. In parametric amplifiers used in microwave communication systems, the amplification is limited by
- (A) Type of biasing (B) A maximum limit of 10
(C) Pump energy (D) Frequency of operation

- f. Which of the following is the correct angular aperture for a paraboloidal reflector antenna for which the aperture number is 0.25?
- (A) 45° (B) 90°
 (C) 120° (D) 180°
- g. A disadvantage of microstrips with respect to stripline circuits is that the former
- (A) Do not lend themselves to printed circuits techniques
 (B) Are more likely to radiate
 (C) Are bulkier
 (D) Are more expensive and complex to manufacture
- h. Which one of the following is a transferred electron device?
- (A) BARITT diode (B) IMPATT diode
 (C) Gunn diode (D) Step recovery diode
- i. A 75 ohm transmission line is first short terminated and minima locations are noted. When the short is replaced by a resistive load R_L , the minima locations are not altered and the VSWR is measured to be 3. What is the value of R_L ?
- (A) 25 ohms (B) 50 ohms
 (C) 225 ohms (D) 250 ohms
- j. In microwave power measurement using bolometers the principle of working is the variation of
- (A) Inductance with absorption of power
 (B) Resistance with absorption of power
 (C) Capacitance with absorption of power
 (D) Cavity dimensions with heat generated by the power

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

- Q.2** a. Derive the transmission line equations. (8)
- b. The diameter of the inner conductor of a coaxial cable is 2 mm and that of the outer conductor is 6 mm and the dielectric constant of the insulation is 1.60. Calculate the characteristic impedance. If the nominal capacitance is 60 pF/m. Find the value of inductance per meter at RF. (8)
- Q.3** a. Define the following terms related to directional coupler. Also write S matrix for the same.
- (i) Directivity (ii) Coupling factor
 (iii) Insertion loss (iv) Isolation. (8)

- b. A rectangular waveguide has dimensions $5 \text{ cm} \times 2.5 \text{ cm}$ (internal). Determine the critical frequency for TE_{10} modes. This waveguide is fed by a 10 GHz carrier from a coaxial cable. If TE_{10} wave is propagated, determine (i) free space wave length (ii) guide wavelength (iii) phase and group velocities. (8)
- Q.4** a. Explain the operation of a Faraday rotation isolator with the help of neat sketch. List the applications of Ferrite isolator. (8)
- b. Derive an expression for resonant frequency F_0 in a rectangular cavity resonator. (8)
- Q.5** a. A two cavity Klystron amplifier has the following parameters: Beam voltage $V_0=900 \text{ V}$, Beam current $I_0=30 \text{ mA}$, Frequency $F=8 \text{ GHz}$, gap spacing in either cavity $d=1 \text{ mm}$, spacing between centres of cavities $L=4 \text{ cm}$, effective shunt impedance $R_{sh}=40 \text{ k}\Omega$. Determine:
(i) electron velocity (ii) dc transit time of electrons. (iii) input voltage for maximum output voltage (iv) voltage gain in dB. (8)
- b. Explain how amplification is achieved in a magnetron with neat sketch. (8)
- Q.6** a. Obtain the scattering matrix of H plane Tee. (8)
- b. Differentiate amongst TE, TM, TEM & HE waves. (4)
- c. Enumerate the advantages and disadvantages of MICS. (4)
- Q.7** a. Describe the method for microwave frequency and noise factor measurement. (8)
- b. Explain working of TWT with neat sketch. (8)
- Q.8** a. Explain in detail the operation of Gunn diode with neat sketch. (8)
- b. Derive the radar range equation. Explain the factors that affects the maximum range of RADAR. (8)
- Q.9** Write short notes on any **TWO** of the following:
- (i) Measurement of high VSWR
 - (ii) Microwave antennas
 - (iii) Reflex Klystron
 - (iv) Impedance matching in RF Transmission line. (2×8)