

**B 2162**

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2007.

Third Semester

Electronics and Communication Engineering

EC 233 — ELECTROMAGNETIC FIELDS

Time : Three hours

Maximum : 100 marks

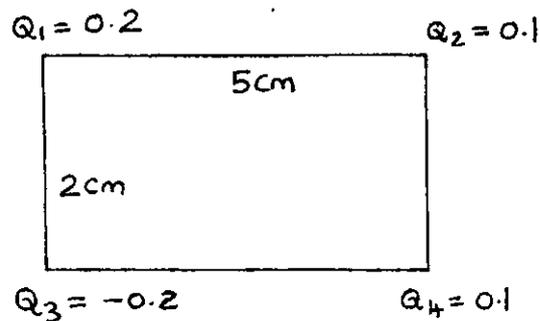
Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Express "Stoke's Theorem" in mathematical form.
2. State Gauss's Law.
3. What is the significance of the Biot-Savart's Law?
4. Find maximum torque on an 85 turn rectangular coil, 0.2 m by 0.3 m, carrying a current of 2.0 A in a field  $B = 6.5$  tesla.
5. What is Polarization?
6. Find the electric field intensity in a material for which the electric susceptibility is 3.5 and  $P = 2.3 \times 10^{-7} C/m^2$ .
7. Define Reluctance.
8. Two coils with negligible resistance and of self inductances of 0.2 H and 0.1 H respectively are connected in series. If their mutual inductance is 0.1 H determine the effective inductance.
9. What is displacement current?
10. What is Poynting vector?

PART B — (5 × 16 = 80 marks)

11. (a) (i) State and explain Coulomb's Law.  
 (ii) Four concentrated charges are located at the vertices of a plane rectangle as shown in fig below. Find the magnitude and direction of resultant force on  $Q_1$ . All charges are in Micro coulombs.



- (iii) A circular disc of radius 'a' is charged uniformly with a charge density of  $\sigma$  cou/m<sup>2</sup>. Find the electric field intensity at a point 'h' meters from the disc along its axis. (4 + 5 + 7)

Or

- (b) (i) Derive the expression for electric field intensity at a point due to an array of point charges.  
 (ii) Three point charges in free space are located as follows,  $+5 \times 10^{-8}$  C at (0,0) m;  $+4 \times 10^{-8}$  C at (3,0) m,  $-6 \times 10^{-8}$  C at (0,4) m.  
 (1) Find the electric field intensity at (3,4) m.  
 (2) What is the total electric flux emanating from a sphere of 5 m radius with center at (0,0)? (8 + 8)

12. (a) (i) Explain the Ampere's law for the static magnetic field.  
 (ii) A thin cylindrical conductor of radius 'a' infinite in length carries a current I. Find H at all points using Ampere's law. (8 + 8)

Or

- (b) (i) Consider a solenoid in a uniform magnetic field of flux density 'B' wb/m<sup>2</sup>. Obtain the expression for the torque on the solenoid.  
 (ii) A conductor located at  $x = 0.4$  m;  $y = 0$  and  $0 < z < 2.0$  m carries a current of 5.0 A in the  $a_z$  direction. Along the length of conductor  $B = 2.5 a_z$  T. Find the torque about Z axis. (8 + 8)

13. (a) (i) Derive the condition at a boundary between two dielectrics with different properties.
- (ii) A dielectric slab of flat surface with relative permittivity 4 is disposed with its surface normal to a uniform field with flux density  $1.5 \text{ C/m}^2$ . The slab occupies a volume of  $0.08 \text{ m}^3$  and is normally polarized. Determine
- (1) The polarization in the slab and
- (2) The total dipole moment of the slab. (8 + 8)

Or

- (b) Derive the expression for the following :
- (i) Capacitance of spherical conductor consisting two concentric spheres of radii  $a$  and  $b$ , the dielectric medium between the two spheres being air.
- (ii) Capacitance of coaxial cable with two dielectrics  $\epsilon_1$  and  $\epsilon_2$ . (8 + 8)
14. (a) (i) Consider a co-axial transmission line with conducting cylinders of radii  $a$  (internal) and  $b$  (external). Derive the expression for inductance of transmission line per unit length.
- (ii) Write short notes about magnetization curve and hysteresis loop of toroid with ferromagnetic core. (10 + 6)

Or

- (b) (i) Derive the boundary conditions for two different media in the magnetic field.
- (ii) A toroid has the dimensions  $15 \times 10^{-2}$  metre mean radius and  $2 \times 10^{-2}$  metre radius of circular cross section and is wound with 1000 turns of wire. The toroid material is iron with an effective relative permeability of 1400 when the current is 0.7 ampere. Calculate the total flux
- (1) with no air gap
- (2) with an air gap of  $10^{-3}$  metre. (8 + 8)

15. (a) Derive the Maxwell's equations in both differential and integral form from
- (i) Ampere's law
- (ii) Faraday's law
- (iii) Gauss law.

Or

- (b) (i) Derive the expression for the Poynting vector to express the power flow in a dielectric.
- (ii) Find the frequency at which conduction current density and displacement current density are equal in
- (1) distilled water, for which  $\epsilon_r = 81$  and  $\sigma = 2.0 \times 10^{-4}$  mho/m.
  - (2) sea water, for which  $\epsilon_r = 1$  and  $\sigma = 4.0$  mho/m. (8 + 8)
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Time :

1. D  
ci

2. B  
B

3. D

4. C  
M

5. V

6. A  
a  
T

7. V