

RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

FIRST YEAR

B.A./B.Sc. SECOND SEMESTER (January – June) 2015

Mid-Semester Examination, March 2015

Date : 18/03/2015

Time : 11 am – 1 pm

PHYSICS (Honours)

Paper : II

Full Marks : 50

[Use a separate answer book for each group]

[Answer any five questions taking at least three from Gr. A and at least one from Gr. B]

Group – A

1. a) State Fourier's theorem. Expand $f(x) = x^2$ into a half range cosine series from $x = 0$ to $x = \pi$. [2+4]
b) Show that $\delta[(x-a)(x-b)] = \frac{1}{|a-b|} [\delta(x-a) + \delta(x-b)]$. [4]
2. a) Derive the expression for Fourier integral. [4]
b) With the help of an example show the comparison between Fourier Series and Fourier integral. [6]
3. a) What are the limitations of the method of separation of variables. [4]
b) A rod of length ℓ with insulated sides is initially at a uniform temperature $\theta^\circ\text{C}$. Its ends are suddenly cooled to 0°C and kept at that temperature. Find the temperature at time t at a point x inside the rod. [6]
4. a) Show that for an attractive inverse-square law of force $f(r) = -\frac{k}{r^2}$ ($k > 0$), the Laplace-Lenz-Range vector $\vec{A} = \vec{p} \times \vec{L} - mk\hat{r}$ is constant. (The symbols have their usual meaning). [5]
b) Use the vector $\vec{A}$ to derive the equation of the orbit followed by a particle moving under the above force. Hence, obtain the expression for the eccentricity, e . [5]
5. a) A particle moves in a spiral orbit $r = a\theta$. If θ increases linearly with time t , is the force a central force? If not, find how θ should vary with t for a central force. [3]
b) Show that for an elliptical Keplerian orbit, of eccentricity e , major axis $2a$ and time period T ,
i) $e = \frac{V_{\max} - V_{\min}}{V_{\max} + V_{\min}}$ ii) $a = \frac{T}{2\pi} \sqrt{V_{\max} \cdot V_{\min}}$
where $V_{\min}$ and $V_{\max}$ are the minimum and maximum orbital speeds respectively. [7]

Group – B

6. a) What do you mean by the irradiance of an electromagnetic wave at a point? If the wave is given by $\vec{E} = \vec{E}_0 \sin(\omega t - \vec{k} \cdot \vec{r})$, find the irradiance. [4]
b) When two electromagnetic waves superpose, find the expression for the overall irradiance. Find the fringe width in Young's experiment with a monochromatic beam. [6]
7. a) What do you mean by coherence of two sources? Do you expect to see interference from two incoherent sources? Explain. [3]
b) Find the irradiance distribution by a monochromatic source when the light passes through a slit of width b . Draw the pattern of irradiance distribution. [7]