2019

B.Sc. (Hons.)

1st Semester Examination

PHYSICS (Honours)

Paper—C 1-P

Full Marks : 20 Time : 3 Hours

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

Attempt any one set of questions from the following : 15 Marks

Total Marks = 20 [Programming, execution, I/O (or graphical display) = 15, Viva + LNB = 5]

Each Question has two parts and carries 10 marks (5+5).

Instructions :

- Write the necessary formula and algorithmic steps.
- Write a clear Python Script (in a file or on interpreter).
- Print the Input and Output.
- Display you result graphically if asked.

1. (i) Create a list of 50 random integers between [1, 10]. Compute the sum and mean of that numbers. [Hint : Use 'randint ( )' function from 'random' module.]

[Turn Over]

(ii) Let an ellipse be given by $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, where we assume that a < b. Compute the parameter (L) of the ellipse where, $L = 4b\int_0^{\pi/2}\sqrt{1-k^2\sin^2\theta}\,d\theta$, where $k^2 = 1 - \frac{a^2}{b^2}$. You may take any value of a and b as input. Use composite Simpson's 1/3 rule to evaluate.

2. (i) In an experiment you recorded some values for some quantity x as the following : 0.98, 1.01, 1.03, 0.96, 1.10, 0.87, 0.89, 1.0, 1.05, 1.11. Compute the standard deviation, $\sigma = \sqrt{\overline{x^2} - \bar{x}^2}$. Also calculate the error bar $\varepsilon = \sigma/\sqrt{n}$.

(ii) Write a Decaying equation for radioactive decar :

$$\frac{dM}{dt} = -\lambda M$$, with $\lambda = 2$, $M(0) = 100$. Solve this by Euler method and plot the solution.

3. (i) A set of 20 numbers are given : 1, 0.1, 5, 3, 10, −1, 4, 20, 100, −9, 2, 14, 4.5, 0.9, 30, 9.8, 11, 22, 48, −10. Write a computer program to count how many numbers are there between 0 to 10 (the upper and lower limits excluded).

(ii) Estimate f (13), given the following table of values :

x	10	12	14	16	18	20
y = f (x)	46	66	81	93	101	108

Use Newton-Gregory Forward difference formula for interpolation.

4. (i) Define a function to compute factorial of an integer. Then use this to find our $\begin{pmatrix} m \\ n \end{pmatrix}$, where m 15, n = 6.

(ii) A population growth model is given by $\frac{du}{dt} = \alpha u (1 - u/R)$, where $\alpha > 0$ and R is the maximum possible value of R. Set the values of α and R yourself and solve the equation by Runge-Kutta 4th order method to print u t different t.

5. (i) Given, $z_1 = 4 - 3j$ and $z_2 = -1 + 2j$, evaluate (i) $|4z_1 - 3z_2|$, (ii) $\sqrt{z_1 z_2}$.

(ii) Find out at least one root of the equation : $f(x) = x^3 - x^2 - 2x + 1$ by bisection method.

6. (i) Starting with $x_0 = 0$ and $x_1 = 1$, generate 20 Fibonacci numbers with the sequence : $x_{n+1} = x_n$

$+ x_{n1}$ and then calculate the sum series sum :

$$S = \Sigma \frac{1}{x_n^2}.$$

(ii) Compute the following integral to verify the expression : $\int_0^{\pi} \frac{x}{x^2+1} \cos(10x^2) = 0.0003156.$

Use composite Simpson's 1/3rd rule. Comment on how your solution can be improved.

7. (i) Calculate the sum $\sum_{k=0}^{\infty} \frac{1}{n^k}$

for n = 2 with an accuracy level of 4 decimal places.

(ii) Compute the following integral :

$$\int_{-\pi/3}^{\pi/3} x^3 \tan x \, dx$$

Use composite Simpson's 1/3 rule. Check your result by increasing the subintervals and comment on the observation how it approaches towards accurate result.

8. (i) Given a string 'university', count how many vowels are there in the string.

(ii) The equation for projectile motion is,

$$u'' = -\frac{k}{m} u' + g$$

Here g = 9.81 (unit), acceleration due to gravity. Take mass, m = 5 (unit) and k = 0.8. Find out the solution and plot the trajectory. Solve this by Euler method.

9. (i) Write a python script to evaluate $\Gamma\left(\frac{21}{2}\right)$, where

$$\Gamma(n + 1/2) = \frac{1.3.5....(2n-1)}{2^n}\sqrt{\pi}.$$

(ii) Solve : $\frac{dy}{dx} + y = x$, $y(0) = 1$ by RK4 method.

10. (i) Find C = 4A − 3B, where

$$A = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}, \quad B = \begin{pmatrix} 9 & 8 & 7 \\ 6 & 5 & 4 \\ 3 & 2 & 1 \end{pmatrix}.$$

(ii) Use the Newton-Raphson method to find the smallest and the second smallest positive roots of the equation $\tan\theta = 4\theta$, correct up to 4 decimal places.

11. (i) Given a number 38479297483, check if this is a palindrome number. [Hint : You may treat the number as a string.]

(ii) Evaluate the following differential equation by RK4 method :

$$e^{y}\frac{dy}{dx}+x^2y^2=2\sin(3x),\ y(0)=5$$

Print the values of (x, y) on screen. Print the output (x, y) in separate lists.

12. (i) Find out f (10), where f (n) + f (n – 1) + 10 and f (0) = 1.

(ii) Given a list of θ-values (in radian) in [0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5] and the corresponding sin (θ) values in [0, 0.48, 0.84, 1.0, 0.91, 0.60, 0.14, –0.35], use any kind of interpolation method to find out sin (1.8).

13. (i) Given a list of number [2.0 –1.2, 3.4, 9.1, 0.1, –5.8, –4.2, 3.9, 10.4, 1.9, –3.8, –9.6], take numbers with index no. 4 to 8 (end elements included) by slicing. Check if the sum of this sliced list of numbers is more or less than the sum of all the numbers in the original list.

(ii) Using Simpson's 1/3 rd rule, calculate

$$\int_{-0.5}^{0.8} x^3\sqrt{1-x^2}\,dx,$$

correct up to 3 decimal places.

14. (i) Given the list of numbers : [–1, 4, –3.8, –8.9, –10, 10, 22, 9, –2, 9.2], write a python script to read the list and print two separate lists consisting of positive and negative numbers.

(ii) Approximate $\int_1^3 e^{x^2} dx$ using Simpson's rule for n = 8, where

	x_0	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
x =	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3

15. (i) Find the value of π from the infinite series : $\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} + \ldots$ up to 6th decimal point of accuracy.

(ii) Using Trapezoidal rule, evaluate : $\int_0^2 xe^{-x^2}$ taking 100 and 1000 subintervals.

16. (i) Given a continued fractions,

$$S = 3 - \cfrac{2}{3 - \cfrac{2}{3 - \cfrac{2}{3 \ldots}}}$$, write a recurrence relation

to find out the terminating value of S. Start from any guess value other than 1.

[*Turn Over*]

(ii) Write a program using the Newton-Raphson method to determine the roots of the equation : $f(x) = x^3 - x^2 - 2x + 1$.

17. (i) Given the matrix, $A = \begin{pmatrix} 2 & -5 & -11 & 0 \\ -9 & 4 & 6 & 13 \\ 4 & 7 & 12 & -2 \end{pmatrix}$,

compute A^T.

(ii) A ball at 1200 K is allowed to cool down in air at an ambient temperature of 300 K. Assuming heat is lost only due to radiation, the differential equation for the temperature of the ball is given by

$$\frac{d\theta}{dt} = -3.58\times10^{-12}\left(\theta^4 - 81\times10^8\right), \ \theta(0) = 1200K$$

where θ is in K and t in seconds. Find the temperature at t = 480 seconds using RungeKutta 4th order method. Assume a step size of h = 10 seconds.