Total No. of Questions : 8] [Total No. of Printed Pages : 3

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EE/EX–401(N)

B. E. (Fourth Semester) EXAMINATION, June, 2011

(Common for EE & EX Engg.)

ELECTRO-MAGNETIC THEORY

Time : Three Hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : Attempt any *five* questions. All questions carry equal marks.

1. (a) Explain physical significance of gradient of a scalar, divergence of a vector and curl of a vector. 10

   (b) Transform the vector field $F = 2r\cos\phi\, a_r + a_\phi$ into Cartesian co-ordinates and evaluate it at P (4, − 2, 3). Also find a unit vector a_F at P. 10

2. (a) Apply Gauss's law to a differential volume element and obtain expression for total charge enclosed. 12

   (b) Show that the energy stored in electric field is given by : 8

$$W_E = \frac{1}{2}\int_{vol} \rho_v V\, dv$$

3. (a) Starting from current density J obtain the current continuity equation. 8

P. T. O.

   (b) At the boundary of two perfect dielectric materials ε_1 and ε_2, D_1 is incident at an angle θ_1 with respect to normal to the boundary surface. Prove that : 12

$$D_2 = D_1\left[\cos^2\theta_1 + \left(\frac{\varepsilon_1}{\varepsilon_2}\right)^2 \sin^2\theta_1\right]^{1/2}$$

4. (a) Derive Poisson's equation and Laplace's equation from the point form of Gauss's law. 8

   (b) For the configuration of Fig. 1, find the V and E for $0 < \phi < \alpha$ using Laplace equation. Hence find the capacitance of the system of Fig. 2 12

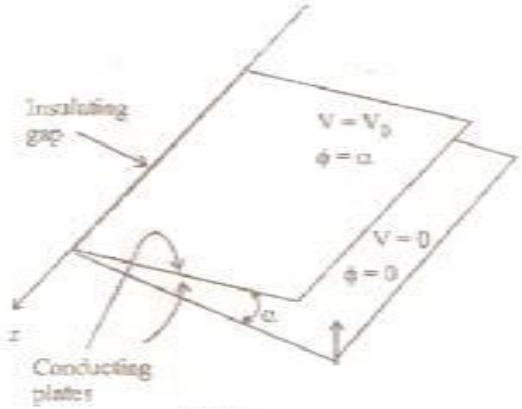

Fig. 1

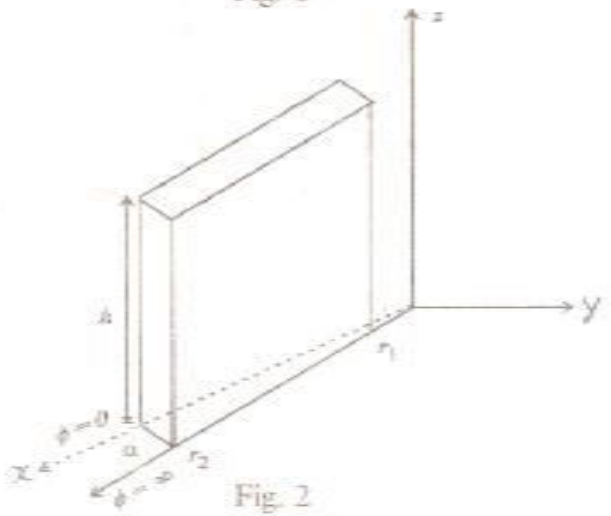

Fig. 2

5. (a) Explain Biot-Savart law. Derive an expression for magnetic field of a current carrying loop. 10

(b) Show that at a boundary between two dielectrics. the tangential component of H and normal component of B must be continuous. 10

6. (a) Derive the point form of Ampere's circuital law. 10

(b) A rectangular loop shown in the Fig. 3 has dimensions 1 m by 2 m (as shown) and lies in the uniform field $B = -6\,a_y + 8\,a_z$T.

The loop current is 10 mA. Find the vector force on each side of the loop. 10

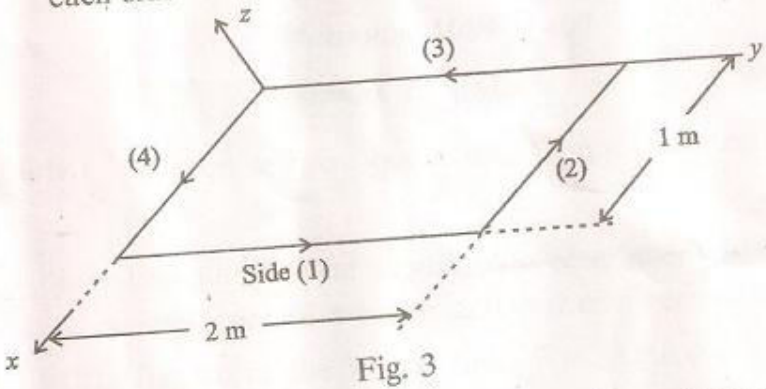

Fig. 3

7. (a) Write Maxwell's equations in vector form, differential form, scalar form and integral form. State the physical significance of equations in integral forms. 12

(b) What is meant by displacement current density ? Derive continuity equation for time varying field. 8

8. Derive the relation between E and H in a uniform plane wave and show that an electromagnetic wave : 20

$$E_y = A \cos \omega (t - x/v)$$

$$H_z = (A/n) \cos \omega (t - x/v)$$

7,100