BACHELOR OF SCIENCE (B.Sc.)

Term-End Examination

December, 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 log tables or a calculator.*

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

(a) Determine the vector $\vec{A}$ normal to the vectors, $\vec{B}$ and $\vec{C}$ given by

$$\vec{B} = 2\hat{i} + 3\hat{j} + 5\hat{k}$$

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

(b) Obtain the directional derivative of $f(x, y, z) = 2x^2 + 3y^2 + z^2$ at the point (2, 1, 3) in the direction of the vector $\vec{a} = \hat{i} - 2\hat{k}$.

(c) A force $\vec{F} = 3\hat{i} - 6\hat{k}$ acts along a line passing through the point P(0, – 1, 4). Determine the torque about the point Q(4, 6, – 1).

(d) The cylindrical coordinates $u_1 = \rho$, $u_2 = \phi$, $u_3 = z$ are related to the Cartesian coordinates x, y and z as follows :

$$x = \rho \cos \phi, \quad y = \rho \sin \phi, \quad z = z.$$

Obtain the square of the arc element given by $ds^2 = g_{11}(du_1)^2 + g_{22}(du_2)^2 + g_{33}(du_3)^2$

(e) Define polar and axial vectors. Give one example of each.

2. Calculate the work done in moving a particle from (1, 1) to (3, 3) along the path x = y by the force

$$\vec{F} = (x + 2y)\hat{i} + (3x - y)\hat{j}$$ *5*

OR

State Stokes' theorem. Using Stokes' theorem evaluate the line integral $\oint \vec{F} \cdot \vec{dl}$ where $\vec{F} = y\hat{i} + z^3 x\hat{j} - yz^3\hat{k}$ over a circle of radius 2 parallel to the x – y plane at z = 3. *5*

3. An unbiased coin is tossed 10 times. Calculate the probability of getting at least 8 heads. *3*

OR

The probability distribution for a continuous variable $0 \leq x \leq L$ is given by $P(x) = \frac{2}{L} \sin^2 \frac{\pi x}{L}$. Calculate $\langle x \rangle$. *3*

4. The radius of a capillary tube is measured 6 times to obtain the following data :

0·0461 mm

0·0464 mm

0·0460 mm

0·0463 mm

0·0461 mm

0·0459 mm

Obtain the best value of the radius and standard error in the mean. *5*

OR

Show that the binomial distribution b(n; x, p) tends to the Poisson's distribution

$$p(x; m) = \frac{e^{-m} m^x}{x\,!}; \quad x = 0, 1, 2, \ldots$$

in the limit $n \to \infty$ but np remaining constant. 5