PONDICHERRY UNIVERSITY-3623016

B. Tech. DEGREE EXAMINATION, NOVEMBER 2012

Third Semester-Electronics and Communication Engineering

ENGINEERING ELECTROMAGNETICS

Time: Three hours Maximum : 75 marks

PART A — (10 × 2 = 20 marks)

Answer ALL questions. All questions carry equal marks.

1. State Divergence theorem.
Ans 1. For answer refer: **Page 30, topic 1.6.3**; Take statement with Formula.

2. What is the physical significance of div D?
Ans 2. $\nabla \cdot D = \rho_v$. where D = Electric flux density and ρ_v = Volume charge density. This represents the presence of the positive charge in the surface enclosed. The divergence operator when applied to a vector function gives the rate per unit volume at which the physical quantity is issuing from the point.

3. Write down the magnetic boundary conditions.
Ans 3. For answer refer: **Page 132 and 133**;

$$\mu_1 H_{1n} = \mu_2 H_{2n} \qquad (1)$$

$$H_{1t} - H_{2t} = k \qquad (2)$$

4. Define potential difference.
Ans 4. For answer refer: **Page 55; topic 2.1**.

5. What is the expression for energy stored and energy density in a magnetic field?
Ans 5. For answer refer: **Page 138 &139; topic 3.14 and 3.14.1**.

$$E = \frac{1}{2} LI^2; \qquad E = \frac{1}{2} \mu H^2$$

6. State Biot-Savart's law.
Ans 6. For answer refer: **Page 107, topic 3.4**, along with diagram & formula.

7. State Faraday's Law of Electromagnetic induction with a mathematical expression.
Ans 7. For answer refer: **Page 154, topic 4.2**.

8. A circular disc of radius 'a' m is charged with a charge density of 6C/m^2. Find the electric field intensity at a point 'h'm from the disc along its axis.
Ans 8. For answer refer: **Page 37, topic 1.8.3 ending**.

$$E = \left(\frac{\rho_s}{2\varepsilon_0}\right)(1 - \cos\psi)$$

$$\cos\psi = \frac{adj}{hyp} = \frac{h}{\sqrt{a^2 + h^2}}$$

$$\rho_s = 6 \text{ C/m}^2$$

$$E = \frac{6}{2\varepsilon_0}\left[1 - \frac{h}{\sqrt{a^2 + h^2}}\right].$$

9. Write down Maxwell's equation in integral form.
Ans 9. For answer refer: **Page 155, topic 4.3 (b)**.

10. What is meant by Poynting vector?
Ans 10. For answer refer: **Page 204**, first greyed box.

PART B – (5 × 11 = 55 marks)

Answer ALL question, One from each Unit. All questions carry equal marks.

UNIT I

11. Obtain an expression for electric field intensity at a point due to a line charge distribution of infinite length.
Ans 11. For answer refer: **Page 33, topic 1.8.1** till page 35 case (ii) for infinitely long wire. [skip case (i)]

(Or)

Second Approach: State Gauss's law from **Page 37, topic 1.9**, grey box ; and topic 1.9.3 "infinite line charge."

Or

12. State and prove Gauss's law and describe any one application of Gauss's law.
Ans 12. For answer refer: **Page 37, topic 1.9**, grey box statement; topic 1.9.1 proof; and 1.9.3 Application to infinite line charge.

UNIT II

13. An insulating sphere of radius a carries "a" total charge Q, which is uniformly distributed over the volume of the sphere. Use Gauss's Law to find the electric field distribution both inside and outside the sphere.
Ans 13. For answer refer: **Page 40, topic 1.9.5** "volume charge" for any point outside the sphere.

Note: Take radius of sphere as "a" and not "r_1"

Or

14. Explain in detail about the boundary conditions for current density.
Ans 14. For answer refer: **Page 80, Topic 2.11** boundary conditions. (till page 81, above the greyed question.)

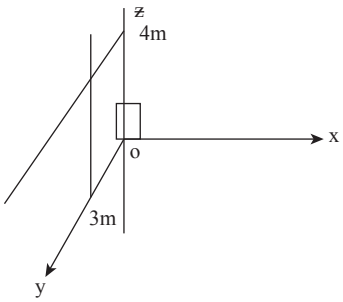
UNIT III

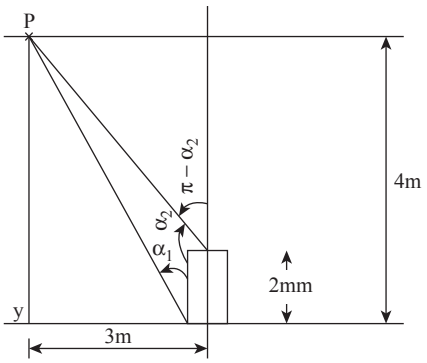
15. Obtain the magnetic field intensity at a point due to current carrying conductor.
Ans 15. For answer refer: **Page116, Topic 3.7.1** till Page 117 end.

Or

16. A small current element at the origin has a length of 2.0 mm and carries a current of 2.0 A in the + direction. Find the magnitude and direction of the magnetic field due to the current element at the point (0, 3.0m, 4.0m).
Ans 16. Data: Length = 2.0 mm

$I = 2$ A
Direction = +Z direction
$P(x, y, z) = P(0, 3, 4)$





Taking only *y–z* plane, we have,

$$H = \left(\frac{I}{4\pi h}\right)\left[\cos\alpha_1 + \cos\alpha_2\right]\hat{a}_x$$

$$\alpha_1 = \tan^{-1}\left(\frac{3}{4}\right) = 36.87°$$

$$(\pi - \alpha_2) = \tan^{-1}\left(\frac{3}{3.998}\right) = 36.88°$$

$$= \alpha_2 = \pi - 36.88 = 143.12°$$

$$\vec{H} = \frac{2}{4\pi(3)}\left[\cos 36.87 + \cos 143.12\right] = 5.55\mu H.$$

UNIT IV

17. Derive an expression for the energy stored in the magnetic field of coil possessing an inductance of L Henry, when the current in the coil is I amps.
Ans 17. For answer refer: **Page138, Topic 3.14** "energy stored in magnetic field".

Or

18. What is meant by motional EMF and derive the expression for Motional EMF?
Ans 18. For answer refer: **Page 157, topic 4.2.2** "Motional EMF".

UNIT V

19. State and prove Poynting theorem.
Ans 19. For answer refer: **Page 204**, Poynting theorem greyed box till Page 205 till

$$\oint_s \left(\vec{E} \times \vec{H}\right) ds = \frac{-\partial}{\partial t} \int_v \left[\frac{1}{2}\mu H^2 + \frac{1}{2}\varepsilon E^2\right] dv - \int_v E \cdot J dv.$$

Or

20. Derive the expression for Maxwell equation, integral form and convert them into differential form.
Ans 20. For answer refer: **Page 163, topic 4.5.2** Derivation of Maxwell's equations till Page 166 $\Rightarrow \nabla \cdot B = 0$.