USN | | | | | | | | | |

06ES36

Third Semester B.E. Degree Examination, Dec. 07 / Jan. 08
Field Theory

Time: 3 hrs. Max. Marks:100

Note : 1. ***Answer any FIVE full questions.***
2. ***Assume any missing data suitably.***

1 a. State and explain Gauss Law. Find out the relation between D and E. **(06 Marks)**

b. Charge is distributed uniformly along an infinite straight line with constant density ρ_l. Develop the expression for E at the general point P. **(06 Marks)**

c. A vector field is given by, $A(r,\phi,z) = 30e^{-r}a_r - 2za_z$. Verify the divergence theorem for the volume enclosed by, $r = 2$, $z = 5$. **(08 Marks)**

2 a. If $E = -8xya_x - 4x^2a_y + a_z (V/m)$. Find the work done in carrying a 6 coulomb charge from A(1, 8, 5) to B(2, 18, 6) along the path $y = 3x + 2$, $z = x + 4$. **(08 Marks)**

b. A potential function is $v = 2x + 4y$ volts, is in free space. Find the stored energy in free space in the 1 m^3 volume centered at origin. **(06 Marks)**

c. Starting with principle of charge conservation, obtain point form of continuity equation. **(06 Marks)**

3 a. Obtain the conditions on the tangential and normal components of electric field intensity and electric flux density at the boundary between two dielectric media. **(08 Marks)**

b. Derive Poisson's and Laplace's equations starting from point form of Gauss law. **(06 Marks)**

c. State and explain uniqueness theorem. **(06 Marks)**

4 a. Find H at the centre of a square current loop of side 4 meters, if a current of 5 amp is passing through it. **(08 Marks)**

b. State and explain Ampere's circuit law. **(06 Marks)**

c. Given $A = (y\cos ax)a_x + (y + e^x)a_z$, find $\nabla \times A$ at the origin. **(06 Marks)**

5 a. Derive Lorentz force equation and mention the application of its solution. **(06 Marks)**

b. Define torque. Find the torque about the z-axis for a conductor located at $x = 0.4$ m, $y = 0$ and 0 < z < 2m, which carries a current of 5A in the a_z direction, along the length of the conductor. $B = 2.5a_z$ Tesla. **(06 Marks)**

c. Derive the expression for the inductance of a toroidial ring with N turns and carrying current I amp. Assume the radius of the toroid be 'R' m and area of cross section of toroidial ring be 'A' m^2. **(08 Marks)**

6 a. State and explain Faraday's law for EMF when a closed conductor single loop circuit is placed in time varying magnetic field and hence show that $\nabla \times E = -\partial B/\partial t$. **(07 Marks)**

b. Write Maxwell's equations for free space in point and integral forms. **(08 Marks)**

c. Write a short note on retarded potentials. **(05 Marks)**

7 a. What is uniform plane wave? Explain its propagation in free space with necessary equations. **(08 Marks)**

b. What is loss tangent? Explain its practical importance. **(06 Marks)**

c. Find the skin depth δ at a frequency of 1.6 MHz in aluminium, where σ = 38.2 MS/m and $\mu_r = 1$. Also find γ, λ and V_P. **(06 Marks)**

8 a. Define the terms i) Reflection co-efficient and ii) Transmission co-efficient. Also bring out the relation between them. **(08 Marks)**

b. Write a short note on SWR. **(05 Marks)**

c. A 50 MHz uniform plane wave has electric field amplitude 10 V/m. The medium is lossless, having $\epsilon_r = 9$ and $\mu_r = 1$. The wave propagates in the x, y plane at a 30° angle to the x axis and is linearly polarized along z. Write down the phasor expression for the electric field. Also find λ_x, λ_y, V_{px} and V_{py}. **(07 Marks)**

SN | | | | | | | | | |

3-4-2

06ES36

Third Semester B.E. Degree Examination, June / July 08

Field Theory

Time: 3 hrs. Max. Marks:100

Note : ***Answer FIVE full questions, selecting atleast two question from each part.***

(11)

PART - A

1 a. State and explain Coulomb's law in vector form. **(04 Marks)**

b. Two point charges of magnitudes 2 mc and –7 mc are located at places $P_1(4, 7, -5)$, and $P_2(-3, 2, -9)$ respectively in free space, evaluate the vector force on charge at P_2. **(06 Marks)**

c. From Gauss Law show that $\nabla.\hat{D} = \rho_v$. **(10 Marks)**

2 a. Find the potentials at $\gamma_A = 5\text{m}$ and $\gamma_B = 15\text{m}$ due to a point charge Q = 500 pc placed at the origin. Find the potential at $\gamma_A = 5\text{m}$ assuming zero as potential at infinity. Also obtain the potential difference between points A and B. **(06 Marks)**

b. Derive an expression for the potential of co-axial cable in the dielectric space between inner and outer conductors. **(06 Marks)**

c. Discuss the boundary conditions between two perfect dielectrics. **(08 Marks)**

a. State and prove uniqueness theorem. **(08 Marks)**

b. From the Gauss's law obtain Poisson's and Laplace's equation. **(06 Marks)**

c. Determine whether or not the following potential fields satisfy Laplace's equation –

i) $V = x^2 - y^2 + z^2$, ii) $V = r\cos\phi + z$. **(06 Marks)**

4 a. Using Biot – Savart law find an expression for the magnetic field of a straight filamentary conductor carrying current 'I' in the Z – direction. **(08 Marks)**

b. Given the magnetic field $H = 2r^2(Z+1)\sin\phi\hat{a}_\phi$, verify Stokes theorem for the portion of a cylindrical surface defined by $r = 2$, $\frac{\pi}{4} < \phi < \pi/2, 1 < Z < 1.5$ and for its perimeter. **(08 Marks)**

c. With necessary expressions, explain scalar magnetic potential. **(04 Marks)**

PART - B

5 a. Find the expression for the force on a differential current carrying elements. **(06 Marks)**

b. Find the normal component of the magnetic field which traverses from medium 1 to medium 2 having $\mu_{r_1} = 2.5$ and $\mu_{r_2} = 4$. Given that $\hat{H} = -30\hat{a}_x + 50\hat{a}_y + 70\hat{a}_z$ v/m. **(06 Marks)**

c. Derive an expression for the self inductance of a co – axial cable. **(08 Marks)**

a. For a closed stationary path in space linked with a changing magnetic field prove that $\nabla \times \hat{E} = \frac{-\partial\hat{B}}{\partial t}$, where $\hat{E}$ is the electric field and $\hat{B}$ is the magnetic flux density. **(08 Marks)**

b. Determine the frequency at which conduction current density and displacement current density are equal in a medium with $a = 2\times10^{-4}$ s/m and $\epsilon_r = 81$. **(04 Marks)**

c. List the Maxwell's equations in differential and integral form as applied to time varying fields. **(08 Marks)**

7 a. Starting from Maxwell's equation, derive the wave equation for a uniform plane wave traveling in free space. **(08 Marks)**

b. A 300 MHz uniform plane wave propagates through fresh water for which $\alpha = 0$, $\mu_r = 1$ $\epsilon_r = 78$. Calculate i) attenuation constant ii) phase constant iii) wave length iv) intrinsic impedance. **(06 Marks)**

c. Explain the skin depth. Determine the skin depth for copper with conductivity of 58×10^6 s/m at a frequency of 10 MHz. **(06 Marks)**

8 a. Show that at any instant t, the magnetic and electric field in a reflected wave are out of phase by 90^0. **(10 Marks)**

b. With necessary expression, explain standing wave ratio (SWR). **(10 Marks)**

USN | | | | | | | | | |

06ES36

Third Semester B.E. Degree Examination, Dec.08/Jan.09

Field Theory

Time: 3 hrs. Max. Marks:100

Note : *1. Answer any FIVE full questions by choosing at least Two from each part*
2. Any missing data can be assumed.
3. Draw neat diagram wherever necessary.

PART - A

1 a. State Coulomb's law of force between any two point charges and indicate the units of the quantities involved. **(06 Marks)**

b. Volume charge density, $\rho_v = 0$ for $\rho < 0.01$(m) and also for $\rho > 0.03$(m). In the region, $0.01 < \rho < 0.03$(m), $\rho_v = 10^{-8}\cos(50\pi\rho)$ (c/m^3), find electric flux density $\vec{D}$ everywhere. **(07 Marks)**

c. Evaluate both sides of gauss – divergence theorem for the field $\vec{D}\ 2xyz\vec{a}_x + 3y^2z\vec{a}_y + x\vec{a}_z(c/m^2)$. the region is defined by $-1 \le x, y, z \le 1$(m). **(07 Marks)**

2 a. Define electric scalar potential. With usual notations, establish the relationship between electric field intensity and electric scalar potential. **(06 Marks)**

b. A metallic sphere of radius 0.1(m) has a surface change density of 10(nc/m^2). Calculate electric energy stored in the system. Derive the formula employed. **(07 Marks)**

c. A capacitor has square plates each of side 'a'(m). The plates make an angle θ with each other. Show that for small θ, the capacitance is $C = \frac{\epsilon_0 a^2}{d}\left(1 - \frac{a\theta}{2d}\right)$(F). **(07 Marks)**

3 a. Derive Poisson's and Laplace's equations. Write laplace's equation in CCS and SCS. **(06 Marks)**

b. Using laplace's equation, prove that the potential distribution at any point in the region between two concentric cylinders of radii A and B as $V = Vo\frac{\ln\left(\rho/B\right)}{\ln\left(A/B\right)}$(Volts) **(07 Marks)**

c. It is known that V = XY is a solution of laplace's equation, where X is a function of x alone and Y is a function y alone. Determine which of the following potential functions are also solutions of laplace's equation i) V = 100X, ii) V = 80XY, iii) V = 3XY + x – by. . **(07 Marks)**

4 a. State and explain Biot – savart law. Using this, find the magnetic flux density at the centre of a circular current loop of radius 'a'(m) **(07 Marks)**

b. Magnetic field intensity in free space is $\vec{H} = 10\rho^2\vec{a}_\phi\left(A/m\right)$ Determine

i) $\vec{J}$

ii) Integrate $\vec{J}$ over the circular surface $\rho = 1$(m), all ϕ and z = 0. **(06 Marks)**

c. Verify the stoke's theorem for the field $\vec{H}\ 6xy\vec{ax} - 3y2\vec{ay}\left(A/B\right)$ and the rectangular path around the region, $2 \le x \le 5$, $-1 \le y \le 1$, Z = 0. Let the positive direction of $\vec{ds}$ be $\vec{a}_z$. **(07 Marks)**

PART B

5 a. Obtain the expression of magnetic force between two current elements and hence for current loops. **(06 Marks)**

b. Find the magnetization in a magnetic material where:

i) $\mu = 1.8 \times 10^{-5}$ (H/m) and H = 120 (A/m).

ii) μ_r = 22, there are 8.3×10^{28} atoms/m^3 and each atom has a dipole moment of 4.5×10^{-27} (A/m^2) and

iii) B = 300 (μT) and $\chi_m = 15$. **(06 Marks)**

c. Define self inductance. Find the same of a solenoid with air core has 2000 turns and a length of 500(mm) core with radius 40 (mm). **(08 Marks)**

6 a. Explain transformer and motional induced emfs. **(06 Marks)**

b. Show that an emf induced in a Faraday's disc generator is $e = -\frac{WBa^2}{2}$ (Volts), where 'W' is the angular velocity in rad/sec, B is the magnetic flux density in Tesla and 'a' is the radius of the disc in metre. **(06 Marks)**

c. Write the Maxwell's equations in point form for static fields and in integral form for time varying fields. **(08 Marks)**

7 a. Discuss the uniform plane wave propagation in a good conducting medium. **(06 Marks)**

b. The magnetic field intensity of uniform plane wave in air is 20 (A/m) in $\vec{a}_y$ direction. The wave is propagating in the $\vec{a}_z$ direction at an angular frequency of 2×10^9(rad/sec)

Find: i) Phase shift constant; ii) Wavelength;

iii) Frequency and iv) Amplitude of electric field intensity. **(06 Marks)**

c. A circular wire having a conductivity σ and radius 'a' carrying a direct current I(Amperes). Using Poynting's theorem, determine the net power entering the wire of length l(m). **(08 Marks)**

8 a. Derive the expressions for transmission co-efficient and reflection co-efficient. **(08 Marks)**

b. Define Standing Wave Ratio(S). What value of S results when reflection coefficient= $\pm$ ½? **(04 Marks)**

c. Given T=0.5, η_1=100 (Ω),η_2=300 (Ω), E^i_{x1}=100 (v/m). Calculate values for the incident, reflected and transmitted waves. Also show that the average power is conserved. **(08 Marks)**

*****

USN | | | | | | | | | | |

06ES36

Third Semester B.E. Degree Examination, June-July 2009
Field Theory

Time. 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least Two full questions from each part.***

PART – A

1 a. State and prove Divergence theorem. **(06 Marks)**

b. Define: i) Electric field intensity; ii) Electric flux density; iii) Volume charge density. **(06 Marks)**

c. Let $\vec{D} = 5r^2\,\hat{a}r$ mc/m^2 for $r \le 0.08$m and
$\vec{D} = \frac{.205}{r^2}\hat{a}r$ μc/m^2 for $r \ge 0.08$m. Find ρ_v for i) r = 0.06m; ii) r = 0.1m. **(08 Marks)**

2 a. Derive the expression for the energy stored in Electrostatic field having electric field intensity $\vec{E}$. **(06 Marks)**

b. A 15-nc point charge is at the origin in free space. Calculate V_1 if point P is located at (2, -3, -1). Also calculate V_1 at P if V = 0 at (6, 5, 4). **(08 Marks)**

c. Derive point form of continuity equation. **(06 Marks)**

3 a. Derive Laplace's equations. **(05 Marks)**

b. Using Laplace equations, derive the expression for the capacitance of a co-oxial cable. **(10 Marks)**

c. Calculate the numerical values for V and ρ_v in free space of $V = \frac{4yz}{x^2+1}$ at p: (1, 2, 3). **(05 Marks)**

4 a. Derive the expression for field at a point P due to an infinitely long filament carrying direct current I. **(08 Marks)**

b. Explain scaler and vector Magnetic Potential. **(08 Marks)**

c. Calculate the value of vector current density in cylindrical co-ordinates at P: (1.5, 90^0, 0.5) if $\vec{H} = \frac{2}{\rho}\cos 0.2\phi ap$. **(04 Marks)**

PART – B

5 a. Define: i) Magnetization; ii) Permeability; iii) Torque. **(06 Marks)**

b. Obtain the boundary conditions at interface between two magnetic materials. **(06 Marks)**

c. Find Magnetization in magnetic material, where: **(08 Marks)**
i) $\mu = 1.8 \times 10^{-5}$ H/m and H = 120 A/m; ii) $\mu_r = 22$, there are 8.3×10^{28} atoms/m^3 and each atoms has a dipole moment of 4.5×10^{-27} A – m^2; iii) B = 300 μT and $X_m = 15$.

6 a. List Maxwell's equations in point form and integral form. **(08 Marks)**

b. Let $\mu = 10^{-5}$ H/m, $\in = 4 \times 10^{-9}$ F/m, $\sigma = 0$ and $\rho_v = 0$. Find K so that each of he following pair of fields satisfies Maxwell's equation.
i) $\vec{D} = \left(6\hat{a}_x - 2y\hat{a}_y + 2z\hat{a}_z \text{ nc/m}^2\right)$, $\vec{H} = \left(kx\hat{a}_x + 10y\hat{a}_y - 25z\hat{a}_z\right)$ A/m.
ii) $\vec{E} = (20y - kt)\hat{a}x$ v/m, $\vec{H} = \left(y + 2x10^6 t\right)\hat{a}_z$ A/m . **(06 Marks)**

c. Write a note on Retarded Potential. **(06 Marks)**

7 a. State and prove Poynting's theorem. **(10 Marks)**

b. Discuss the behaviour of good conductor when uniform ϕ line wove propagates through it. **(10 Marks)**

8 a. Discuss the problem of wave reflections from multiple interfaces. **(08 Marks)**

b. Define: i) Reflection coefficient; ii) Standing wave Ratios. **(04 Marks)**

c. Consider a 50 MHz uniform plane wave having Electric field amplitude 10 v/m. The medium is loss less having $\in_r = \in_{r1} = 9.0$ and $\mu r = 1.0$. The wave propagates in xy plane at 30^0 angle to x axis and is linearly polarized along z. Write the phasor expression for the electric field. **(08 Marks)**

USN | | | | | | | | | | |

06ES36

Third Semester B.E. Degree Examination, Dec.09/Jan.10
Field Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define electric field intensity due to a point charge in vector form. With usual notations, derive the expression for field at a point due to many charges. **(07 Marks)**

b. State and prove divergence theorem. **(05 Marks)**

c. Calculate the divergence of vector D at the points specified using cartesian, cylindrical and spherical coordinates:

i) $D = \frac{1}{z^2}[10xyz.a_x + 5x^2za_y + (2z^3 - 5x^2y)a_z]$ c/m^2 at point P(2, 3, 5)

ii) $D = 5z^2.a_\rho + 10\rho z \, . \, a_z$ at $\rho(3, -45°, 5)$ **(08 Marks)**

2 a. Define electric field and electric potential. With usual notations establish the relationship between electric field intensity and electric potential. **(10 Marks)**

b. With usual notations, derive the boundary conditions for perfect dielectric materials of permitivities $\in_1$ and $\in_2$. **(05 Marks)**

c. Given the potential field $V = 50x^2yz + 20y^2$ volts in free space, find

i) Potential V at P(1, 2, 3)

ii) $|E_P|$ (Magnitude of electric potential)

iii) $\hat{a}_r$ at P. **(05 Marks)**

3 a. With usual notations, deduce the Poisson's equation and Laplace equation from Maxwell's first equation. Express $\nabla^2 V$ in different co-ordinate systems. **(10 Marks)**

b. Given $V = A\ln\left[B\frac{(1-\cos\theta)}{1+\cos\theta}\right]$ volts

i) Show that V satisfies Laplace equation in spherical coordinates.

ii) Find A and B so that V = 100V, $|E| = 500$ V/m at r = 5mt, $\theta = 90°$ and $\phi = 60°$. **(10 Marks)**

4 a. State and prove the Stroke's theorem. **(06 Marks)**

b. If the vector magnetic potential at a point in a space is given as $A = 100\ \rho^{1.5}a_z$ wb/mt, find the following: i) H ii) J and show that $\oint H.dl = I$ for the circular path with $\rho = 1$. **(06 Marks)**

c. In cylindrical coordinates, a magnetic field is given as $H = [4\rho - 2\rho^2]a_\phi$ A/m, $0 \le \rho \le 1$.

i) Find the current density or a function of ρ within cylinder.

ii) Find the total current that passes through the surface Z = 0 and $0 \le \rho \le 1$ mt in the a_z direction. **(08 Marks)**

PART – B

5 a. With usual notations, derive the equation for magnetic force between two differential current elements. **(06 Marks)**

b. Find the torque vector on a square loop having corners (-2, -2, 0), (2, -2, 0), (2, 2, 0) and (-2, 2, 0) i) about the origin by $B = 0.4a_xT$ ii) About the origin by $B = 0.6a_x - 0.4a_yT$. **(06 Marks)**

c. Determine the mutual inductance between conducting loop and a very long straight wire shown in Fig.5(c). **(08 Marks)**

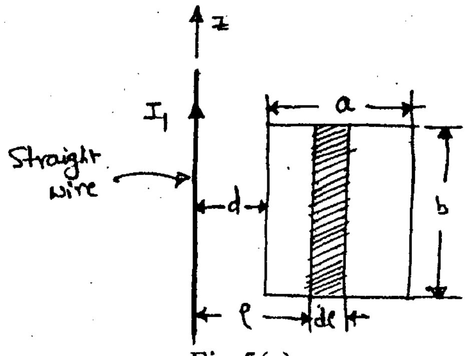


Fig.5(c)

6 a. With usual notations, derive the Maxwell's equation in point form as derived from Faraday's law. Hence show that electric field $E = 2x^3a_x + 4x^4a_y$ v/m can not arise from a static distribution of charges. **(08 Marks)**

b. With usual notations, derive the differential form of continuity equation from the Maxwell's equations. **(04 Marks)**

c. The time varying magnetic field in free space is given as $B = \begin{cases} 4\sin\omega t a_z & \rho \le \rho_0 \\ 0 & \rho > 0 \end{cases}$

Determine E using Faraday's law. Verify the same using Maxwell's equations. **(08 Marks)**

7 a. State and explain Polynting theorem. **(04 Marks)**

b. With usual notations, derive the expression for intrinsic impendence for lossy media. **(06 Marks)**

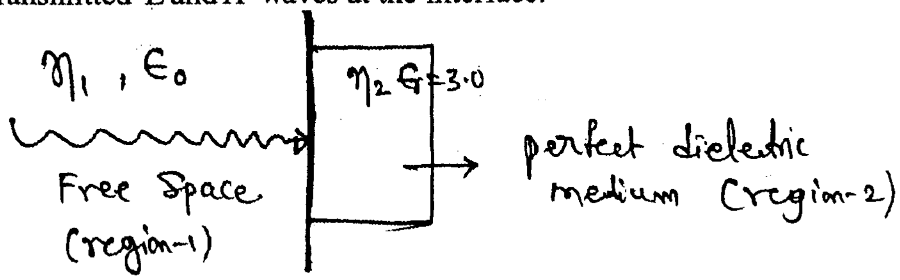
c. The electric field intensity of 300 MHz uniform plane wave in free space is given by $E = (20 + j50)(a_x + 2a_y)e^{-j\beta z}$ V/m. Find

i) ω, λ, u and β ii) E at t = 1 ns z = 10 cm iii) What is $|H|_{max}$? **(10 Marks)**

8 a. Write a short note on standing wave ratio (SWR). **(04 Marks)**

b. With usual notations, derive a general expression for a traveling plane wave. **(06 Marks)**

c. Travelling $\vec{E}$ and $\vec{H}$ waves in the free space (region-1) are normally incident on the interface with a perfect dielectric (region-2) with $\epsilon_r = 3.0$. Compare the magnitude of the incident wave and transmitted $\vec{E}$ and $\vec{H}$ waves at the interface.



(10 Marks)

* * * * *

USN | | | | | | | | | | **06ES36**

Third Semester B.E. Degree Examination, May/June 2010

Field Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Explain the term 'Electric field intensity' and derive the expression for field due to an infinite line of charge. **(12 Marks)**

b. Given $\vec{D} = 5r\hat{a}_r \, c/m^2$, prove divergence theorem for a shell region enclosed by spherical surfaces at r = a and r = b (b>a) and centered at the origin. **(08 Marks)**

2 a. Prove that the energy density in an electrostatic field is given by $\frac{1}{2} \in \vec{E}^2$ J/m^3. **(08 Marks)**

b. Given $V = 2x^2y - 5z$ at point P(-4, 3, 6). Find the potential, electric field intensity and volume charge density. **(08 Marks)**

c. Derive the boundary conditions for $\vec{E}$ and $\vec{D}$ between two dielectrics. **(04 Marks)**

3 a. State and prove uniqueness theorem. **(10 Marks)**

b. Derive the expression for capacitance of a coaxial cable using Laplace's equation. **(10 Marks)**

4 a. State and explain Biot-Savart law for a small differential current element. **(04 Marks)**

b. Derive the expression for magnetic flux density on the axis of a circular loop of radius 'a' carrying current I using Biot Savart law. **(07 Marks)**

c. Vector magnetic potential in free space is given by $\vec{A} = 100e^{1.5}\hat{a}_z$ Wb/m. Find the magnetic field intensity and current density and hence prove Ampere's circuital law for ρ = 1. **(09 Marks)**

PART – B

5 a. Deduce the expression for inductance of a toroidal coil having N turns and carrying a current of I amps. **(06 Marks)**

b. A point charge Q = 18 nC has a velocity of 5×10^6 m/s in the direction $\hat{a} = 0.6\hat{a}_x + 0.75\hat{a}_y + 0.3\hat{a}_z$. Calculate the magnitude of the force exerted on the charge by the field $\vec{B} = -3\hat{a}_x + 4\hat{a}_y + 6\hat{a}_z$ mT. **(06 Marks)**

c. A sq. loop carrying 2 mA current is placed in the field of an infinite filament carrying current of 15 Amp as shown, fig. Q5 (c). Find the force exerted on the sq.loop. **(08 Marks)**

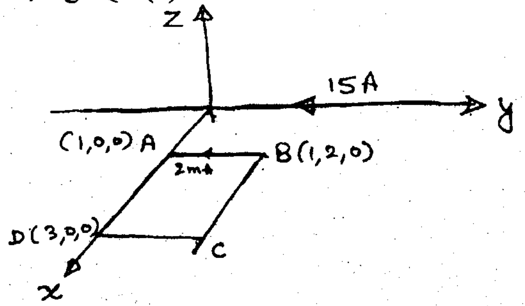


Fig. Q5 (c)

6 a. What do you mean by displacement current and equation of continuity? Derive Maxwell's I equation fro Ampere's circuital law. (08 Marks)

b. Write Maxwell's equations in point form and integral form. (06 Marks)

c. A 9.375 GHz uniform plane wave is propagating in polyethylene $(\epsilon_r = 2.26)$. If the amplitude of the $\vec{E}$ is 500 V/m and the material is assumed to be lossless, find

i) Phase constant ii) Wavelength iii) Velocity of propagation

iv) Intrinsic impedance v) Magnetic field intensity (06 Marks)

7 a. What is meant by 'uniform plane wave'? Derive the expression for UPW in free space. (07 Marks)

b. Deduce the expressions for α and β for a wave traveling in lossy medium. (07 Marks)

c. A 100 V/m wave of frequency 300 MHz is traveling through a lossy medium having $\epsilon_r = 9$, $\mu_r = 1$ and $\sigma = 10$ S/m. Find the power dissipated over a distance of 1 μm with surface area of 2 m^2. (06 Marks)

8 Write short notes on:

a. Poynting's theorem.

b. Reflection of plane waves at normal incidence. (20 Marks)

* * * * *