Name:

Enrolment No:

UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

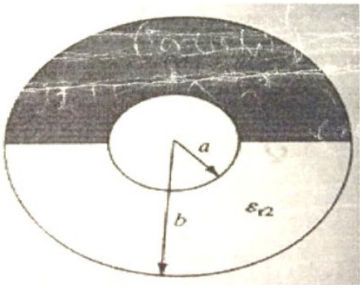
End Semester Examination, September/ October 2018

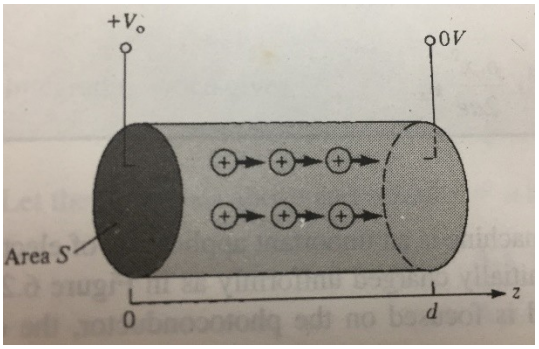
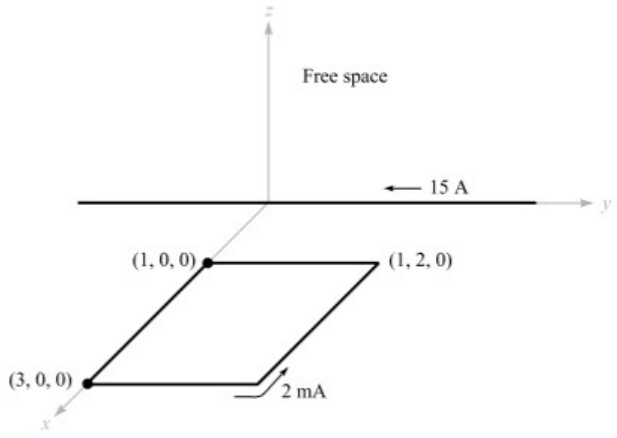
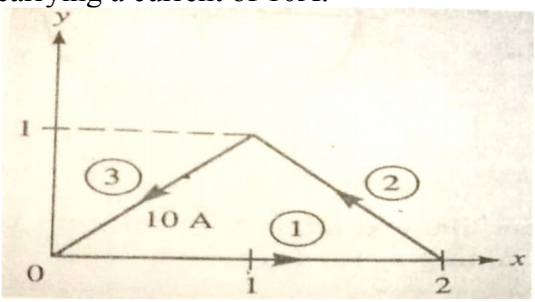
Programme Name: B.Tech Electrical Engg. **Semester : III**
Course Name : Electromagnetic Field Theory **Time : 03 hrs**
Course Code : ECEG 2007 **Max. Marks : 100**
Nos. of page(s) : 3
Instructions: All questions are compulsory.

SECTION A

S. No.		Marks	CO
Q 1	Discuss in brief the physical significance of each Maxwell's equations for static EM fields.	4	CO 4,1
Q 2	Discuss the concept of magnetic vector potential with relevant equations.	4	CO 3
Q 3	For plane z = 0 and z = 4 carrying current **K**= -10 $\mathbf{a}_x$ A/m and **K**= 10 $\mathbf{a}_x$ A/m respectively. Determine **H** at (1,1,1) .	4	CO 2
Q 4	"The Poynting vector physically denotes the power density leaving or entering a given volume in a time varying field". Justify with relevant equations.	4	CO 4
Q 5	Derive laplace's equation pertaining to electrostatic potential distribution in a charge free space.	4	CO 3,1

SECTION B

Q 6	If $\boldsymbol{J}= \frac{1}{r^3}¿+sin\theta\, a_\theta)\frac{A}{m^2}$, calculate the current passing through a hemispherical shell of radius 20cm, $0<\theta<(\Pi/2)$ and $0<\phi<2\Pi$.	10	CO1,2
Q 7	An electric field in free space is given by **E**= 50 cos (10^8 t + βx) $\mathbf{a}_z$ V/m. a. Find the direction of wave propagation. b. Calculate β and the time it takes to travel a distance of λ/2 . c. Sketch the wave at t=0, T/4, and T/2	10	CO2
Q 8	Determine the equivalent capacitance for the cross section of spherical capacitor shown in the figure 1 below, given a=2.5mm, b=5mm, ε_{r1}=3.5 and ε_{r2}=4.5.  Figure 1 (or) Electrohydrodynamic (EHD) pumping is modelled in figure 2 below. The region	10	CO3

	between electrodes contains a uniform charge p_o , which is generated at the left electrode and collected at the right electrode. Calculate the pressure of the pump if p_o=25mC/m^3 and Vo=22kV.  *Figure 2*		
Q 9	A square loop of wire placed in z=0 plane carrying 2 mA is subjected to a non-uniform magnetic field of an infinite filament on the y axis, as shown. The infinite filament carries current 15A. Determine the total force on the loop.  	**10**	**CO2,4**
	SECTION C		
Q 10	Determine **H** at (0,0,5) due to the segments 1 and 3 of the conducting triangular loop in following figure 3 carrying a current of 10A.  *Figure 3*	**(20)**	**CO2,1**

	Or a. Discuss in brief the significance of magnetic vector potential in solving electromagnetic problems. b. Using the concept of magnetic vector potential derive Biot Savart's Law and Ampere's Circuital Law. (4+16=20)		
Q 11	a. Using the concept of uniform plane waves explain the operating principle of microwave oven . b. Show that for a good conductor skin depth is given by $2\pi/\lambda$. (10+10)	**20**	**CO4**

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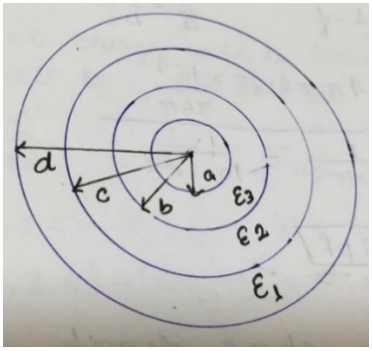
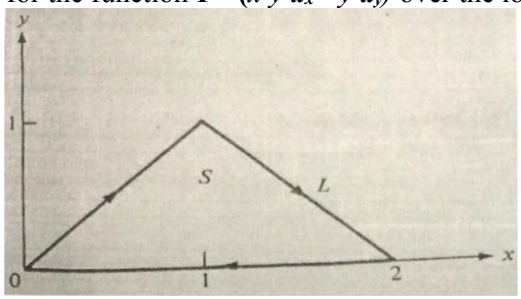
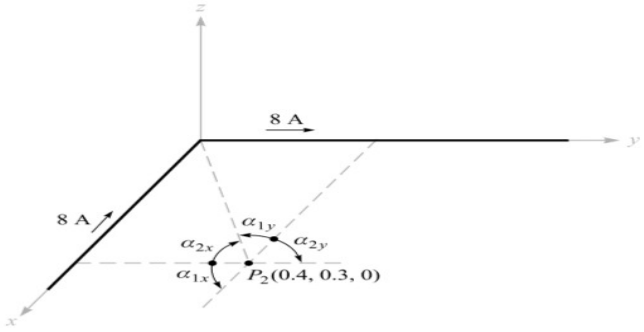
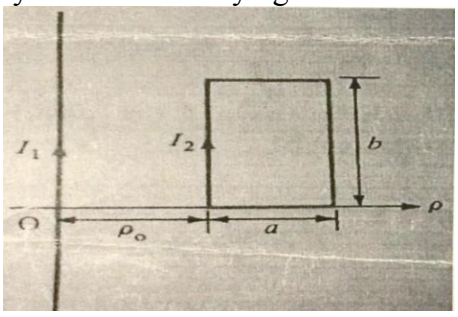
SECTION A

S. No.		Marks	CO
Q 1	Show that points P1(5,2,-4), P2 (1,1,2) and P3(-3,0,8) all lie on a straight line.	**4**	**CO1**
Q 2	Discuss in brief the application of Laplace and Poisson's equation in Electromagnetic Field problems.	**4**	**CO3**
Q 3	For '**D**' to be vanished for r > 10 cm for a sphere of radius 10cm has $\rho_v = (r^3/100)$ C/m^3 , determine the point charge that must be placed at the center of the sphere.	**4**	**CO2**
Q 4	If $\mathbf{P} = 2\sin(10t + x - \pi/4)\,\mathbf{a}_y$ and $\mathbf{Q}_S = e^{jx}(\mathbf{a}_x - \mathbf{a}_y)\sin \pi y$. Determine the phasor form of **P** and instantaneous form of $\mathbf{Q}_S$.	**4**	**CO4**
Q 5	Obtain differential and integral form of Maxwell's equations for static electric and magnetic field.	**4**	**CO4**

SECTION B

Q 6	A spherical capacitor has inner radius 'a' and outer radius 'd', concentric with the spherical conductors and lying between them is a spherical shell of outer radius 'c' and inner radius 'b'. if the regions d>r>c, c>r>b, and b>r>a are filled with materials having permittivities ε_1, ε_2 and ε_3 respectively, as shown in the figure 1 below. Determine the capacitance of the system.  Fig. 1	**10**	**CO3**
Q 7	i. State Poynting's Theorem. ii. In a non magnetic medium $\mathbf{E} = 4\sin(2\pi x 10^7 t - 0.8x)\,\mathbf{a}_z$ V/m. Determine a. ε_r and intrinsic impedance b. Time average power carried by the wave c. Total power crossing 100 cm^2 of plane 2x+ y =5.	**10**	**CO4**

Q 8	Verify Stoke's Theorem for the function **F= ($x^2y\ a_x - y\ a_y$)** over the loop L shown in figure 2.  Fig. 2 (or) Show that Ampere's Law for steady currents is not applicable for time varying currents. Hence explain the concept of displacement current	**10**	**CO2,4**
Q 9	Determine **H** at $P_2(0.4,0.3,0)$ in the field of an 8A filamentary current is directed inward from infinity to the origin on the positive x axis,and then outward to infinity along the y axis.  	**10**	**CO2,1**
	SECTION C		
Q 10	a. Discuss the concept of maglev technology. Give its applications. b. For a rectangular loop carrying current I_2 placed parallel to an infinitely long filamentary wire carrying current I_1 shown in figure 3, determine the force experienced by the loop by the current carrying wire.  Fig. 3 (8+12=20) (or) A solid conductor of circular cross section is made of a homogeneous nonmagnetic	**(20)**	**CO2,4,**

	material. If the radius a = 1mm, the conductor axis lies on the z-axis, and the total current in the $\mathbf{a}_z$ direction is 20A, find: a. $\mathbf{H}_\varphi$ at ρ =0.5mm; b. $\mathbf{B}_\varphi$ at ρ = 0.8mm; c. the total magnetic flux per unit length inside the conductor; d. the total flux for ρ<0.5mm; e. the total magnetic flux outside the conductor (5*4=20)		
Q 11	a. Discuss the phenonmenon of skin effect. (8) b. i.)"Regular lumped circuit components such as resistors, inductors and capacitors cannot be used at microwave frequencies". Justify. ii) Also discuss the concept of S-parameters. (6+6)	**20**	**CO4**