4E2088

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B. Tech. (Sem. IV) (Main / Back) Examination, June/July - 2013
Electronics & Comm. (Common for 4EC4, 4EI62 & 4BM6.2)
4EC4 Electromagnetic Field Theory

Time : **3** Hours] [Total Marks : **80**
[Min. Passing Marks : **24**

Attempt any five questions, selecting one question from each unit. All questions carry equal marks. Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly.
Units of quantities used/calculated must be stated clearly.

Use of following supporting material is permitted during examination.
(Mentioned in form No. 205)

1. Calculator 2. NIL

UNIT - I

1 (a) Express the vector field $\vec{A} = xy^2z\,\vec{a_x} + x^2yz\,\vec{a_y} + xyz^2\,\vec{a_z}$ in cylindrical and spherical coordinates at (3, –4, 5). **10**

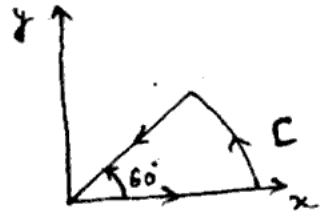
(b) Determine the divergence and curl of vector $\vec{A} = \rho z \sin\phi\,\vec{a_\rho} + 3\rho z^2\cos\phi\,\vec{a_\phi}$ at $\left(5, \pi/2, 1\right)$ **3×2**

OR

1 (a) Verify the divergence theorem for vector $\vec{A} = \rho^2\cos^2\phi\,\vec{a_\rho} + z\sin\phi\,\vec{a_\phi}$ over closed surface of the cylinder $0 \le z \le 1,\ \rho = 4$. **8**

(b) Give physical interpretation of gradient of a scalar. **4**

(c) Calculate the circulation of vaector $\vec{A} = \rho\cos\phi\,\vec{a}_\rho + z\sin\phi\,\vec{a}_z$ around the edge C of the wedge defined by $0 \le \rho \le 2, 0 \le \phi \le 60^\circ$ and $z = 0$.



4

UNIT - II

2 (a) Find the flux density at a point $P(6,4,-5)$ cased by
(i) a point charge of 20mC at the origin
(ii) a uniform line charge $\rho_L = 20\,\mu C/m$ on the z-axis and
(iii) a uniform charge density $\rho_S = 60\,\mu C/m^2$ at a plane $x = 8$.

6

(b) Given the potential $V = \dfrac{10\sin\theta\cos\phi}{r^2}$, calculate the work done in moving a $10\mu C$ charge from point A $\left(1, 30^\circ, 120^\circ\right)$ to point $B\left(4, 90^\circ, 60^\circ\right)$.

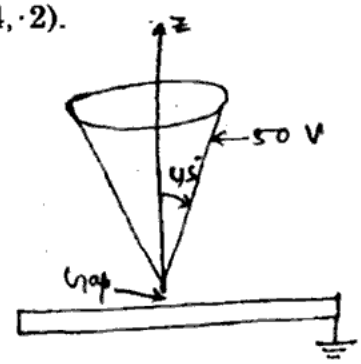
2

(c) Derive the expression of energy density in electrostatic fields.

8

OR

2 (a) A large conducting cone $\left(\theta = 45^\circ\right)$ is placed on a conducting plane with a tiny gap separating it from the plane as shown in figure. If the cone is connected to a 50 volt source, find V and $\vec{E}$ at (–3, 4, 2).



8

(b) Explain the field determination by method of images.

8

UNIT - III

3 (a) Derive Bio-Savart's law and Ampere's law using vector magnetic potential. Why it should be a vector, whereas the analogous quantity in electric field is voltage, that is scaler quantity.

4+2

(b) The positive y-axis (semi-infinite line with respect of the origin) carries a filamentary current of 2A in the $-\vec{a}y$ direction. Assume it is part of a large circuit. Find $\vec{H}$ at (2, 3, 0).

6

(c) The radii of the inner and outer conductors of a coxial cable are 2mm and 6mm respectively. $\mu = \mu_0$, find the inductance of a 10m long cable.

4

OR

3 (a) A current distribution gives rise to the vector magnetic potential $\vec{A} = x^2 y\,\vec{a_x} + y^2 x\,\vec{a_y} - 4xyz\,\vec{a_z}$ Wb/m. Calculate $\vec{B}$ at (–1, 2, 5) and the flux through the surface defined by $z = 1,\ 0 \le x \le 1,\ -1 \le y \le 4$.

6

(b) Two homogeneous, linear and isotropic media have an interface at $x = 0$, $x < 0$ describes medium 1 and $x > 0$ describes medium 2. $\mu_{r1} = 2$ and $\mu_{r2} = 5$. The magnetic field in medium 1 is $\vec{H_1} = 150\,\vec{a_x} - 400\,\vec{a_y} + 250\,\vec{a_z}$ A/m.

Determine :

(i) Magnetic field in medium 2.
(ii) Magnetic flux density in medium 1.
(iii) Magnetic flux density in medium 2.

6

(c) The core of a toroid is $12cm^2$ and is made of material with $\mu_r = 200$. If the mean radius of the toroid is 50 cm, calculate the number of turns needed to obtain an inductance of 2.5 H.

4

UNIT - IV

4 (a) Solve the wave equation for a uniform plane wave in an isotropic homogeneous lossy dielectric medium with no sources. Calculate the propagation constant, attenuation constant and phase constant.

8

(b) A uniform plane wave in a medium having $\sigma = 10^{-3}\ s/m$, $\varepsilon = 80\,\varepsilon_0$ and $\mu = \mu_0$ is having a frequency of 10 kHz. Explain the nature of given media. Calculate

(i) Attenuation constant
(ii) Phase constant
(iii) Intrinsic impedance
(iv) Wavelength
(v) Velocity of wave.

8

OR

4 (a) Derive expression for reflection coefficient and transmission coefficient for $\vec{E}$ and $\vec{H}$ fields when an electromagnetic wave is incident normally on the boundary separating two different media

(i) conducting
(ii) perfectly dielectric.

8

(b) In a nonmagnetic medium $(\mu = \mu_0)$

$\vec{E} = 4\sin\left(2\pi \times 10^7 t - 0.8x\right)\vec{a_z}\ V/m$ find

(i) ε_r, η
(ii) The time average power carried by the wave and
(iii) The total power crossing 100cm^2 of plane $2x + y = 5$.

8

UNIT - V

5 (a) Discuss radiation from a small current element (Hertzain dipole) and hence calculate value of radiated power and radiation resistance.

10

(b) Explain the retarded potentials.

6

OR

5 (a) What do you understand by EMI and EMC ? Discuss different methods to eliminate EMI.

10

(b) Calculate the power radiated and radiation resistance by a hertzian dipole of length $\frac{l}{40}$ in free space if it carries a uniform current of $I = 0.5$ Amp.

6
