Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2021

Programme Name: B Tech EL **Semester : IV**
Course Name : Electromagnetic Fields & Electrical Materials **Time : 03 hrs**
Course Code : ECEG2012 **Max. Marks : 100**
Nos. of page(s) : 5
Instructions:

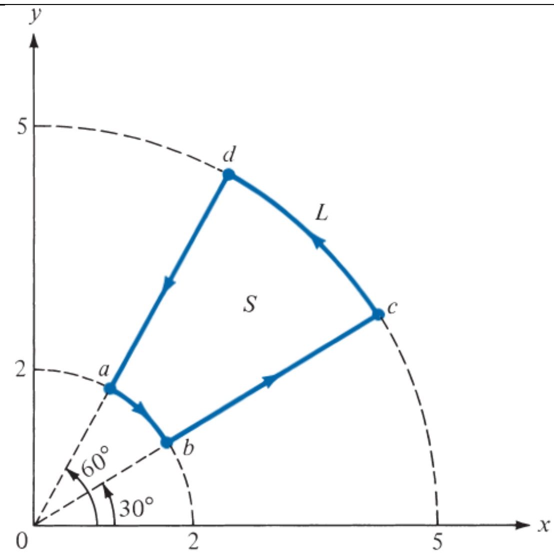
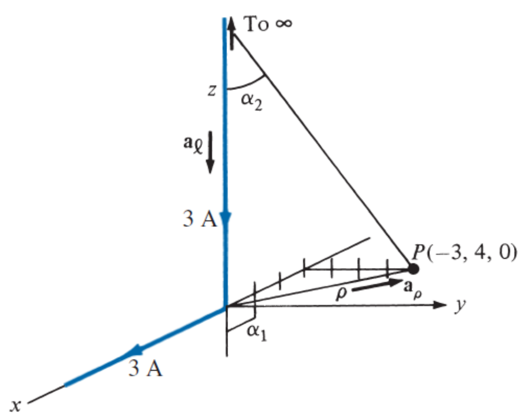
- Attempt all questions.
- Section-A consists 6 questions, first 5 are MCQs.
- Assume any data if required and indicate the same clearly. Unless otherwise indicated symbols and notations have their usual meanings.
- The answer should be neat and clean. Draw a freehand sketch for circuits/tables/schematics wherever required.

SECTION-A (30 Marks)

Q1	**(i)** Which of these is correct? (a) $A \times A = \|A\|^2$ (b) $A \times B + B \times A = 0$ (c) $A \cdot B \cdot C = B \cdot C \cdot A$ (d) $a_x \cdot a_y = a_z$ (e) $a_k = a_x - a_y$, where a_k is a unit vector **(ii)** Which of the following is zero? (a) grad div (c) curl grad (b) div grad (d) curl curl **(iii)** Equation $\nabla^2 V = -\rho/\epsilon$ is called the (a) Poisson's equation (b) Laplace equation (c) Continuity equation (d) None **(iv)** A vector field is given by A = 3xy a_x-y^2 a_y. find $\int A.dl$ along the curve y = $2x^2$ in the xy plane from (0,0) to (1,2) (a) -9/2 (b) 7/6 (c) -7/6 (d) 2/3	**1+1+1 +2**	**CO1**
Q2	**(i)** In a uniform electric field, field lines and equipotential (a) are parallel to one another (b) intersect at 45° (c) intersect at 30° (d) are orthogonal **(ii)** When a charge is given to a conductor (a) It distributes uniformly all over the surface (b) It distributes uniformly all over the volume (c)It distributes on the surface, inversely proportional to the radius of curvature (d) It stays where it was placed. **(iii)** Two infinite parallel metal plates are charged with equal surface charge density of the same polarity. The electric field in the gap b/w the plates is	**1+1+1 +2**	**CO2**

	(a) The same as that produced by one plate (b) Double of the field produced by one plate (c) Dependent on coordinates of the field point (d) Zero **(iv)** Consider the following statements regarding field boundary conditions: 1. The tangential component of electric field is continuous across the boundary between two dielectrics. 2. The tangential component of electric field at a dielectric – conductor boundary is non – zero 3. The discontinuity in the normal component of the flux density at a dielectric conductor boundary is equal to the surface charge density on the conductor. 4. The normal component of the flux density is continuous across the charge free boundary between two dielectrics. Of these statements (a) 1,2 & 3 are correct (b) 2,3 & 4 are correct (c) 1,2 & 4 are correct (d) 1,3 & 4 are correct		
Q3	**(i)** In ferromagnetic materials, the net magnetic moment created due to magnetization by an applied field is: (a) Normal to the applied field (b) Adds to the applied field (c) In line with magneto motive force (d) Subtracts from the applied field **(ii)** At what temperatures domains lose their ferromagnetic properties? (a) Above ferromagnetic Curie temperature (b) Below paramagnetic Curie temperature (c) Above 4° K (d) At room temperature **(iii)** Magnetic flux density at a point distance R due to an infinitely long linear conductor carrying a current I is given by (a) $\frac{1}{2\pi\mu R}$ (b)) $\frac{\mu I}{2R}$ (c) $\frac{\mu I}{2\pi R}$ (d) $\frac{\mu I}{2\pi R^2}$ **(iv)** Plane $y = 0$ carries a uniform current of 30$\mathbf{a}_z$ mA/m. At (1, 10, -2), the magnetic field intensity is (a) -15$\mathbf{a}_x$ mA/m (b) 15$\mathbf{a}_x$ mA/m (c) 477.5$\mathbf{a}_y$ mA/m (d) 18.85$\mathbf{a}_y$ nA/m	**1+1+1 +2**	**CO3**
Q4	**(i)** Which of the following Maxwell's equations represents Ampere's law with correction made by Maxwell? (a) $\nabla \cdot E = \rho/\epsilon_0$ (b) $\nabla . B = 0$ (c) $\nabla \times E = -\frac{\partial B}{\partial t}$ (d) $\nabla \times H = J + \varepsilon_0 \frac{\partial E}{\partial t}$ **(ii)** The electric field component of a wave in free space is given by **E** = 10 cos($10^7 t$ + kz)$\mathbf{a}_y$ V/m. It can be inferred that (a) The wave propagates along a_y (b) The wavelength λ= 188.5 m (c) The wave number k= 0.33 rad/m (e) The wave attenuates as it travels	**1+2+2**	**CO4**

	(iii) Given that **H** = 0.5 $e^{-0.1x}$ $\sin(10^6 t - 2x)$ $\mathbf{a}_z$ A/m, which of these statements are incorrect? (a) α = 0.1 Np/m **(b) β = 22 rad/m** (c) ω = 10^6 rad/s (d) The wave travels along $\mathbf{a}_x$.		
Q5	**(i)** Two identical coaxial circular coils carry the same current *I* but in opposite directions. The magnitude of the magnetic field **B** at a point on the axis midway between the coils is (a) Zero (b) The same as that produced by one coil (c) Twice that produced by one coil (d) Half that produced by one coil. **(ii)** Which of the following statements are not true about electric force $\mathbf{F}_e$ and magnetic force $\mathbf{F}_m$ on a charged particle? (a) **E** and $\mathbf{F}_e$ are parallel to each other, whereas **B** and $\mathbf{F}_m$ are perpendicular to each other. (b) Both F_e and F_m depend on the velocity of the charged particle. (c) Both $\mathbf{F}_e$ and $\mathbf{F}_m$ are produced when a charged particle moves at a constant velocity. (d) $\mathbf{F}_m$ is generally small in magnitude in comparison to $\mathbf{F}_e$. **(iii)** Identify the statement that is not true of ferromagnetic materials. (a) They have a large χ_m. (b) They have a fixed value of μ_r. (c) Energy loss is proportional to the area of the hysteresis loop. (d) They lose their nonlinearity property above the curie temperature.	**2+2+1**	**CO3**
Q6	State the following laws: Coulomb's law; Gauss law. Also mention the applications of Gauss law.	**5**	**CO2**
	SECTION-B (50 Marks)		
Q1	If $A = \rho\cos(\emptyset)\ a_\rho + \sin(\emptyset)\ a_\rho$, evaluate $\oint A.dl$ around the path shown in **Fig. 1**. Confirm this by Stokes's theorem.	**10**	**CO1**

	 **Fig. 1**		
Q2	**(a)** A point charge of 5 nC is located at (-3, 4, 0) while the line y = 1, z = 1 carries uniform charge of 2 nC/m. If potential V = 0 V at O (0, 0, 0), find V at A (5, 0,1) **(b)** the finite sheet $0 \le x \le 1$, $0 \le y \le 1$ on the z = 0 plane has a charge density $\rho_s = xy(x^2 + y^2 + 25)^{3/2}$ nC/m^2. Find the total charge on the sheet and electric field at (0, 0, 5).	**5+5**	**CO2**
Q3	Two extensive homogeneous isotropic dielectric meets on plane z = 0. For z > 0, $\varepsilon_{r1} = 4$ and for z < 0, $\varepsilon_{r2} = 3$. A uniform electric field $E_1 = 5a_x - 2a_y + 3a_z$ kV/m exists for z $\ge$ 0. Find (a) E_2 for $z \le 0$; (b) the angles E_1 and E_2 make with the interface; (c) the energy densities (in J/m^3) in both dielectrics;	**10**	**CO2**
Q4	Find the magnetic field intensity H at (-3, 4, 0 due to current filament shown in **Fig. 2**  **Fig. 2**	**10**	**CO3**
Q5	(a) A square loop of wire in the *z* = 0 plane carrying 2 mA in the field of an infinite filament on the *y* axis, as shown in **Fig.3** find the total force on the loop.	**5+5**	**CO3**

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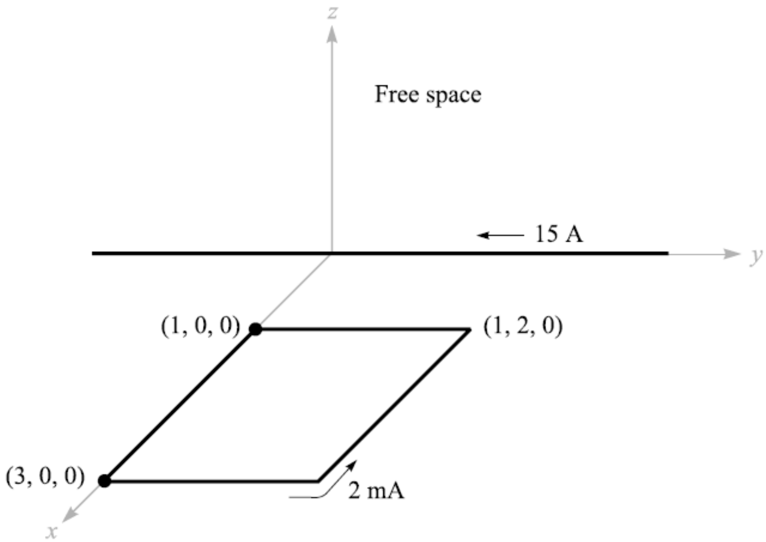

Fig.3

(b) Let us assume that $\mu = \mu_1 = 4\ \mu$H/m in region 1 where $z > 0$, whereas $\mu_2 = 7\ \mu$H/m in region 2 wherever $z < 0$. Moreover, let $\mathbf{K} = 80\ \mathbf{a}_x$ A/m on the surface $z = 0$. We establish a field, $\mathbf{B}_1 = 2\mathbf{a}_x - 3\mathbf{a}_y + \mathbf{a}_z$ mT, in region 1 and find the value of $\mathbf{B}_2$.
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SECTION-C (20 Marks)

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Q1

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A plane wave with $E = 30e^{-\alpha z} \sin(\omega t - z)\ a_x$ V/m is propagating through a lossy dielectric medium having an intrinsic impedance of $300\angle 30^0$ and $\mu_r = 1$.

(a) Determine the phasor and instantaneous field expressions for H
(b) Find the loss tangent, propagation constant, wave polarization and the dielectric constant of the medium at 15 MHz
(c) Determine the skin depth and the depth at which the amplitude of the field is 1% of the value at z=0.

OR

A plane wave travelling in the +z direction in free space (z<0) is normally incident at z = 0 on a conductor (z>0) for which $\sigma = 61.7$ MS/m, $\mu_r = 1$. The free space wave has a frequency of 2.5 MHz. the E field amplitude is 1.5 V/m at the interface. Find the expression for H in the conductor. Also find the loss tangent and skin depth.
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CO4

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