BACHELOR OF SCIENCE (B.Sc.)

Term-End Examination

June, 2016

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 meanings.*

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

(a) Determine a unit vector normal to the plane formed by the vectors $\vec{A} = 2\hat{i} + \hat{j} - \hat{k}$ and $\vec{B} = \hat{i} - \hat{j} + \hat{k}$.

(b) Determine the directional derivative of $f(x, y, z) = xy + z^2$ at the point (1, 0, 2) along the vector $\vec{A} = 2\hat{i} + \hat{j} + 3\hat{k}$.

(c) Show that for a vector field $\vec{A}(x, y, z)$, $\vec{\nabla} \cdot (\vec{\nabla} \times \vec{A}) = 0$.

(d) The relations between the spherical polar coordinates r, θ and ϕ and the Cartesian coordinates x, y and z are given by : $x = r \sin\theta \cos\phi$; $y = r \sin\theta \sin\phi$ and $z = r \cos\theta$. Calculate g_{ij} for all i, j and show that the spherical coordinate system is orthogonal.

(e) The position vector of a particle of mass m moving along a curve is given by

$$\vec{r} = ut\hat{i} + at^2\hat{j} + s_0\hat{k}$$

Calculate the velocity and angular momentum of the particle about the origin.

2. Calculate the work done by a force

$$\vec{F} = (x + 2y)\hat{i} + (2x - y)\hat{j}$$

in moving a particle along a circle of radius 3 with its centre at the origin and lying in the x-y plane. 5

OR

State Gauss's divergence theorem. Using the divergence theorem, evaluate the surface integral $\int_S (2x\hat{i} + 4y\hat{j} - 3z\hat{k}) \cdot \vec{dS}$ over the surface of a cube of side 2. 5

3. An unbiased dice is tossed 5 times. Calculate the probability of getting at least 3 sixes. 3

OR

A random variable x lying between 0 and 1 ($0 \leq x \leq 1$) has the probability density function $p(x) = 3x^2$. Calculate the mean $< x >$ and the variance σ. 3

4. When a resistance is measured six times, the following data is obtained :

R (in Ω) : 0·0461, 0·0464, 0·0460, 0·0463, 0·0461 and 0·0459.

Obtain the best value of the resistance and the standard error of the mean. 5

OR

The surface tension of a liquid is measured as a function of temperature. In appropriate units, the measured values are as given below :

Temp. (T)	0°	10°	20°	30°	40°
Surface Tension (σ)	80	72	60	55	50

Obtain the least square fit

$$\sigma = \sigma_0 + \alpha T$$

to the data. *5*