UG (CBCS) Even Semester Examination, May 2025

EDUCATION
(B.Sc. B.Ed.)

6th Semester

Course No. : BSPH - 602

(Mathematical Physics II, Electricity & Magnetism II)

Full Marks : 50
Pass Marks : 20

Time : 2 hours

The figures in the margin indicate full marks for the questions

(*Answer five questions*)

1. (a) A covariant tensor has components xz, $2y-z^2$, xy in rectangular coordinates. Find its components in spherical polar coordinates. 5+5=10

   (b) If $(ds)^2 = (dr)^2 + r^2\,(d\theta)^2 + r^2\sin^2\theta\,(d\phi)^2$, then find the values of $[22,1]$, $\begin{bmatrix}1\\22\end{bmatrix}$ symbols have their usual meanings.

Or

2. (a) Prove that 5+5=10

$$|f'(z)|^2 = \frac{1}{4}\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right)|f(z)|^2$$

$$= \begin{vmatrix} \partial u/\partial x & \partial u/\partial y \\ \partial v/\partial x & \partial v/\partial y \end{vmatrix}$$

(*Turn Over*)

(b) Find the analytic function $f(z) = u(r, \theta) + i\, v(r, \theta)$ so that
$u(r, \theta) = r\cos\theta - r^2 \cos 2\theta + 1$

3. Calculate the self inductance of a solenoid 10

Or

4. Calculate the mutual inductance between two co-axial parallel circular loops. 10

5. Describe the Langerin's theory of paramagnetism. 10

Or

6. (a) Show that in case of paramagnetic materials, susceptibility at high temperature leads to Curie law. 5+5=10

(b) Describe the process of cooling by adiabetic demagnetism.

7. (a) Evaluate the dimension of poynting vector $(\vec{s}_0)$. Hence describe the physical meaning of the surface integral $\int \vec{s}_0 . d\vec{s}$.

(b) Establish the following relation between poynting vector $(\vec{s}_0)$, electric field $(\vec{E})$ and magnetic field strength $(\vec{H})$: 3+7=10

$$(\vec{s}_0) = \frac{1}{z}\langle \vec{E}^* \times \vec{H} \rangle = \frac{1}{2}\langle \vec{E} \times \vec{H}^* \rangle$$

symbols have their usual meanings.

Or

8. If $\vec{B}, \vec{E}$ are in same phase, establish the following relation between energy density (u_0) and $\in$-m field parameters as

$$\langle u_0 \rangle = \frac{1}{4}\, \text{Re}\,[ED^* + BH^*]$$

symbols have their usual meanings. 10

9. (a) Show that current flowing through an inductor always leads the supply voltage by 90^0. 3+7=10

(b) For a series LCR circuit, evaluate the condition for maximum voltage across inductor.

Or

10. (a) Show that voltage across the capacitor always lags the supply current by 90^0. 3+7=10

(b) For a series LCR circuit, evaluate the condition for maximum voltage across capacitor.

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