Roll No: ----------

UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program: B.Tech Electrical | **Semester – III**
Subject (Course): EMFT | **Max. Marks : 100**
Course Code :ELEG 231 | **Duration : 3 Hrs**
No. of page/s:2

All questions are compulsory.

Section A **(5*4=20 M.M.)**

1. (CO4) Obtain Maxwell's equations in differential and integral form for time varying fields.
2. (CO2) Explain what you understand by magnetic dipole, magnetic dipole moment, magnetic susceptibility and magnetization **M.**
3. (CO3) Derive laplace's equation pertaining to electrostatic potential distribution in a charge free space.
4. (CO1) Points P and Q are located at (0,2,4) and (-3,1,5). Calculate the position vector **P** and distance vector from P to Q
5. (CO2) 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) and (0,-3,5).

Section B **(5*8=40 M.M.)**

6. (CO1) Two uniform vector fields are given by **E**= -5 $\mathbf{a}_\rho$ +10 $\mathbf{a}_\phi$ +3$\mathbf{a}_z$ and **F**= $\mathbf{a}_\rho$ +2 $\mathbf{a}_\phi$ - 6$\mathbf{a}_z$. Calculate
   a. | **E** X **F** |
   b. The vector component of **E** at p(5, Π/2, 3) parallel to the line x=2, z=3
   c. The angle **E** makes with the surface z=3 at P. (3+4+3=10)

7. (CO2) A point charge of 12 nC is located at point P(0,0,3) while the conducting plane z=0 is grounded. Determine V and **E** at R(7,4,4).

8. (CO4) Discuss how magnetic levitation can be understood by electromagnetic levitation. Also explain Faraday's Law of Electromagnetic Induction.

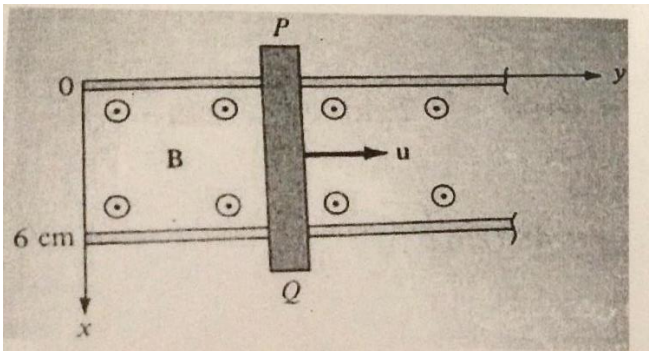
9. (CO3) Show that Ampere's Law for steady currents is not applicable for time varying currents. Hence explain the concept of displacement current.

10. (CO5) If **P**= 2 sin(10t + x - $\pi/4$) $\mathbf{a}_y$ and $\mathbf{Q}_S = e^{jx}(\mathbf{a}_x - \mathbf{a}_y)$ sin πy. Determine the phasor form of **P** and instantaneous form of $\mathbf{Q}_S$.

Section C **(2*20=40 M.M.)**

11. (CO4) Following figure shows a conducting bar which can slide freely over two conducting rails. Determine the induced voltage in the bar:
    a) If bar is stationed at y=10cm and $\mathbf{B}= 4 \cos 10^6 t\ \mathbf{a_z}$ mWb/m^2
    b) If bar slides at a velocity $\mathbf{u}= 20\ \mathbf{a_y}$ m/s and $\mathbf{B}= 4\ \mathbf{a_z}$ mWb/m^2
    c) If bar slides at a velocity $\mathbf{u}= 20\ \mathbf{a_y}$ m/s and $\mathbf{B}= 4 \cos (10^6 t - y)\ \mathbf{a_z}$ mWb/m^2
    d) Write down Faraday's Law and derive the expression for transformer and motional emf.

(4+5+5+6=20)



(OR)

11. (CO4) Given magnetic boundary conditions for the interface between two magnetic media with μ_1 and μ_2 as the respective permeabilities of media1 and media 2.
    Given $\mathbf{H_1} = -2\ \mathbf{a_x} +6\ \mathbf{a_y} +4\mathbf{a_z}$ A/m in region y-x-2 $\leq$ 0, where $\mu_1= 5\ \mu_0$, calculate
    a. $\mathbf{M_1}$ and $\mathbf{B_1}$
    b. $\mathbf{H_2}$ and $\mathbf{B_2}$ in region y-x-2 $\geq$ 0, where $\mu_2= 2\ \mu_0$ (10+10=20)

12. (CO5) State Poynting's Theorem.
    In a non magnetic medium $\mathbf{E}= 4 \sin(2\pi \times 10^7 t - 0.8x)\ \mathbf{a_z}$ 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.

(4+6+5+5=20)

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Section A (5*4=20 M.M.)

1. (CO4) 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.
2. (CO3) Discuss the concept of magnetic vector potential with relevant equations.
3. (CO1) Convert **Q** into spherical coordinates and evaluate **Q** at (0,-4,3)

$$\mathbf{Q} = \frac{\sqrt{x^2+y^2}\,\mathbf{a}_x}{\sqrt{x^2+y^2+z^2}} - \frac{yz\mathbf{a}_z}{\sqrt{x^2+y^2+z^2}}$$

4. (CO4) Determine which of the following represents magneto static field? Justify.
   $\mathbf{B} = e^{-y}(\cos x\mathbf{a}_x - \sin x\mathbf{a}_y)$
   $\mathbf{D} = 5e^{-2z}(\rho\mathbf{a}_\rho + \mathbf{a}_z)$
5. (CO5) State Poynting's Theorem. Give relevant equations.

Section B (5*8=40 M.M.)

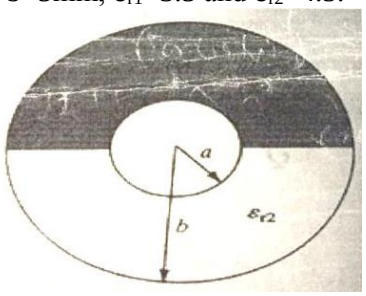
6. (CO1) If $\mathbf{G}(r) = 10\,e^{-2z}(\rho\mathbf{a}_\rho + \mathbf{a}_z)$, determine the flux of **G** out of the entire surface of the cylinder $\rho=1$, $0 \leq z \leq 1$. Confirm the result by using divergence theorem.

7. (CO2) Determine the electric field intensity and electric potential for a group of charges each having a magnitude 'q' C placed along x=1, x=2, x=4, x=8, x=16, x=32 and so on.

8. (CO4) Discuss phenomenon of electromagnetic levitation and give its applications.

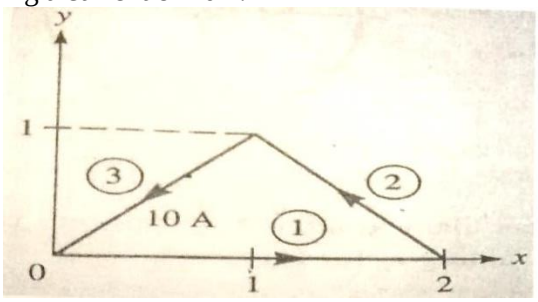
9. (CO5)) A charged particle of mass 2kg and charge 2C starts at point (1,-2,0) with velocity $4\mathbf{a}_x + 3\mathbf{a}_z$ m/s in an electric field $12\mathbf{a}_x + 10\mathbf{a}_y$ V/m. At time t=1s determine
   a. Acceleration of the particle
   b. Its velocity
   c. Its kinetic energy (3+4+3=10)

10. (CO3) Determine the equivalent capacitance for the cross section of spherical capacitor shown in the figure below, given a=2.5mm, b=5mm, ε_{r1}=3.5 and ε_{r2}=4.5.



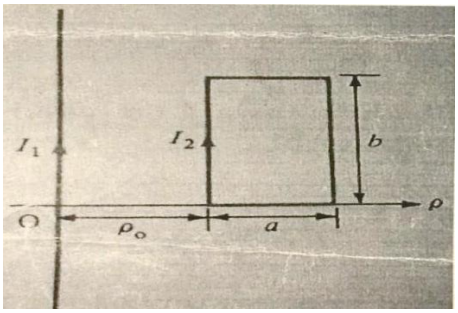
Section C **(2*20=40 M.M.)**

11. (CO4) Determine **H** at (0,0,5) due to the segments 1,2 and 3 of the conducting triangular loop in following figure carrying a current of 10A. (20)



(or)

11. (CO4) For a rectangular loop carrying current I_2 placed parallel to an infinitely long filamentary wire carrying current I_1 is shown in figure. Determine the force experienced by the loop by the current carrying wire. (20)



12. (CO5) Give the general characteristics of a wave.
An electric field in 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. (5+4+6+5=20)