RM-6491/500

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B. E. II (Sem. IV) (Electronics & Communication) Examination

May / June – 2010

Electromagnetics

Time : 3 Hours] [Total Marks : 100

Instruction :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :
☛ B. E. 2 (Sem. 4) (Electronics & Communication)

Name of the Subject :
☛ Electromagnetics

☛ Subject Code No. : 6 4 9 1 ☛ Section No. (1, 2,.....) : 1&2

Seat No. :

Student's Signature

(2) Answers to **two** sections must be written in **separate** answer sheets.
(3) Draw the neat diagrams whenever necessary.
(4) Assume suitable data wherever required.
(5) Use formula list if necessary.

SECTION - I

1 (a) Answer the following : **5**

(i) Which of the following is not a vector?
- (a) Force
- (b) acceleration
- (c) weight
- (d) momentum

(ii) Which of the following is zero?
- (a) grad div
- (b) curl grad
- (c) div grad
- (d) curl curl

(iii) Express P (2, 30^o, 5) in cartesian coordinates.

(iv) Express Maxwell's first and second equation.

(v) Define : Electric field intensity due to point charge.

(b) Match the following : 5

A		B	
(i)	Gauss Law	(1)	$\oint \bar{D} \cdot \bar{ds} = \int_v \nabla \cdot \bar{D} dv.$
(ii)	Point form of Gauss law	(2)	$\nabla \cdot \bar{J} = -\frac{d\rho_v}{dt}$
(iii)	Divergence theorem	(3)	$\psi = \int_s \bar{D} \cdot ds = Q$
(iv)	Point form of continuity equation	(4)	$\bar{J} = \sigma \bar{E}$
(v)	Point form of Ohm's law	(5)	$div\ \bar{D} = \rho v.$

(c) Determine gradient of following scalar fields. 5

(i) $U = x^2y + xyz$

(ii) $V = \rho z \sin\phi + Z^2 \omega s^2 \phi + \rho^2$

(iii) $f = \cos\theta \sin\phi \ln r + r^2\phi$

(d) Infinite uniform line charge of 5 nc/m lie along the positive and negative x and y axes in free space. Find E at P_A (0, 0, 4). 5

2 (a) Applying Gauss's law to a small differential volume, derive expression of flux density D. 8

(b) Given the electric flux density $D = 0.3\ r^2 ar\ nC/m^2$ in free space : 7

(i) Find E at point P (r=2, $\theta = 25^o$, $\phi = 90^o$)

(ii) Find the total charge within the sphere r = 3.

(c) Find the total electric flux leaving the sphere r = 4.

OR

2 (a) Explain electric dipole. Derive the expression of electric field due to electric dipole at a given point. 8

(b) An electric field is expressed in rectangular coordinates by 7

$E = 6x^2ax + 6yay + 4az$ V/m.

Find

(i) V_{MN} if M and N are specified by M (2,6, -1) and N (-3, -3, 2)

(ii) V_M if V = 0 at Q (4, -2, -35)

(iii) V_N if V = 2 at P (1, 2, -4)

3 Attempt any **three** : **15**

(i) Potential gradient

(ii) Continuity of current

(iii) Boundary conditions between conductor and free space

(iv) Uniqueness Theorem

(v) Capacitance.

SECTION - II

4 (a) Answer the following in brief : **10**

(i) State and explain Stokes Theorem.

(ii) The net magnetic flux through a closed surface is zero. State true or false. Justify your answer.

(iii) Define magnetic torque and moment.

(iv) State the Maxwells equations for static Electromagnetic, magnetic fields.

(v) Comment on the vector field if $\nabla . A = 0$ and $\nabla \times A = 0$.

(b) Match the following : **5**

	A		B
(i)	Biot-Savart Law	(a)	$A = \frac{\mu\ m \times a_r}{4\ \Pi\ R^2}$
(ii)	Amperes Circuital Law	(b)	$V_{emf} = -N\ d\Phi/dt$
(iii)	Lorentz Force Equation	(c)	$F = Q(E + u \times B)$
(iv)	Faradays Law	(d)	$\int H \cdot dl = I_{enclosed}$
(v)	Magnetic Vector Potential	(e)	$dH = \frac{I\ dl \times R}{4\ \Pi\ R^3}$

(c) State the analogy between Electric and Magnetic Circuits. **5**

5 (a) Explain the concept of Magnetic Scalar and Vector Potential. **8**

(b) A current element of length 2 cm is located at the origin in free space and carries current 12 mA along a_x. A filamentary current of $15a_z$ A is located along x = 3, y = 4. Find the force on the current filament. **7**

OR

5 (a) State and explain the Magnetic Boundary conditions between two different media. **8**

(b) An infinitely long conductor of radius a is placed such that its axis is along the z-axis. The vector magnetic potential, due to a direct current Io flowing along a_z in the conductor is given by : **7**

$$A = -\frac{I_0}{4\ \Pi a^2}\ \mu_0 \left(x^2 + y^2\right) a_z Wb/m$$

Find the corresponding H. Also confirm the result using Amperes Law.

6 Attempt any **three** : **15**

(i) Explain the concept of displacement current and displacement current density.

(ii) A rod of length of length 1 rotates about the Z-axis with angular velocity W. If $B = B_o\ a_Z$, calculate the voltage induced in the conductor.

(iii) Explain Faradays law in context to Stationary loop in Time-varying field.

(iv) What is a magnetic circuit? Derive the expression for n magnetic circuit elements in parallel.

(v) Planes z = 0 and z = 4 carry current $K = -10a_x$ A/m and $K = 10a_x$ A/m respectively. Determine H at : (a) (1,1,1) and (b) 9, -3, 10).

Formula List for different Co-ordinate Systems

Operation	Cartesian coordinates (x,y,z)	Cylindrical coordinates (ρ,φ,z)	Operation
Gradient ∇f	$\frac{\partial f}{\partial x}\hat{\mathbf{x}} + \frac{\partial f}{\partial y}\hat{\mathbf{y}} + \frac{\partial f}{\partial z}\hat{\mathbf{z}}$	$\frac{\partial f}{\partial \rho}\hat{\rho} + \frac{1}{\rho}\frac{\partial f}{\partial \phi}\hat{\phi} + \frac{\partial f}{\partial z}\hat{z}$	$\frac{\partial f}{\partial r}\hat{\boldsymbol{r}} + \frac{1}{r}\frac{\partial f}{\partial \theta}\hat{\boldsymbol{\theta}} + \frac{1}{r\sin\theta}\frac{\partial f}{\partial \phi}\hat{\boldsymbol{\phi}}$
Divergence $\nabla \cdot \mathbf{A}$	$\frac{\partial A_x}{\partial x} + \frac{\partial A_y}{\partial y} + \frac{\partial A_z}{\partial z}$	$\frac{1}{\rho}\frac{\partial(\rho A_\rho)}{\partial \rho} + \frac{1}{\rho}\frac{\partial A_\phi}{\partial \phi} + \frac{\partial A_z}{\partial z}$	$\frac{1}{r^2}\frac{\partial(r^2 A_r)}{\partial r} + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(A_\theta \sin\theta) + \frac{1}{r\sin\theta}\frac{\partial A_\phi}{\partial \phi}$
Curl $\nabla \times \mathbf{A}$	$\left(\frac{\partial A_z}{\partial y} - \frac{\partial A_y}{\partial z}\right)\hat{\mathbf{x}} + \left(\frac{\partial A_x}{\partial z} - \frac{\partial A_z}{\partial x}\right)\hat{\mathbf{y}} + \left(\frac{\partial A_y}{\partial x} - \frac{\partial A_x}{\partial y}\right)\hat{\mathbf{z}}$	$\left(\frac{1}{\rho}\frac{\partial A_z}{\partial \phi} - \frac{\partial A_\phi}{\partial z}\right)\hat{\boldsymbol{\rho}} + \left(\frac{\partial A_\rho}{\partial z} - \frac{\partial A_z}{\partial \rho}\right)\hat{\boldsymbol{\phi}} + \frac{1}{\rho}\left(\frac{\partial(\rho A_\phi)}{\partial \rho} - \frac{\partial A_\rho}{\partial \phi}\right)\hat{\boldsymbol{z}}$	$\frac{1}{r\sin\theta}\left(\frac{\partial}{\partial\theta}(A_\phi\sin\theta) - \frac{\partial A_\theta}{\partial\phi}\right)\hat{\boldsymbol{r}} + \frac{1}{r}\left(\frac{1}{\sin\theta}\frac{\partial A_r}{\partial\phi} - \frac{\partial}{\partial r}(rA_\phi)\right)\hat{\boldsymbol{\theta}} + \frac{1}{r}\left(\frac{\partial}{\partial r}(rA_\theta) - \frac{\partial A_r}{\partial\theta}\right)\hat{\boldsymbol{\phi}}$
Laplace operator $\Delta^2 \mathbf{f}$	$\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2}$	$\frac{1}{\rho}\frac{\partial}{\partial\rho}\left(\rho\frac{\partial f}{\partial\rho}\right) + \frac{1}{\rho^2}\frac{\partial^2 f}{\partial\phi^2} + \frac{\partial^2 f}{\partial z^2}$	$\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial f}{\partial r}\right) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial f}{\partial\theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 f}{\partial\phi^2}$