BACHELOR OF SCIENCE (B.Sc.)

Term-End Examination

June, 2017

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. You may use log tables or non-programmable calculators.*

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

(a) Determine the volume of a parallelepiped whose three adjacent sides are given by $\vec{a} = 2\hat{i} - 4\hat{k}$, $\vec{b} = \hat{i} + 2\hat{j} - \hat{k}$ and $\vec{c} = 2\hat{i} - 3\hat{j} + 4\hat{k}$.

(b) A rigid body is rotating with an angular speed of 3·0 rad s^{-1} about an axis OL = $2\hat{i} - 2\hat{j} + \hat{k}$, where O is the origin. Determine the velocity of the body at the point P(4, 1, 2).

(c) A particle moves along a curve whose parametric equations are $x = 3t^2$, $y = t^2 - 2t$, $z = t^3$, where the parameter t is time. Calculate its velocity and acceleration at $t = 2$ s.

(d) Calculate a unit vector normal to the surface $x^3 + y^3 + 3xyz = 3$ at the point $(1, 2, -1)$.

(e) Prove that :

$$\nabla^2(r^n) = n(n+1)\, r^{n-2}$$

2. Using the line integral, calculate the work done by the force $\vec{F} = (2y + 3)\,\hat{i} + xz\,\hat{j} + (yz - x)\,\hat{k}$ when it moves a particle from the point (0, 0, 0) to the point (2, 1, 1) along the curve $x = 2t^2$, $y = t$, $z = t^3$. 5

OR

Using Stokes' theorem, evaluate the integral $\int_C \vec{A} \cdot d\vec{l}$, where $\vec{A} = z^2\,\hat{j} + yz\,\hat{k}$ and C is a closed path in the yz-plane joining the points O(0, 0, 0), P(0, 3, 0) and Q(0, 3, 1). 5

3. A class in probability theory consists of 6 boys and 4 girls. An examination is conducted and the students are ranked according to their marks. Assuming that no two students obtain the same score, what is the probability that girls receive the top four scores ? *3*

OR

Calculate the probability of getting 3 heads when an unbiased coin is tossed five times. *3*

4. Determine the constants a and b such that the curve $y = ae^{bx}$ is the 'best fit' for the following data : *5*

x :	2	4	6	8	10
y :	4·0777	11·084	30·128	81·897	222·62

OR

Derive the expressions of the mean and variance of the following distribution

$$f(x) = \frac{1}{\sqrt{2\pi\sigma}} \exp\left(-\frac{x^2}{2\sigma^2}\right), -\infty < x < \infty. \quad 5$$