



**WEST BENGAL STATE UNIVERSITY**  
B.Sc. Honours Part-I Examination, 2020

**PHYSICS**

**PAPER-PHSA-I**

Time Allotted: 2 Hours

Full Marks: 50

*The figures in the margin indicate full marks.  
Candidates should answer in their own words and adhere to the word limit as practicable.  
All symbols are of usual significance.*

**UNIT-IA**

**Question No. 1 is compulsory and answer *one* more question from the rest**

1. Answer any *five* questions from the following: 3×5 = 15
- (a) Test the convergence of the series  $1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \dots$ .
  - (b) What are Cauchy-Riemann conditions? Test the following function for analyticity  $f(z) = z^2$ .
  - (c) Show that if  $A$  be an orthogonal matrix, then  $\det A = \pm 1$ .
  - (d) Poisson distribution is given by  $P(x) = \frac{e^{-m} m^x}{x!}$ . Prove that  $\sum_{x=0}^{\infty} P(x) = 1$ .
  - (e) Write down the Dirichlet conditions for a function to be expanded in Fourier Series.
  - (f) Write down Galilean transformation equations and show that Newton's second law of motion is invariant under them.
  - (g) Find the eigenvalues and one of the eigenvectors of the matrix  $\begin{pmatrix} 1 & 1 \\ 4 & 1 \end{pmatrix}$ .
  - (h) State the perpendicular axis theorem of moment of inertia.
2. (a) A particle of constant mass  $m$  moves in space under the influence of a force field  $\vec{F}$ . Assuming that at times  $t_1$  and  $t_2$  the velocities are  $\vec{v}_1$  and  $\vec{v}_2$  respectively, prove that the work done is the change in kinetic energy. 2
- (b) Evaluate  $\int \vec{A} \times \frac{d^2 \vec{A}}{dt^2} dt$ . 2

- (c) A particle of unit mass moves according to the equation  $\vec{r} = \hat{i}(2 + 3t^2) + \hat{j}5t^2 + \hat{k}t$ . 4  
 Find the force  $\vec{F}$  on it, torque  $\vec{N}$  and angular momentum  $\vec{L}$  about the origin.  
 Hence, verify that  $\vec{N} = \frac{d\vec{L}}{dt}$ .
- (d) Show that all the eigenvalues of an Hermitian matrix are real. 2
3. (a) A raindrop of mass  $m$  falls from rest at a place where gravitational acceleration is  $g$ , 2+4  
 the air resistance is proportional to the velocity  $\vec{v}$ ,  $k$  being the proportionality constant. Set up the equation of motion and show that the terminal velocity of the drop is  $v_r = mg/k$ .
- (b) Check if  $x = 0$  is a singular point for the differential equation 2  

$$(1 - x^2)\ddot{y} - 2x\dot{y} + \alpha(\alpha + 1)y = 0$$
- (c) The generating function for Legendre Polynomials  $P_n(x)$  is given by 2  
 $(1 - 2xt + t^2)^{-1/2} = \sum_n P_n(x)t^n$ . Show that  $P_n(1) = 1$ .

### UNIT-IB

**Question No. 4 is compulsory and answer one more question from the rest**

4. Answer any **five** questions from the following: 3×5 = 15
- (a) Show that for a particle moving in a central force field the angular momentum is conserved.
- (b) Show that for a non-dispersive medium the phase velocity and group velocity of a progressive wave are equal.
- (c) Define torsional rigidity and find its dimension.
- (d) Define co-efficient of viscosity. What is meant by non-Newtonian fluids?
- (e) What are the basic criteria for the waves to have the occurrence of beats and interference?
- (f) State and explain Jurin's law of surface tension.
- (g) A circular disc of mass  $M$  and radius  $R$  is rolling without slipping on a horizontal table with an angular velocity  $\omega$ . Show that its total energy is  $\frac{3}{4}M\omega^2 R^2$ .
- (h) What do you mean by normal modes and normal co-ordinates in connection with coupled vibration?
5. (a) A drop of water 1 mm in diameter gets broken up into a million droplets, all drops 2  
 having the same size. Find the change in energy in the process.  
 (Surface Tension of water = 74 dyne / cm).
- (b) Write down Gauss's theorem of gravitation. Derive gravitational field intensity due 1+3  
 to a point mass  $M$  at a distance  $R$  from it using this theorem.

- (c) An artificial satellite revolves about the Earth (of radius  $R$ ) at a height  $H$  above the surface of the earth. Find the orbital speed and the orbital period of the artificial satellite if the gravitational acceleration at the surface of the Earth is  $g$ . 4
6. (a) For an under-damped oscillation, set up and solve the equation of motion. 1+3
- (b) What is the difference between ‘Phon’ and ‘Bel’? 2
- (c) A metal wire of length  $l$ , cross-section  $A$  and Young’s Modulus  $Y$  is stretched slowly by a very small length  $x$  within its elastic limit. Find the following: 2+2
- (i) What is the corresponding tensile force?
- (ii) Find the strain energy in the stretched wire.

**N.B. :** *Students have to complete submission of their Answer Scripts through E-mail / Whatsapp to their own respective colleges on the same day / date of examination within 1 hour after end of exam. University / College authorities will not be held responsible for wrong submission (at in proper address). Students are strongly advised not to submit multiple copies of the same answer script.*

————x————