2015

ELECTRONICS

[Honours]

PAPER — IV (Theory)

Full Marks : 100

Time : 4 hours

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

GROUP – A

Answer any two questions :   15 × 2

1. (*a*) Consider the propagation of a plane electromagnetic wave through an isotropic dielectric medium of permiability μ and permittivity ϵ.

(i) Write the Maxwell's equations in this case.

(ii) Show that velocity of the EM wave is $v = \dfrac{1}{\sqrt{\in \mu}}$.

(iii) Show that electric field and magnetic fields are in phase.

(iv) Find out the expression of wave impedance in this case.

(v) Show that energy is equally shared between magnetic and electric fields.

(b) Using Maxwell's field equations find out the expression of field and show that the field amplitudes are spacially attenuated— if the EM wave propagates through a homogeneous isotropic conducting medium.

$$(1+3+3+1+3)+4$$

2. (a) What do you mean by waveguide ?

(b) Considering Transverse Electric (TE) waves propagating along a rectangular waveguide

with perfectly conducting walls, find the cut-off wavelength (λ_c) and guide wavelength (λ_g).

(c) Show that

$$\frac{1}{\lambda_0^2} = \frac{1}{\lambda_c^2} + \frac{1}{\lambda_g^2}$$

where λ_0 is the corresponding free space wavelength and λ_c and λ_g are as stated above.

(d) What is the velocity of energy propagation through the waveguide ?

(e) Consider a highly conducting rectangular waveguide of infinitely long along z-axis with a 2 cm along x-axis and 1 cm along y-axis. An EM wave is propagating along the guide in TE_{10} mode. Find the value of guide wavelength and the speed of propagation of EM energy along the guide. Given $\lambda_0 = 3$ cm. $\qquad 2+6+2+2+3$

3. (a) Explain the significance of Einstein's A and B coefficients. Write down the rate equation for thermal equilibrium.

(b) Describe qualitatively how a He-Ne laser works with energy level diagrams of the relevant atoms involved.

(c) In connection of the operation of laser action, explain the concept of negative temperature.

(d) A He-Ne laser, transition from 3S to 2P level gives a laser of $\lambda = 632\cdot8$ nm. Calculate the pumping energy required for this. Assume that no loss in the He-Ne laser and the energy of the 2P level is equal to $1\cdot52\times10^{-19}$ J. $(3+2)+5+2+3$

GROUP – B

Answer any **five** questions : 8×5

4. Explain the phenomena of selective fading in communication system through tropospheric wave. What do you mean by maximum usable frequency (MUF) ? $6+2$

5. Derive the general dispersion formula and explain the phenomenon of anomalous dispersion. Under what conditions does the normal dispersion occur ?   6 + 2

6. (a) Briefly discuss the working principle of a fiber guide.

   (b) What do you mean by numerical aperture of a fiber ? Derive the expression of numerical aperture in a step-index fiber.   3 + (2 + 3)

7. (a) What are the characteristics of a holographic image ? Explain the construction and reconstruction process of a hologram.

   (b) Write the main difference between ordinary photography and holography.   2 + 4 + 2

8. (a) Consider the propagation of EM wave through a dilute ionised gas. Derive the expression of medium refractive index in terms of electron plasma frequency and angular frequency of the wave.

   (b) Discuss the possibilities of total internal reflection of radio waves from the ionosphere.
                                           5 + 3

9. (a) State and establish Poynting's theory. Compare it with the equation of continuity and give an interpretation of Poynting vector.

(b) The electric field associated with an EM wave is

$$\vec{E} = \hat{x} E_0 \cos(kz - wt) + \hat{y} E_0 \sin(kz - wt)$$

where E_0 is a constant. Find out the corresponding magnetic field $\vec{H}$ and the corresponding Poynting's vector.   5 + 3

10. (a) Explain the terms Data Bus, Address Bus and Control Bus.

(b) Explain the difference between

(i) Compiler and interpreter

and (ii) Source program and object program.
                                                    5 + 3

11. (a) What do you mean by flowchart ? Write the advantages of using flowchart. Explain various flowchart symbols.

(b) Write the algorithm and draw the flowchart to solve a linear equation

$$Ax + B = C$$

where A is not equal to zero. $(1 + 2 + 2) + 3$

GROUP – C

Answer any **five** questions : 4×5

12. (a) Describe the working principle of a phototransistor.

 (b) Explain how LED generates light. $2 + 2$

13. Briefly explain the effects of Earth's magnetic field on the propagation of radio waves.   4

14. What is a LAN ? Write the difference between LAN and WAN. Give one example of each. $1 + 2 + 1$

15. Write a short note about Ethernet Protocol.   4

16. Define displacement current. An alternating emf $E = E_0 \cos wt$ of frequency 10^{20} Hz is applied to a conductor. Prove that the displacement current

in the conductor is much greater than the conduction current. Given σ of the conductor is 10^3 ohm/m.   1+3

17. Derive the expression of the retarded potential of an oscillating electric dipole.   4

18. Write a short note about RAM and ROM.   2+2

19. Explain some mechanisms that are responsible for absorption losses in optical signal through a fiber. What are the necessity of repeaters in a fiber optic link ?   3+1

[*Internal Assessment* : 10 marks]

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