2025

ELECTRONICS — HONOURS

Paper : DSE-B-4

(Transmission Lines, Antenna and Microwave Devices)

Full Marks : 50

The figures in the margin indicate full marks.

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

Answer ***question no.* 1** and ***any four*** questions from the rest.

1. Answer ***any ten*** questions : 1×10

(a) The velocity factor of a transmission line is defined as

(i) the ratio of signal velocity in the line to that in free space

(ii) the ratio of signal velocity in free space to that in the line

(iii) the product of signal frequency and wavelength

(iv) the inverse of the propagation constant.

(b) A transmission line with characteristic impedance Z_0 has a load Z_L. The load will absorb maximum power when

(i) $Z_L = Z_0$ (ii) $Z_L = Z_o^*$

(iii) $Z_L = 1/Z_0$ (iv) $Z_L = \infty$.

(c) The wavelength inside a transmission line compared to free space wavelength is

(i) always shorter (ii) always longer

(iii) same (iv) depends on the line parameters.

(d) For a lossy transmission line with R, L, G, C parameters, the condition for minimum alternation is

(i) R/L = G/C (ii) RC = LG

(iii) R/G = L/C (iv) RC = 1/LG.

(e) The wave impedance for TE modes in a rectangular waveguide

(i) increase with frequency (ii) decreases with frequency

(iii) remains constant (iv) first increases and then decreases with frequency.

(f) The alternatives in a waveguide operating just above cut-off frequency is

(i) minimum (ii) maximum

(iii) zero (iv) independent of frequency.

(g) The effective length of an antenna is

(i) its physical length

(ii) the ratio of induced EMF to the maximum current

(iii) the ratio of maximum current to the induced EMF

(iv) the length of an equivalent Hertzian dipole.

(h) The polarization of an electromagnetic wave is determined by

(i) Directions of propagation (ii) Directions of electric field vector

(iii) Direction of magnetic field vector (iv) Frequency of the wave.

(i) The skip zone in sky wave propagation is

(i) the region where both ground wave and sky wave are received

(ii) the region where only ground wave is received

(iii) the region where no signal is received

(iv) the region where only sky wave is received.

(j) Virtual height in ionospheric propagation refers to

(i) the actual height of ionosphere

(ii) height calculated assuming wave reflection from a mirror

(iii) the maximum height of ionosphere

(iv) the height of the transmitting antenna.

(k) In a transferred electron device like Gunn diode, the negative resistance arises due to

(i) Domain formation (ii) Avalanche multiplication

(iii) Tunneling effect (iv) Transit time effect.

(l) The repeller in a reflex Klystron is used to

(i) accelerate electrons (ii) focus the electron beam

(iii) reverse the electron beam (iv) modulate the electron beam.

2. (a) Derive the condition for distortionless transmission.

(b) What is time delay in a transmission line? How does it relate to the phone constant?

(c) A co-axial cable with inner conductor diameter 2 mm and outer conductor diameter 8 mm has a dielectric with E_r = 2.25. Calculate the characteristic impedance, the capacitance per meter length. 4+(2+1)+(2+1)

3. (a) Explain the constructions and operating principles of slot lines and coplanar transmission lines.

(b) A lossless transmission line of $3\lambda/8$ with characteristic impedance 75Ω is terminated with a load of 150Ω. Calculate input impedance, reflection coefficient at input and standing wave ratio.

(c) What are the advantages and disadvantages of microstrip lines over conventional transmission lines? 4+(2+1+1)+2

4. (a) Derive the field equations for TM modes in a rectangular waveguide.

(b) What is meant by group velocity and phase velocity in a waveguide? How are they related?

(c) A circular waveguide has a radius of 2 cm. Calculate the cut-off frequency for the TE_{11} mode. (Given that the first root of $J_1'(x) = 0$ is 1.841). 5+(2+1)+2

5. (a) Explain the principle of operation of a directional coupler. What is its significance in microwave systems?

(b) Describe the construction and working principle of an isolator. How does it differ from a circulator?

(c) What factors determine the Q-factor of a rectangular cavity resonator? How can it be improved? 3+(3+1)+(2+1)

6. (a) Define the terms 'beam efficiency' and 'antenna noise temperature'. How are they related to performance of an antenna?

(b) Derive the expression for the far-field components of a small loop antenna. Compare its radiation pattern with that of a short dipole.

(c) An antenna has a gain of 15 dB and operates at 2 GHz. Calculate its effective aperture.

(2+2)+(3+2)+1

7. (a) Explain the working principle of a log-periodic antenna. What are its advantages over other broadband antenna?

(b) How does a helical antenna generate circularly polarized waves? Discuss its axial mode and normal mode of operation.

(c) Explain the concept of antenna arrays. How does the spacing between elements affect the radiation pattern? (2+1)+(2+2)+(2+1)

8. (a) Describe the formation of duct propagations. What meteorological conditions favour duct formation?

(b) Explain the working principle of TWT with necessary diagrams.

(c) How does an IMPATT diode generate microwave? (2+1)+4+3
