

## BACHELOR OF SCIENCE (B.Sc.)

## Term-End Examination

June, 2014

## PHYSICS

## PHE-04 : MATHEMATICAL METHODS IN PHYSICS-I

Time :  $1\frac{1}{2}$  hours

Maximum Marks : 25

**Note :** Attempt **all** questions. The marks for each question are indicated against it. Symbols have their usual meaning. You may use a log table or calculator.

1. Answer any **three** parts : 3×4=12

(a) Three vectors  $\vec{a}$ ,  $\vec{b}$  and  $\vec{c}$  are given by

$$\vec{a} = 2\hat{i} + 4\hat{j} + \hat{k}$$

$$\vec{b} = 7\hat{i} + 4\hat{j} + 2\hat{k}$$

$$\vec{c} = 4\hat{i} + 3\hat{j} + \hat{k}$$

Determine the angle between the vectors

$$(\vec{b} - \vec{a}) \text{ and } (\vec{c} - \vec{a}).$$

(b) Obtain the unit vector normal to the surface of a cone  $z^2 = 4(x^2 + y^2)$  at the point (1, 0, 2).

- (c) The spherical polar coordinates  $u_1 = r$ ,  $u_2 = \theta$  and  $u_3 = \phi$  are related to the cartesian coordinates  $x, y, z$  as follows :

$$x = r \sin \theta \cos \phi$$

$$y = r \sin \theta \sin \phi$$

$$z = r \cos \theta$$

Show that the spherical polar coordinate system is orthogonal.

- (d) Compute  $(\vec{A} \times \vec{B}) \cdot (\vec{C} \times \vec{D})$  for the vectors

$$\vec{A} = \hat{i} + 2\hat{j}$$

$$\vec{B} = -3\hat{i} + 2\hat{j}$$

$$\vec{C} = 2\hat{i} + 3\hat{j} + 4\hat{k}$$

$$\vec{D} = 6\hat{i} - 7\hat{j} + 2\hat{k}$$

- (e) The position vector  $\vec{r}(t)$  of a particle of mass  $m$  is moving on a curve given by

$$\vec{r}(t) = 3t^2\hat{i} + 6t\hat{j} + 7\hat{k}$$

Determine the angular momentum of the particle about the origin.

2. Obtain the work done by the force

$$\vec{F} = z\hat{i} + x\hat{j} + y\hat{k}$$

in moving a particle along the curve  $x = \cos t$ ,  
 $y = \sin t$ ,  $z = 3t$  for  $(0 \leq t < 2\pi)$ .

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OR

State Gauss's divergence theorem and use it to evaluate the surface integral  $\int_S \vec{A} \cdot d\vec{S}$  over a

spherical surface of radius 2 units, for

$$\vec{A} = 7x \hat{i} - z \hat{k}. \quad 5$$

3. The probability of a successful brain operation is 0.2. What is the probability that at least one person out of 10 undergoing the operation will survive? 3

**OR**

The probability distribution for a continuous random variable  $X$  lying between  $0 \leq X \leq \infty$  is  $e^{-X}$ . Calculate the mean  $\langle X \rangle$  and the variance  $\sigma$ . 3

4. Resistance of a coil at different temperatures is measured. The data is given below :
- |          |     |     |     |     |     |
|----------|-----|-----|-----|-----|-----|
| T (°C) : | 40° | 50° | 60° | 70° | 80° |
| R (Ω) :  | 1.2 | 1.3 | 1.4 | 1.6 | 1.7 |
- Obtain the equation  $R = a + bT$  for the best fit. 5

**OR**

Obtain the value of  $E(X^2)$  for the Poisson distribution : 5

$$p(x; m) = \frac{e^{-m}}{x!} m^x.$$