M.Sc. 2nd Semester Examination, 2025

ELECTRONICS

(Electromagnetism and Antennas)

PAPER — ELC-201

Full Marks : 50

Time : 2 hours

Answer any **four** questions each from Group-A and Group-B and **two** questions from Group-C

Attempt all the Parts of a question at one place only. Otherwise, marks will be deducted.

Use of Smith Chart is encouraged

Make necessary assumptions with justifications, if necessary

The figures in the right hand margin indicate marks

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

GROUP — A

Answer any four questions :   2 × 4

1. What are dual equations and dual variables in electromagnetics ?

2. At what condition a transmission line becomes distortion less ? What were Pupin and Heaviside's technique to solve it ?

3. In a region E and H fields are given by

    $$\vec{E} = 3j\hat{x} + 5\hat{y} + 4j\hat{z}, \ \vec{H} = 5\hat{x} + 7j\hat{y} + j\hat{z}$$

    Find the average power flow.

4. What is skip distance and virtual height in ionospheric propagation ?

5. What is the difference between a transmission line and a waveguide ? Give the necessary field distributions.

6. Give an example of a travelling antenna. What is its main advantage ?

GROUP – B

Answer any **four** questions : 4×4

7. Deduce Telegrapher's equation for transmission line.

8. Compute attenuation in one meter of a rectangular copper guide WR-90 (23 mm × 10 mm) at a frequency of 10 GHz and operating in TE_{10} mode. It is given that the conductivity of copper is 5.8×10^7 mho/meter.

9. Draw the E and H plane radiation patterns of a dipole antenna. Define directivity and half power beam width of an antenna.

10. Compute the far field of a center-fed dipole antenna of total length 10 cm carrying a current 1 mA (peak) at 10 GHz. Also compute the radiation resistance of the dipole.

11. Write down integral and differential forms of Maxwell's equations in its complete form.

12. The load impedance $100 - j50$ is to be matched to 50Ω using single stub. Find length and location of the stub.

GROUP – C

Answer any **two** questions : 8×2

13. Find expressions for the E_θ and H_Φ of a Hertz dipole.

14. A current element of length 2 cm is in air. It is oriented along the z axis of a rectangular coordinate system with its midpoint at the origin. It carries a current of

$$I = 5\cos(2\pi \times 10^6 t) A.$$

Find the magnetic vector potential at P(20m, 0, 25m) at $t = 1$ μsec.

15. Show that the quality factor of a transmission line resonator is $Q = \dfrac{\beta}{2\alpha}$. Where α and β are attenuation constant and propagation constants. A 50Ω low-loss transmission line has a loss of 2dB/m. The velocity of voltage wave on the line is 1.5×10^8 m/s. Find the Q-factor.

16. A 50Ω transmission line is terminated with load $Z_L = 60 + j50$. Use Smith chart to find RL, VSWR, maximum and minimum impedance and their distance from load, the input impedance at a distance 0.15λ away from the load, reflection coefficient at a distance 0.15λ away from the load.

[Internal Assessment — 10 Marks]