2020

Time : 2 hours

Full Marks : 70

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

The figures in the margin indicate full marks.

*Answer from **all** the Sections as directed.*

Section – I

(Objective Type Questions)

(Compulsory)

1. Choose the correct answer from the following : $2\times10 = 20$

(a) The electric and magnetic fields $\vec{E}$ and $\vec{H}$, respectively constituting the electromagnetic wave, differs is phase by :

(i) $\frac{\pi}{2}$

(ii) $\frac{\pi}{4}$

(iii) π

(iv) 0

(b) The poynting vector of e-m waves is represented by :

(i) $\vec{E} \times \vec{H}$

(ii) $\frac{E}{B}$

(iii) $\frac{E}{H}$

(iv) $\vec{E} \times \vec{B}$

(c) The ratio of electric and magnetic field vectors has the dimension of :

(i) Capacitance

(ii) Resistance

(iii) Inductance

(iv) Permitivity

(d) Optical fibre works on the principle of :

(i) Interference

(ii) Diffraction

(iii) Polarization

(iv) Total Internal Reflection

(e) The electric displacement vector $\vec{D}$ in a medium is

(i) $\vec{P}$

(ii) $\epsilon_0 E$

(iii) $\epsilon_0 E + P$

(iv) None of these

(f) $\vec{B}$ and $\vec{H}$ are related with :

(i) $BH = \mu$

(ii) $\mu B = H$

(iii) $B = \mu H$

(iv) None of these

(g) The Velocity of light c in free space is :

(i) $\sqrt{\mu_0 \epsilon_0}$

(ii) $\sqrt{\frac{\mu_0}{\epsilon_0}}$

(iii) $\sqrt{\frac{\epsilon_0}{\mu_0}}$

(iv) $\frac{1}{\sqrt{\mu_0 \epsilon_0}}$

(h) Refractive index μ is :

(i) $\frac{c}{v}$

(ii) $\frac{v}{c}$

(iii) cv

(iv) None of these

(i) The critical angle for two media with permittivities of 16 and 8 respectively, is :

(i) 30°

(ii) 45°

(iii) 60°

(iv) 90°

(j) The expression for the velocity of a wave in a conductor is :

(i) $v = \sqrt{2\omega/\mu\sigma}$

(ii) $v = \sqrt{2\omega\mu\sigma}$

(iii) $v = 2\omega/\mu\sigma$

(iv) $2\omega\mu\sigma$

Section – II

(Short-answer Type Questions)

Answer any three questions of the following : 10×3 = 30

2. Derive simple plane wave equation of an isotropic non-conducting medium.

3. What do you understand by Poynting vector ?

4. Show that the electromagnetic wave travel with velocity of light in free space.

5. Discuss the reflection and refraction of a plane electromagnetic wave at a plane boundary of two dielectric media and hence establish the law of reflection.

6. Discuss the Fresnel's theory of optical rotation.

7. What is optical fibers ? Define numerical Aperture.

8. Starting from the boundary condition satisfied by electromagnetic fields at an interface between two dielectric media, deduce Snell's law

9. For an optical fibre with refractive index of the core 1.47 and of its cladding 1.46, calculate the pulse dispersion per km.

Section – III

(Long-answer Type Questions)

Answer any one question :

10. (a) What is the equation of continuity ? Explain, how could Maxwell correct the present Ampere's law in its generalized form.

(b) Derive Maxwell's equations and give their physical interpretation. 20

11. (a) What is meant by Polarization of a uniform plane E. M. wave ?

(b) Derive the wave equation for a plane polarized E M wave having finite values of ϵ and μ in free space. 12+8 = 20

12. (a) Derive Fresdnel's relation for reflection and refraction of plane electromagnetic waves at interface between two dielectric media when the electric field vector of the incident wave is parallel to the plane of incidence.

(b) Discuss the phenomenon of total internal reflection on the basis of electromagnetic theory. Determine the change of phase in the reflected ray when it suffers a total internal reflection. 12+8 = 20

13. (a) A plane electromagnetic wave propagating in a conducting medium is characterized by the parameter ϵ, μ and σ. Show that propagation constant is complex in this case and is given by $\beta = \omega\sqrt{\epsilon\mu(1+i\sigma/(\omega\epsilon))}$

Hence discuss the propagation of electro-

magnetic waves in a good and a bad conductor. Here ϵ, μ and σ are the permittivity, permiability and conductivity of the medium, respectively.

(b) Calculate the skin depth for a conductor at 1GHz, given that $\sigma = 3.8 \times 10^7$ mho/m, $\mu = 2.57 \times 10^{-7}$ H/m. 15+5 = 20