বিদ্যাসাগর বিশ্ববিদ্যালয়

VIDYASAGAR UNIVERSITY

Question Paper

B.Sc. Honours Examinations 2020

(Under CBCS Pattern)

Semester - I

Subject: PHYSICS

Paper : C 1-T & C 1-P

(Mathematical Physics - I)

Full Marks : 60 (Theory-40 + Practical-20)

Time : 3 Hours

Candidates are required to give their answers in their own words as far as practicable.
The figures in the margin indicate full marks.

C 1 - T

[THEORY]

Full Marks : 40

Answer any ***two*** questions : $2 \times 20 = 40$

1. (i) What is the difference between exact and inexact differential?

   (ii) Show that spherical polar co-ordinates are orthogonal curvilinear co-ordinates

   (iii) What is Lagrange multiplier?

   (iv) Write the geometrical interpretation of scalar triple product.

   (v) Find out the value of m if $\vec{A} = \hat{i} + 3\hat{j} - 2\hat{k}$, $\vec{B} = \hat{i} + \hat{k}$ and $\vec{C} = m\hat{i} + 4\hat{j}$ are coplanar.

(vi) Given $\vec{\nabla}.\left(\vec{\nabla}\times\vec{A}\right)=0$; what is the significance of vector $\vec{A}$? 3+5+2+4+5+1

2. (i) Find the constant a, b, c if a vector $\vec{V}$ is irrotational, where $\vec{V}=(x+2y+az)\hat{i}+(bx-3y-z)\hat{j}+(4x+cy+2z)\hat{k}$

(ii) Show that the necessary and sufficient condition for a vector $\vec{r}=\vec{f}(t)$ to have constant magnitude is f.df/dt = 0.

(iii) Evaluate $\iint_s \vec{F}.\hat{n}ds$, where $\vec{F}=4xz\hat{i}-y^2\hat{j}+yz\hat{k}$ and s is the surface of the cube bounded by x = 0, x = 1, y = 0, y = 1, z = 0, z = 1. 7+7+6

3. (i) Find the constant c, such that the function

$f(x)=\begin{cases}-cx^2, 0<cx<3 \\ 0, \text{otherwise}\end{cases}$ is a density function, and compute probability $p(1 < x < 2)$

(ii) Show that $F(r)\hat{r}$ is irrotational.

(iii) Obtain the expression of ∇^2 in plane polar co-ordinates.

(iv) If $\vec{a}.\left(\vec{b}\times\vec{c}\right)=0$ then write its significance. 6+6+6+2

4. (a) Write the Gaussian distribution function. Mention a physical phenomena that follow Gaumian distribution.

(b) Write a note on Divac delta function

(c) What is scalar and vector field?

(d) Define the directional derivative.

(e) If a, b, c are unit vectors satisfying the condition $\vec{a}+\vec{b}+\vec{c}=0$, show that $\vec{a}.\vec{b}+\vec{b}.\vec{c}+\vec{c}.\vec{a}=-3/2$

(f) Write the expression of the Gradient of φ in cylindrical polar co-ordinate system; φ is scalar quantity. (2+2)+4+3+3+4+2

Paper - C-1-P

(Mathematical Physics - I Lab)

(Practical)

Full Marks : 20

Answer any ***one*** question from the following : 1 × 20 = 20

- Write the necessary formula.
- Write the computer code in PYTHON
- Print the input and output

1. (i) Write a computer program to find the product of following matrices

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} \text{ and } B = \begin{bmatrix} 3 & 2 & 1 \\ 9 & 8 & 7 \\ 6 & 5 & 4 \end{bmatrix}$$

(ii) Consider the error function

$$\text{erf}(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} \, dt,$$

the values of which are given as

x	1.0	1.2	1.4	1.6	1.8	2.0
erf(x)	0.84270	0.91031	0.95229	0.97635	0.98909	0.99532

Write a forward or backward difference interpolation program to calculate the value of $\text{erf}(1.433)$. 8+12

2. (i) Given some data : x = 28, 75, 87, 92, 132, 54, 67, 12; find the (arithmetic) mean and rms value of the carriable x.

(ii) Write a computer program to find the cosine series

$$\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \ldots$$ 8+12

3. (i) Write a computer program to compute *n*!, where *n* = 10.

(ii) Write a computer program following Newton-Raphson method to find out a real root of the equation $\cos x = 3x - 1$ around $x \approx 1$. 8+12

4. (i) Write a computer program to check whether 153 is Armstrong number.

(ii) Compute : $\int_{1.8}^{3.4} f(x)\,dx$, where we have

x	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4
$f(x)$	6.050	7.389	9.025	11.023	13.464	16.445	20.086	24.533	29.964

8+12

5. (i) Write a computer program to check 1999 and 2020 are leap year or not.

(ii) The temperature θ of a well stired liquid by the isothermal heating coil is given by the equation :

$$\frac{d\theta}{dt} = K(100 - \theta)$$

where K is a constant of the system. Write a computer program to solve the equation by Runge-Kutta fourth order method to find θ at t = 1.0 sec for K = 2.5. Initial condition : $\theta = 25°C$ at t = 0 sec. 8+12

6. (i) Write a program to calculate variance and standard deviation of five numbers : 34, 88, 32, 12, 10.

(ii) Calculate the value of the elliptical integral of the first kind :

$$K(0.25) = \int_0^{\pi/2} \frac{dx}{\sqrt{1 - 0.25\sin^2 x}}$$

Divide the intervals $[0, \pi/2]$ into 1000 equal parts and use composite Trapezoidal rule to evaluate the integral 8+12

7. (i) Write a computer program where you utilize random number generator to evaluate the value of π with the level of accuracy of 10^{-4}.

(ii) Compute :

$$\binom{N}{n} = \frac{N!}{n!(N-n)!}$$

for N = 15, n = 6 10+10

8. (i) Write a computer program to find out the sum of digits of 87694.

(ii) Compute the value of π from the formula :

$$\frac{\pi}{4} = \int_0^1 \frac{dx}{x^2+1}$$

Use composite Simpson's 1/3 rule to evaluate with an accuracy of the order of 10^{-5}. 8+12

9. (i) Write a program to verify approximately,

$$\ln 100! \approx 100 \ln 100 - 100$$

(ii) The distance travelled by a car in km, at intervals of 2 min are given as follows :

Time (min)	2	4	6	8	10
Distance (km)	0.75	2.00	3.50	5.35	8.00

Write a computer program to evaluate the velocity at $t = 5$ min. 8+12

10. (i) A set of 20 numbers are given : 1, 0.1, 5, 4, 10, –1, 3, 20, 1000, –9, 2, 14, 4.5, 0.9, 30, 9.8, 11, 22, 38, –10. Write a computer program to count how many numbers are there between 0 to 10.

(ii) Write a computer program to find the roots of the equation

$$x^3 - 3x + 5 = 0$$

by Bisection method. 8+12