Total number of printed pages–7

1 (Sem–2/FYUGP) PHY 21 MJ

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PHYSICS

(Major)

Paper : PHY4200104MJ

(Mathematical Physics and Electricity and Magnetism)

Full Marks : 45

Time : 2 hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions : 1×5=5

(a) Write the Laplace equation in three dimension.

(b) What does it mean by the rank of a matrix ?

(c) Two conducting spheres of same radii, one solid and the other hollow are charged to same potential. Which one will hold more charge ? Give reason.

(d) Define a Bilateral circuit.

(e) Give *one* example of ferromagnetic material.

2. Answer ***any five*** of the following questions : 2×5=10

(a) Find the degree of the following differential equation

$$\left(\frac{d^3y}{dx^3}\right)^{2/3} + 4 - 3\frac{d^2y}{dx^2} + 5\frac{dy}{dx} = 0$$

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(b) What are the eigenvalues of the matrix

$$\sigma_3 = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} ?$$

(c) What are the *two* necessary conditions for applying Gauss's Law to find electric field intensity due to a charge distribution ?

(d) Calculate the electric flux originating from a charge of 10*C*. Given $\epsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^{-1}$.

(e) Define dielectric constant of a medium. What is its value for vacuum ?

(f) Distinguish between polar and non-polar dielectric.

(g) State the Biot-Savart's law.

(h) What information can be drawn from hysteresis loop ?

(i) Draw the phasor diagram for series LCR circuit.

(j) A coil of inductance $10mH$ and resistance 10ohm is connected in parallel with a condenser of capacity $0.1\mu F$. Find the impedance of the circuit at resonance.

3. Answer ***any four*** of the following questions : 5×4=20

(a) Test whether

$$\left(\frac{1}{y}-\frac{2}{x}\right)dx+\left(-\frac{x}{y^2}+\frac{3}{y}\right)dy=0$$

is an exact equation and find its solution accordingly.

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(b) Show that sum of *two* Hermitian matrices is a Hermitian matrix.

(c) Establish the Coulomb's law from Gauss's law.

(d) Two point charges carrying $15\mu C$ and $2.5\mu C$ amount of charges are located $30cm$ apart. Find the potential at the mid point of the line joining the two charges.

(e) Discuss the phenomenon of polarization in dielectrics.

(f) Express the Ampere's circuital law in differential form.

(g) A magnetizing field of $800Am^{-1}$ produces a magnetic flux of 4.8×10^{-5} weber in a bar of iron of cross-section $0.1cm^2$. Calculate the magnetic permeability and magnetic susceptibility of the bar. 3+2=5

(h) Define Q-factor of an oscillatory circuit. What is its dimension? Write the relation between Q-factor and band width.

4. Answer ***any one*** of the following questions : $10\times1=10$

(a) A spring for which spring constant $K = 400 Nm^{-1}$ hangs in a vertical position with its upper end fixed to a support. A mass of $20kg$ is attached to the lower end and the system brought to rest. Find the position of the mass at time t, if a force of $(40\ sin\ 4t)\ N$ is applied to the support.

(b) Find the electric field intensity at a point lying outside a uniformly charged sphere.

(c) What is a dielectric? Derive the relation between dielectric constant and susceptibility. 2+8=10

(d) Obtain the condition of resonance in parallel LCR circuit.

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