N.B. (1) Question No. 1 is compulsory.
(2) Attempt any **four** questions out of remaining **six** questions.
(3) **Figures** to the **right** indicate **full** marks.
(4) Vector notations should be used wherever **necessary**.
(5) Assume any **suitable data** whenever **required** but justify the **same**.

1. (a) Derive the boundary condition for the normal and tangential components of electric and magnetic field. **6**
(b) Derive the wave equation for homogeneous, unbound source free medium starting from Maxwell's equation. **6**
(c) A uniform plane wave in a medium having $\sigma = 10^{-3}$ s/m, $\epsilon = 80\ \epsilon_0$ and $\mu = \mu_0$ is having a frequency of 10 KHz. Find velocity of wave, wavelength, α, β, η. **8**

2. (a) State and prove Poynting theorem. Explain the terms instantaneous, average and complex Poynting vector. **10**
(b) In a non-magnetic medium **10**

$E = 4 \sin (2\pi \times 10^7 t - 0{\cdot}8x)\ \hat{a}_z$ v/m . Find—

(i) ϵ_r, η
(ii) The time average power carried by the wave.

3. (a) Derive the expression for the reflection and transmission coefficient for parallel polarised plane wave at oblique incidence. **8**
(b) An EM wave travels in free space with the electric field component $E = 100\ e^{j(0{\cdot}866y + 0{\cdot}5z)}\ \hat{a}_x$ v/m is incident on a dielectric medium having $\sigma = 0$, $\epsilon = 4\ \epsilon_0$, $\mu = \mu_0$ and occupying $z \geq 0$.
Calculate :—
(i) The angle of incidence, reflection and transmission **2**
(ii) The reflection and transmission coefficients **2**
(iii) The toal E field in free space **4**
(iv) The total E field in dielectric. **4**

4. (a) Derive an expression for the input impedance of a two wire transmission line. **10**
(b) A 2 m long lossless line has an impedance of 300 Ω. The velocity of propagation is $2{\cdot}5 \times 10^8$ m/s. The load has an impedance of 300 Ω with sending end voltage being 60 V at 100 MHz. Find : **10**
(i) The phase constant
(ii) The load voltage
(iii) The load current
(iv) The power delivered to the load
(v) The load reflection coefficient and standing wave ratio.

5. Explain briefly radiation from a short dipole in free space. Show that power radiated by the short dipole is $P_T = 80\ \pi^2\ I_{rms}^2 \left(\frac{dl}{\lambda}\right)^2$. Hence obtain the expression for radiation resistance. **20**

6. (a) Derive the expression for the field components of a transverse electric wave propagating through a rectangular waveguide. **12**
(b) An air filled rectangular waveguide of inside dimensions $7 \times 3{\cdot}5$ cm^2 operates in the TE_{10} mode. **8**
(i) Find cut-off frequency
(ii) Determine guide phase constant of the wave in waveguide at operating frequency of 3·5 GHz.
(iii) Determine guide wavelength at the same operating frequency.
(iv) Find 'Phase velocity' of the EM wave.

7. Write short notes on any **four** :— **20**
(i) Smith chart
(ii) Skin depth
(iii) Maxwell's equation for time varying field
(iv) Surface impedance of conductor
(v) Concept of retarded potentials
(vi) Parallel plane waveguides.

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