M.Sc. 1st Semester Examination, 2010

ELECTRONICS

(Electromagnetic Fields and Plasma Electronics)

PAPER—ELC-102

Full Marks : 50

Time : 2 hours

Answer **Q.No.1** and any **three** from the rest

The figures in the right-hand margin indicate marks

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

Illustrate the answers wherever necessary

1. Answer *all* questions of the following : 2×5

(*a*) Express the secondary constant of a transmission line in terms of its primary constants and its primary constants in terms of its secondary constants.

(*b*) A lossless transmission line is terminated in a short-circuit. What is the minimum length of the line so that the input impedance is capacitive ?

(*c*) A 2 m long air-filled rectangular waveguide of $a = 2$ cm and $b = 1$ cm supports the TM_{11} mode with a propagation constant of $\hat{\gamma}_{11} = j200$. What is the operating frequency of the waveguide ?

(*d*) A dipole antenna has a length of $\lambda/8$ m. What is its radiation resistance ?

(*e*) What is Debye screening distance ?

2. (*a*) Draw the equivalent electric circuit model for lossy transmission line.

(*b*) Obtain an expression for input impedance of a lossy line in terms of voltage reflection coefficient.

(*c*) A lossy transmission line is operated at 100 MHz and has $Z_c = (75 + j0)\,\Omega$, $\alpha = 0{\cdot}02$ Np /m and $\beta = 3$ rad/m. Determine the per-unit length resistance, inductance, capacitance and conductance of the line. 2 + 4 + 4

3. (*a*) A square, air filled waveguide operates in the TE_{22} mode at twice the cut-off frequency. If both components of the electric fields have amplitude 100 V/m, calculate the average power transmitted by the guide ?

(*b*) Obtain an expression for the average power transmitted by the same guide in TM_{11} mode. 5 + 5

4. (*a*) A rectangular cavity resonator made of copper has dimensions $a = 3$ cm, $b = 1$ cm and $l = 4$ cm, and operates at the dominant mode. Determine the resonant frequency and quality factor of this resonator. The conductivity of copper is $5{\cdot}76 \times 10^7$ S/m.

(*b*) An electric dipole of length 50 cm is situated in free space. If the maximum value of the current is 25 A and its frequency is 10 MHz. Calculate (*i*) the electric and magnetic fields in the far zone. (*ii*) the average power density (*iii*) the radiation resistance. 5 + 5

5. (*a*) Derive the expression for the field strength of space wave propagation in tropospheric conditions.

(*b*) Explain the terms 'skip distance' and 'critical frequency' in connection with sky wave propagation. 6 + 4

6. (*a*) Show that the critical frequency for propagation of e.m. waves in plasma is given by

$f_c = 9\sqrt{n_0}$, where n_0 = no. of electrons/m^3.

(*b*) Calculate the plasma frequency and maximum penetration depth for a plasma containing 10^{18} electrons/m^3.

(*c*) What is Debye screening distance? 4 + 4 + 2

[*Internal Assessment* : 10 Marks]