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17EC36

Third Semester B.E. Degree Examination, Dec.2019/Jan.2020
Engineering Electromagnetics

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Obtain an expression for electric field intensity at any given point due to 'n' number of point charges. **(04 Marks)**

b. Four 10 nC positive charges are located in the z = 0 plane at the corners of a square 8 cm on a side. A fifth **10** nC positive charge is located at a point 8 cm distant from the other charges. Calculate the magnitude of the total force on this fifth charge for e = e $_0$. **(08 Marks)**

c. Find the total charge contained in a 2 cm length of the electron beam for 2 cm < z < 4 cm, p = 1 cm and p_v = —5 e^{-100}PII.ic/m^3. **(08 Marks)**

OR

2 a. Define electric flux and electric flux density, and also, obtain the relationship between electric flux density and electric field intensity. **(06 Marks)**

b. Infinite uniform line charges of 5 nC/m lie along the (positive and negative) x and y axes in free space, Find E at P(1, 2, 3). **(10 Marks)**

c. Given a 60 JAC point charge located at the origin, find the total electric flux passing through:

(i) That portion of the sphere r = 26 cm bounded by 0 < 0 < $\frac{Tr}{2}$ and 0 < 14)r < $\frac{Ir}{2}$.

(ii) The closed surface de fined by p = 26 cm and z = ±26 cm. **(04 Marks)**

Module-2

3 a. State and obtain mathematicall f l i of Gauss law. **(07 Marks)**

b. Given D = 6p sin $\frac{1}{2}$ a, + p cos $\frac{0)}{2}$ a $_m$ C/m^2. Evaluate both sides of divergence theorem for the region bounded by ***p*** **=** 2m, sir = 0, (1) = 7c rad, z = 0 and z = 5m. **(08 Marks)**

c. Derive the point form of current continuity equation. **(05 Marks)**

OR

4 a. Given the non-uniform field E = y x + x a' $_y$ + 2 'a, V/m, determine the work expended in carrying 2C from B(1, 0, 1) to A(0.8, 0.6, 1), along the shorter arc of the circle; $x^2 + y^2$ =1, z = 1. **(07 Marks)**

b. Derive the expression for potential field resulting from point charge in free-space. **(07 Marks)**

c. Find the value of volume charge density at p(r = 1.5 in, 0 = 30°, (I) = 50°), when D= 2rsin Ocos4;lar+reosecos(1)au—rsin4la, C/m^2. **(06 Marks)**

Module-3

5 a. Using Gauss law derive Poisson and Laplace equations. **(05 Marks)**

b. State and prove uniqueness theorem. **(10 Marks)**

c. Calculate A 1-12 at P_2(4, 2, 0) resulting from I A L = 2rc az1.1Am at P1(0, 0, 2). **(05 Marks)**

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OR

6 a. Show that $\nabla^2 V = 0$, for V = (5p ^{4} — 6p $^{-4}$)sin44). **(05 Marks)**

b. Evaluate both sides of Stoke's theorem for the field H = 6xy 3y ^{2} a $_y$ A/m and the rectangular path around the region, 2 x S 5, —1 y 1, z = 0. Let positive direction of d; be a, . **(08 Marks)**

c. State and explain Ampere's circuital law. Using the same, obtain the expression for H at any given point due to the infinite length filamentary conductor, carrying current **I.** **(07 Marks)**

Module-4

7 a. Obtain an expression for Lorentz force equation. **(05 Marks)**

b. Obtain the relationship between magnetic fields at the boundary of two different magnetic media. **(09 Marks)**

c. Derive the expression for force between two infinitely long. Straight, parallel filamentary conductors, separated by distance d, carrying equal and opposite currents, I. **(06 Marks)**

OR

8 a. Given a ferrite material which operates in a linear mode with **B =** 0.05 T, calculate value.,::: for magnetic susceptibility, magnetization and magnetic field intensity. Given J. = 50. **(05 Marks)**

b. Obtain expressions for magneto motive force (mmf) and reluctance in magnetic circuits by making use of analogy between electric and magnetic circuits. **(08 Marks)**

c. Two differential current elements, 1 $_i$ALI = 3(10 $^{-6}$) a $_y$ Am at P $_1$(1, O, O) and I,AL2 =3(10 $^{-6}$)(-0.5ax+ 0.4a, + 0.3az) Am at P2(2, 2, 2) are located in free space. Find vector force exerted on 1 $_1$ 01,2 by 1, 4 L, . **(07 Marks)**

Module-5

9 a. Explain the inadequacy of Ampere's circuital law for time-varying fields. Obtain a suitable correction for the same, which will remain consistent for both time and non-time-varying fields. **(05 Marks)**

b. Let pt = 10 $^{-5}$ H/m, E = 4 x le F/m, 6 = 0 and p, = 0. Find K (including units) so that the following pair of fields satisfy Maxwell's equations: E = (20y —Kt)ax V/m ;— **H** =(y + 2x 10 ^{6} t) , A/m. **(05 Marks)**

e. Starting from Maxwell's curl equation, obtain the equation of Poynting's theorem and interpret the same. **(10 Marks)**

OR

10 a. Express Maxwell's equations in phasor form as applicable to free-space. Using the same, obtain vector Helmholtz equation in free space. **(09 Marks)**

b. Obtain an expression for skin depth when an electromagnetic wave enters a conducting medium. Also, calculate the skin depth when a 160 MHz plane wave propagates through aluminum of conductivity 10 ^{5} U/m, E $_r$ = M $_r$ = 1 **(05 Marks)**

c. Starting from equation of Faraday's law, obtain the point form of Maxwell's equation concerning spatial derivative of E and time derivative of H .