# Bachelor of Science Examination (Supplementary), 2018

## (1st Year, 1st Semester)

# PHYSICS : SO1

## (SUBSIDIARY)

Time: Two Hours | Full Marks: 50

ANSWER ANY FOUR QUESTIONS.

(1). (a) Given a vector $\vec{A} = 3\hat{i} + 4\hat{j} - 4\hat{k}$, find a unit vector $\hat{B}$ that lies in the $XY$ plane and is perpendicular to $\vec{A}$. Find also a unit vector $\hat{C}$ that is perpendicular to both $\vec{A}$ and $\hat{B}$.

(b) Now let $\vec{V}$ be any arbitrary vector in 3 dimensions and let $\hat{n}$ be a unit vector in some chosen fixed direction. Show that the vector $\vec{V}$ can always be decomposed as: $\vec{V} = \left(\vec{V}\cdot\hat{n}\right)\hat{n} + \left(\hat{n}\times\vec{V}\right)\times\hat{n}$. [7 + 5½]

(2). A particle moving on the 2-dimensional plane has its trajectory suitably described in polar coordinates. $(r, \theta)$ by the equation: $r = C_0 e^{\theta}$. It is given that the angular velocity of the particle is constant. Find the expressions for the *radial* and the *tangential* components of the acceleration of the particle (in plane polar coordinates). Hence show that the radial acceleration of the particle vanishes and its tangential acceleration is proportional to its distance from the origin. [12½]

(3). (a). Define *work* done by a force. What do you mean by a *conservative* force. A point mass moves under the action of an external force $\vec{F}$. Write down the expression for the total work done in moving the mass along an arbitrary closed loop, and hence establish that if $\vec{F}$ is conservative, this work done is zero.

(b). A particle is moving on the $XY$-plane with its velocity $\vec{v}$ given by, $\vec{v} = 5\left(y\hat{i} - x\hat{j}\right)$. Find the equation of its trajectory on the $XY$-plane. [9 + 3½]

(4). If the sum of two vectors is equal (in magnitude) to their difference, then show that these two vectors must be perpendicular to each other. On the $XY$ plane, consider the figure $ABCD$ which has vertices at $(0,0), (2,0), (3,1)$ and $(1,1)$. Find the vectors $AC$ and $BD$. Hence show that the angle between the diagonals of $ABCD$ is $\cos^{-1}(-\frac{1}{\sqrt{5}})$ [5 + $7\frac{1}{2}$]

(5). Explain the notion of a *rigid* body. A rigid body is undergoing pure rotation about an axis with angular velocity $\vec{\omega}$. What is the expression for its *Moment of Inertia* and explain how it is related to the rotational kinetic energy of the body.

Consider a right circular cylinder (of mass $M$ and) with radius $R$ and length $L$. Find its moment of inertia about its principal axis (the axis running parallel to its length). [2 + $5\frac{1}{2}$ + 5]

(6). (a) The trajectory of a body undergoing simple harmonic motion in one dimension is given by: $x = A_0 \cos(\omega t + \phi)$. Obtain the expression for its total energy at any point of its trajectory, and show that it is conserved.

(b) Consider a solid sphere of radius $R$ and mass $M$. Find the gravitational potential due to this mass distribution at a point $P$ which is at a distance $r$ from the centre of the sphere. Consider the two different cases: $(i)$ when $0 < r < R$, and $(ii)$ when $r > R$. [ 6 + $6\frac{1}{2}$]

7. (a) State Hooke's law.

(b) What is Poisson's ratio?

(c) Show that for a homogeneous isotropic medium Y = 2n (1 + $\sigma$). Show that $\sigma$ lies between +0. and -1.0, where Y, n and $\sigma$ are the Young's modulus, modulus of rigidity and Poisson's ratio respectively. (2+2+6.5+2)

8. (a) Define surface tension. What is the dimension of surface tension

(b) What is capillary action? Explain why water rises in a narrow glass tube. Describe the capillary tube method of measuring the surface tension of a liquid. (2+1+1+2+6.5)

9. (a) What is meant by coefficient of viscosity.

(b) What is Reynold's number?

(c) Derive Poiseuille's equation for flow of liquid through a horizontal narrow tube.

(3+3+6.5)

10. Write Short Notes on (Any Two): [2 X 6]

(*i*) The Parallel Axis Theorems of Moment of Inertia.

(*ii*) The phenomenon of *Resonance.*

(*iii*) Angular Momentum and Torque of a rigid rotatiing body.

(*v*) Radius of gyration of a rigid rotating body.