2019

PHYSICS — HONOURS — PRACTICAL

Paper : CC-5-P

Full Marks : 30

Set-1

Date : 26/11/2019

[Program = 20, CNB = 5, Viva = 5]

Answer ***any one*** question.

1. (i) Create a one-dimensional array of 50 random numbers in the interval : [0, 2] with the help of an appropriate function from random module in numpy. Compute the standard deviation (σ) of those numbers. Use the formula $\sigma = \sqrt{\langle x^2 \rangle - \langle x \rangle^2}$

(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 $k^2 = 1 - \frac{a^2}{b^2}$. The values of a and b may be supplied or chosen by you. Use composite Simpson's 1/3rd rule to evaluate.

(i) Program : 4, Output : 1

(ii) Algorithm : 3, Program : 10, Output : 2

2. (i) Plot the following three functions in the same graph using matplotlib : $y = x^2, y = e^{x/2}, y = 5x$. Take $x \in [0, 10]$.

Label the axes as 'X' and 'Y' and write title 'My Graph'.

(ii) Write a Python script to determine one root of the equation :

$x^4 - 1.99x^3 - 1.76x^2 + 5.22x - 2.23 = 0$ which is close to $x = 1.5$. Use bisection method.

(i) Program : 6, Output : 2

(ii) Algorithm : 3, Program : 7, Output : 2

3. (i) Create a one-dimensional numpy array with 20 random numbers between [– 1, 1]. Reshape this into a (4, 5) 2D array. Treat this as a 4×5 matrix. Transpose the matrix and take product between the two. Print the product matrix.

(ii) Solve : $\frac{dy}{dx} + y = x,\ y(0) = 1$ by Euler method to find $y(10)$.

Plot y vs. x in the range [0, 10] using matplotlib. Label the axes as 'X-axis' and 'Y-axis'.

(i) Program : 5, Output : 1

(ii) Algorithm : 2, Program : 8, Output : 1, Plot : 3

4. (i) Given the array of numbers [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 slice array of numbers is more or less than the sum of all the numbers in the original array.

(ii) Solve the following 1st order differential equation by Euler method :

$$\dot{u} = \left(1 - \frac{4}{3}t\right)u, \quad u\,(0) = 1.$$

Plot the solution by matplotlib along with the exact result : $u(t) = \exp\,(t - {}^{2}/_{3}\, t^2)$.

(i) Program : 4, Output : 2

(ii) Program : 8, Plot : 3+3

5. (i) Given a numpy array $[[1, 2, 3, 4, 5], [0, 1, 2, 3, 4]]$ treat the first element as x-data and the second element as y-data. Plot y^2 vs. x through matplotlib. Label the axes as 'X-Data' and 'Y-Data' and set title as 'Experimental plot'.

(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

$$\frac{d\theta}{dt} = -3.58 \times 10^{-12}\left(\theta^4 - 81 \times 10^8\right),\ \theta(0) = 1200\text{K}$$

where θ is in K and t in seconds. Find the temperature at t = 480 seconds using Euler method. Assume a step size h = 10 seconds.

(i) Program : 4, Plot : 2

(ii) Algorithm : 2, Program : 10, Output : 2

6. (i) Use the function, simps() or quad() to find out the following integral :

$$I = \int_0^{4.5} J_{2.5}(x)\,dx$$

The integrand is a Bessel function which you can obtain from importing the scipy.special module. Check the result and compare with the following true value,

$$I = \sqrt{\frac{2}{\pi}}\left(\frac{18}{27}\sqrt{2}\cos(4.5) - \frac{4}{27}\sqrt{2}\sin(4.5) + \sqrt{2\pi}.\,Si\left(\frac{3}{\sqrt{\pi}}\right)\right), \text{ where}$$

$Si(x) = \int_0^x \sin\left(\frac{\pi}{2}t^2\right)dt$ is the Fresnel Sine Integral, using the functions in special module.

[Hint : Use $jn(n, x)$, $n = 2.5$..]

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

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

Use Simpson's 1/3rd rule to evaluate with an accuracy of 10^{-4}.

(i) Program : 8, Output : 2

(ii) Algorithm : 2, Program : 7, Output : 1

7. (i) For a random variate x, generate an array of 50 random values between 0 and 1 using numpy array.

Find the relative fluctuation $\sqrt{\langle x^2\rangle - \langle x\rangle^2} \big/ \langle x\rangle$.

(ii) Generate (x, y) data where x-values are from 0 up to 2.0 in the equal interval of $\Delta x = 0.2$ and y-values follow $y = \sin(x^2)$. Now you have to find out $\sin(0.9^2)$ from the data set through Lagrange interpolation.

(i) Program : 4, Output : 2

(ii) Algorithm : 2, Program : 10, Output : 2

8. (i) Consider a vector, $r = (2, 1, 3)$ in the XYZ coordinate system. The vector is rotated by $\theta = 35°$ with the following rotational operator : $R = \begin{pmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix}$. Find the new vector.

(ii) Using Newton-Raphson method, find the root of the equation $x^3 + (x+1)^2 + 4x = 20$ that lies in the range $1.0 < x < 2.5$, correct up to 4 decimal places. Comment on the other roots by plotting the function using matplotlib.

(i) Program : 4, Output : 2

(ii) Algorithm : 2, Program : 8, Output : 2, Comment : 2

2019

PHYSICS — HONOURS — PRACTICAL

Paper : CC-5-P

Full Marks : 30

Set-2

Date : 27/11/2019

[Program = 20, CNB = 5, Viva = 5]

Answer ***any one*** question.

1. (i) Using an appropriate numpy function, create a one dimensional array of 9 numbers from 1 to 2 and then reshape the array to make it a 3 × 3 array. Now treat this as a 'matrix'. Obtain a symmetric matrix of the same order using this matrix. Using linear algebra module in numpy, obtain the eigenvalues and eigenvectors. Check, if the eigenvectors are orthogonal to each other or not.

(ii) The equation for radioactive decay : $\frac{dM}{dt} = -\lambda M$, with $\lambda = 2$, $M(0) = 100$. Solve this by Euler method. Store the output in lists and plot the solution through matplotlib. Label the axes as 'Time' and 'Mass'.

(i) Program : 6, Output : 2

(ii) Algorithm : 2, Program : 6, Output : 1, Plot : 3

2. (i) Given two matrices, $A = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$ and $B = \begin{pmatrix} 5 & 6 \\ 7 & 8 \end{pmatrix}$, write steps to confirm that $(AB)^T = B^T A^T$.

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

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

(i) Program : 6, Output : 2

(ii) Algorithm : 2, Program : 7, Output + Comment : 2+1

3. (i) Compute $C = AB - BA$, where

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

(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.

(i) Program : 5, Output : 1

(ii) Algorithm : 2, Program : 8, Output : 2+2

4. (i) Create a numpy array of 100 random numbers between [0, 1] and arrange the numbers in ascending order. Isolate the first 50 numbers to a separate array and the last 50 numbers to another array. Now compute the difference of the averages of the two arrays.

(ii) Approximate $\int_1^3 e^{x^2}\,dx$ using Simpson's 1/3rd 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

(i) Program : 5, output : 2

(ii) Algorithm : 2, Program : 8, Output : 3

5. (i) Numerically show that the following identity holds :

$$(n+1)P_{n+1}(x) = (2n+1)xP_n(x) - nP_{n-1}(x)$$

Here $P_n(x)$ is n-th order Legendre polynomial. Use appropriate modules and functions in Python to show this for $n = 4$ and 5.

(ii) Evaluate error function $erf(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2}\,dt$ for a set of x-values between [– 4, 4] and plot. Use Simpson's 1/3rd rule explicitly to evaluate the integral.

(i) Program : 4, Output : 2

(ii) Algorithm : 2, Program : 10, Output : 2

6. (i) Consider a vector, $r = (2, 1, 3)$ in the XYZ coordinate system. The vector is rotated by $\theta = 45°$ with the following rotational operator : $R = \begin{pmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix}$. Find the normalized new vector.

(ii) Solve : $y' + 2y = 2 - e^{-4t}$, $y(0) = 1$ by Euler method.

Exact Solution $y(t) = 1 + \frac{1}{2}e^{-4t} - \frac{1}{2}e^{-2t}$.

Plot the numerical solution and the exact solution on the same graph by matplotlib. Label the axes as 'Time' and 'Displacement'.

(i) Program : 5, Output : 1

(ii) Algorithm : 2, Program : 8, Plot : 4

7. (i) Let $A = \begin{pmatrix} 1 & -2 \\ 4 & 5 \end{pmatrix}$, where the characteristic (eigenvalue) equation is $x^2 - 6x + 13 = 0$. It is said (by Caley-Hamilton theorem) that the matrix A satisfies this characteristic equation. Establish this numerically.

(ii) Find $\sqrt{10}$ by bisection method.

(i) Program : 5, Output : 1

(ii) Formulation : 2, Algorithm : 2, Program : 8, Output : 2

8. (i) Establish the following identity numerically :

$$1 = [J_0(x)]^2 + 2\sum_{k=1}^{\infty} [J_k(x)]^2,$$

where J_k's are Bessel functions of first kind. Use scipy.special module.

(ii) Estimate the integral with accuracy level of 0.0001 by Simpson's 1/3rd method :

$$I = \int_0^1 \left(\frac{3}{x^2\sqrt{2\pi}}\right) e^{-9/\left(2x^2\right)} dx$$

(i) Program : 4, Output : 2

(ii) Algorithm : 3, Program : 9, Output : 2

2019

PHYSICS — HONOURS — PRACTICAL

Paper : CC-5-P

Full Marks : 30

Set-3

Date : 28/11/2019

[Program = 20, CNB = 5, Viva = 5]

Answer ***any one*** question.

1. (i) A generating function of Legendre polynomial $P_n(x)$ is given by

$$g(t,x) = \left(1 - 2xt + t^2\right)^{-1/2} = \sum_{n=0}^{\infty} P_n(x) t^n$$

Numerically and approximately verify this by taking one chosen set of values of x and t. Use the scipy.special module to obtain Legendre polynomials.

(ii) Estimate $f(15)$ from the following table of values :

x	10	12	14	16	18	20	22
$y = f(x)$	46	66	81	93	77	53	36

Use Lagrange interpolation formula.

(i) Program : 6, Output : 2

(ii) Algorithm : 2, Program : 8, Output : 2

2. (i) Create a one-dimensional numpy array with 15 random numbers between [– 2, 2]. Reshape this into a (5, 3) 2D array. Treat this as a 5 × 3 matrix. Transpose the matrix and take product between the two and print the trace of the product matrix.

(ii) The temperature θ of a well stirred 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 Euler method to find θ at $t = 1.0$ sec for $K = 2.5$. Initial condition : $\theta = 25°$ C at $t = 0$ sec.

(i) Program : 7, Output : 1

(ii) Algorithm : 2, Program : 8, Output : 2

3. (i) Create two 1D random arrays to length 10 each, through numpy. Print the two arrays. Compare the two arrays and check if they are same. Find the mean values of the two arrays of numbers.

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

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

Print the output (x, y) in separate lists, taking the range of x in $[0, 5]$ with step 0.2.

(i) Program : 4, Output : 2

(ii) Algorithm : 2, Program : 10, Output : 2

4. (i) Generate 100 random integers between 1 to 100 from an appropriate function in random module in numpy. Now treat the first 10 values as x-data and the last 10 values as y-data. Plot x-y through matplotlib as scattered points with symbols. Set the symbol size as 14 point.

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

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

Divide the interval $[0, \pi/2]$ into 1000 equal parts and use composite Simpson's $1/3^{rd}$ rule to evaluate the integral.

(i) Program : 4, Plot : 2

(ii) Algorithm : 2, Program : 10, Output : 2

5. (i) Establish the following identity numerically,

$$\int_{-1}^{1} P_n(x)P_m(x)dx = \frac{2}{2n+1}\delta_{mn},$$

where P_n's are the Legendre polynomials. Utilize the Legendre polynomials and integration function from the suitable modules.

(ii) The period of a pendulum of length L oscillating at a large angle α is given by

$$T = \frac{2T_0}{\pi} \int_0^{\pi/2} \frac{d\varphi}{\left(1 - \sin^2 \alpha/2 \sin^2 \varphi\right)^{1/2}}.$$

Now, write a script to solve with Simpson's $1/3^{rd}$ rule.Calculate the ratio T / T_0 for $\alpha = 45°$.

(i) Program : 6, Output : 2

(ii) Algorithm : 2, Program : 8, Output : 2

6. (i) Generate 12 random numbers between 0 to 1 using numpy, reshape it into a 3×4 array, call it A. Now reshape the same set of numbers into a 4×3 array, call it B. Now treat A and B as matrices. Compute $C = AB$.

(ii) Given the system of equations :

$$4x + y + 2z = 4$$
$$3x + 5y + z = 7$$
$$x + y + 3z = 3$$

Write a Python script to solve for x, y, z following Gauss-Seidel method.

(i) Program : 4, Output : 2

(ii) Algorithm : 2, Program : 10, Output : 2

7. (i) Given a set of data (in appropriate units) from a measurement,

Temperature	0	20	40	60	80	100
Pressure	0.0002	0.0012	0.0060	0.0300	0.0900	0.2700

Plot the Temperature-Pressure data with matplotlib with data-points as discrete symbols and lines. Label the axes and write 'Temperature-Pressure graph' as legend inside the graph.

(ii) Create 10 x-data values in the interval [0, 1] by numpy, with equal interval. Now, consider y-values are given by $y = 4x^3$. Using forward difference formulas,

$y' = (f(x+\Delta x) - f(x-\Delta x))/(2\Delta x)$ and

$y'' = (f(x+\Delta x) - 2f(x) + f(x-\Delta x))/\Delta x^2$, obtain the arrays for 1st and 2nd order differentials and plot them in separate graphs by matplotlib.

(i) Program : 4, Plot : 2

(ii) Program : 8, Plot : 6

8. (i) It is given that $P=\begin{pmatrix} 1 & 4 \\ -1 & 1 \end{pmatrix}$ and $A=\begin{pmatrix} 5 & 4 \\ 1 & 2 \end{pmatrix}$. Do a similarity transformation on A by P and find the new matrix B. [Similarity Transform : $B = P^{-1} AP$]

(ii) Calculate the following integral by composite Trapezoidal rule : $\int_0^5 \frac{1}{1+x^2}\, dx$.

Verify that the answer is $\arctan(5)$.

(i) Program : 4, Output : 2

(ii) Algorithm : 2, Program : 8, Output : 4

2019

PHYSICS — HONOURS — PRACTICAL

Paper : CC-5-P

Full Marks : 30

Set-4

Date : 29/11/2019

[Program = 20, CNB = 5, Viva = 5]

Answer ***any one*** question.

1. (i) If your (x, y) data is given in the form : [(1, 2), (2, 3), (3, 8), (4, 12), (5, 20)], using numpy extract the data in the form of x-list and y-list and plot through matplotlib. Set x-limit on the x-axis between 0 and 6 and y-limit on the y-axis between 0 and 25.

(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 u. Set the values of α and R yourself and solve the equation by Euler method to print $u - t$ in a file.

(i) Program : 8, Plot : 2

(ii) Algorithm : 2, Program : 6, Data File : 2

2. (i) The set $O = \{u_1, u_2, u_3\} = \left\{\left(\frac{1}{\sqrt{2}}, 0, 1/\sqrt{2}\right), (0, 1, 0), \left(\frac{1}{\sqrt{2}}, 0, -1/\sqrt{2}\right)\right\}$ is an orthonormal basis set for 3D Euclidean space. Check this numerically. Use Numpy.

(ii) Use the following discrete differentiation with forward differences :

$$f'(x) = \frac{f(x+\Delta x) - f(x-\Delta x)}{2\Delta x}$$

$$f''(x) = \frac{f(x+\Delta x) - 2f(x) + f(x-\Delta x)}{\Delta x^2}$$

Calculate $f'(x)$ and $f''(x)$ at all possible points where
x = [0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9] and
y = [0, 0.004, 0.032, 0.108, 0.256, 0.5, 0.864, 1.372, 2.048, 2.916].
Plot $(x, f'(x))$ and $(x, f''(x))$ in two different graphs with matplotlib.

(i) Program : 4, Output : 2

(ii) Program : 8, Plot : 3+3

3. (i) Plot $y = x^2 \sin x$, where x ranges from 0 to 6π with spacing 0.15. Use plotting function from matplotlib package. Label the axes and give a suitable title for the plot.

   (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).

   (i) Program : 4, Plot : 2

   (ii) Algorithm : 3, Program : 10, Output : 1

4. (i) Given a matrix $A = \begin{pmatrix} 5 & 1 \\ 3 & 3 \end{pmatrix}$,

   Find out the eigenvalues and eigenvectors and print them. Form the Diagonal matrix, D with the eigenvalues. Consider the matrix V whose columns are the eigenvectors. Now show that $V.D.V^{-1} = A$.

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

   (i) Program : 6, Output : 5

   (ii) Algorithm : 2, Program : 6, Output : 1

5. (i) Consider the logistic equation for a population $N : \frac{dN}{dt} = rN(1 - N/K)$, where r is the rate of growth and K is the carrying capacity. Take initial population of 80 with carrying capacity of 50 and growth rate 4. Solve this equation by Euler method at t = 10 and 100.

   (ii) Given a set of x-y data in the form of an array [1, 0.5, 2, 3.8, 3, 7.9, 4, 16.5, 5, 27.5] where the alternate elements are x and y. Prepare two separate lists for x and y and plot y against x with x-label as 'Time' and y-label as 'Temperature'.

   (i) Program : 4, Output : 2

   (ii) Algorithm : 2, Program : 8, Output : 4

6. (i) Consider the following numpy arrays :

$x = [2, 4, 5, 6, 8, 10]$ and $y = [5, 9, 11, 10, 12, 19]$.

Now calculate the correlation coefficient :

$$r = \frac{n\Sigma xy - \Sigma x \Sigma y}{\sqrt{n\Sigma x^2 - (\Sigma x)^2} \cdot \sqrt{n\Sigma y^2 - (\Sigma y)^2}}$$

Scatter plot (x, y) with matplotlib. Give title : "x–y Plot" with the axes labelled as 'X' and 'Y'.

(ii) In an electrical circuit, comprising of DC voltage sources and resistor elements, the mesh equations are written (by Kirchhoff's voltage law) as follows.

$$50I_1 - 30I_3 = 80$$
$$40I_2 - 20I_3 = 80$$
$$-30I_1 - 20I_2 + 100I_3 = 0$$

Solve this to find the currents by matrix inversion. [Hint : Use the module for linear algebra from numpy package.]

(i) Program : 7, Output : 2, Plot : 3,

(ii) Program : 6, Output : 2

7. (i) Plot $J_0(x)$, $J_1(x)$, $J_2(x)$, and $J_3(x)$, in four different graphs as subplots (four different graphs in the same plot) through matplotlib. In this $J_n(x)$'s are the Bessel functions of 1st kind which can be obtained from scipy.special module. Take x-scale from 0 to 10. [Hints : Consider $jn(n, x)$ function]

(ii) Generate (x, y) data where x-values are from 0 up to 2.0 in the equal interval of $\Delta x = 0.2$ and y-values follow $y = \sin(x^2)$. Now you have to find out y at $x = 0.3$ from the data set by Lagrange interpolation formula. Write a Python script for that.

(i) Program : 6, Plot : 2

(ii) Algorithm : 2, Program : 8, Output : 2

8. (i) Generate 100 random integers between 10 and 50 from an appropriate random module in numpy. Now treat the first 20 values as *X*-data and the last 20 values as *Y*-data. Plot *X*-*Y* through matplotlib as scattered points with big symbols.

(ii) Use bisection method to find the root of the equation.

$$\cos^2 x - 5.6\, x^2 + x + 20 = 0$$

that lies in the range $1 < x < 2.5$.

(i) Program : 6, Output : 2

(ii) Algorithm : 3, Program : 7, Output : 2

2016

PHYSICS — HONOURS — PRACTICAL

Eighth Paper

(Group – B)

Full Marks – 50

The figures in the margin indicate full marks

Programming Language : C or Fortran

Print the output of your programs at the terminals

Group A

1. Given an integer M (say, 3), find the smallest integer n for which the series

$$1+\frac{1}{2}+\frac{1}{3}\cdots+\frac{1}{n}$$

is larger than M.
(Flow chart/Algorithm - 2, Program - 8, Result - 2)

2. Read 10 numbers and write a program to arrange them in ascending order. Test your program for the following numbers :
1.2, -2.9, 2.1, 6.9, -9.8, 8.7, 5.1, 1.8, -3.5, -4.7
(Flow chart/Algorithm - 2, Program - 8, Result - 2)

3. Each term of a sequence $\{a_1, a_2, a_3, \cdots\}$ is generated by taking the sum of the previous three terms. If the first three terms are 0 and 1 and 2, find the ratio a_{n+1}/a_n correct to three decimal places for $n \to \infty$.
(Flow chart/Algorithm - 2, Program - 8, Result - 2) 1.839

4. The series expansion for $\log_e(x)$ in the range $x > 1$ is

$$\log_e(x) = \frac{x-1}{x} + \frac{1}{2}\left(\frac{x-1}{x}\right)^2 + \frac{1}{3}\left(\frac{x-1}{x}\right)^3 + \cdots$$ 1.147 ✓

Evaluate $\log_e(x)$ for $x = \pi$ up to three decimal places by using this expansion.
(Flow chart/Algorithm - 2, Program - 8, Result - 2)

5. Find the prime numbers less than or equal to 59.
(Flow chart/Algorithm - 2, Program - 8, Result - 2)

[Turn Over]

6. Four positive integers i, j, k, l, each ≤ 8, satisfy the condition $i^2 + j^2 + k^2 = l^2$. Write down all possible such sets with a program.
(Flow chart/Algorithm - 2, Program - 8, Result - 2)

1, 2, 2, 3
2, 1, 2, 3
2, 2, 1, 3
2, 3, 6, 7
2, 6, 3, 7
3, 2, 6, 7
3, 6, 2, 7
6, 2, 3, 7
6, 3, 2, 7
2, 4, 4, 6
4, 2, 4, 6
4, 4, 2, 6
12

7. Write a program to compute the matrix

$$A + \frac{1}{2}A^2 + \frac{1}{6}A^3$$

where

$$A = \begin{pmatrix} 1 & 2 \\ 2 & 1 \end{pmatrix}$$

(Flow chart/Algorithm - 2, Program - 8, Result - 2)

8. Calculate the commutator $[A, B]$, where

$$\begin{bmatrix} 0 & 0.1162 & 0.1342 \\ 0.1162 & 0 & 0.3687 \\ 0.1342 & -0.3687 & 0 \end{bmatrix}$$

$$A = \begin{pmatrix} \cos\alpha & \sin\alpha & 0 \\ -\sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} \cos\beta & 0 & -\sin\beta \\ 0 & 1 & 0 \\ \sin\beta & 0 & \cos\beta \end{pmatrix}$$

with $\alpha = 40°$ and $\beta = 35°$
(Flow chart/Algorithm - 2, Program - 8, Result - 2)

~~0 0.1162 0.1342~~
~~0.1162 0 0.36~~
~~0~~

Group B

1. Use the *Gauss-Seidel* method (without rearrangement or refinement) to solve the simultaneous equations

$$\begin{aligned} 9x_1 + x_2 + x_3 + x_4 &= 75 \\ x_1 + 8x_2 + x_3 + x_4 &= 54 \\ x_1 + x_2 + 7x_3 + x_4 &= 43 \\ x_1 + x_2 + x_3 + 6x_4 &= 34 \end{aligned}$$

$x_1 = 7$
$x_2 = 5$
$x_3 = 4$
$x_4 = 3$

(Flow chart/Algorithm - 4, Program - 10, Result - 4)

2. Given the data

x	0.1	0.2	0.3	0.4	0.5	0.6
$f(x)$	0.545	0.331	0.275	0.258	0.240	0.235

0.2928

find the value of $f(x)$ for $x = 0.25$ using *Lagrange's interpolation formula* using all the points.
(Flow chart/Algorithm - 4, Program - 10, Result - 4)

3. Given the data

x	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
$f(x)$	-1.26	-1.10	-0.91	-0.67	-0.54	-0.32	-0.10	0.08	0.33	0.51

-0.369957

find the value of $f(x)$ for $x = 0.58$ using *Lagrange's interpolation formula* using all the points.

(Flow chart/Algorithm - 4, Program - 10, Result - 4)

4. Using the following data, calculate the values of m and c for *least square fit* to a straight line $y = mx + c$.

x	1	2	3	4	5	6	7	8	9	10
y	-0.94	-0.82	-0.72	-0.58	-0.49	-0.32	-0.21	-0.08	0.06	0.20

$m = 0.126667$

$c = -1.086667$

(Flow chart/Algorithm - 4, Program - 10, Result - 4)

5. Using the *bisection* method, find the root of the equation

$$x^3 - 5.816x^2 + 9.632x - 7.632 = 0$$

3.816

correct upto the third decimal place. (This equation has only one root, that lies in the range $0 < x < 5$.)

(Flow chart/Algorithm - 4, Program - 10, Result - 4)

6. Using the *bisection* method, find the root of the equation

$$20 - 2.5x - 0.01x^3 = 0$$

6.76

correct upto 3 significant digits. (This equation has only one root, that lies in the range $0 < x < 10$.)

(Flow chart/Algorithm - 4, Program - 10, Result - 4)

7. Using the *Newton-Raphson* method, find the root of the equation

$$x^2 \ln x = 5.72$$

2.499

correct upto the third decimal place. (This equation has only one root, that lies in the range $2 < x < 3$.)

(Flow chart/Algorithm - 4, Program - 10, Result - 4)

8. Using *Newton-Raphson* method, find a real root of the equation

$$x^2 - 2\exp(-x) = 0$$

0.901

correct upto 3 significant digits. (This equation has only one root, that lies in the range $0 < x < 1$.)

(Flow chart/Algorithm - 4, Program - 10, Result - 4)

9. Using *trapezoidal* rule, calculate

$$\int_0^{\pi} \sqrt{x} \exp x \, dx$$

−32.831

correct upto 3 significant digits.
(Flow chart/Algorithm - 4, Program - 10, Result - 4)

10. Using *trapezoidal* rule, calculate

$$\int_0^{\pi/4} \sqrt{1-x^2} \cos x \, dx$$

−0.63298

correct upto 3 decimal places.
(Flow chart/Algorithm - 4, Program - 10, Result - 4)

11. Using *Simpson's one-third rule*, calculate

$$\int_0^{\pi} e^{-x^2} \sin x \, dx$$

0.424

correct upto 3 significant digits.
(Flow chart/Algorithm - 4, Program - 10, Result - 4)

12. Using *Simpson's one-third rule*, calculate

0.878

$$\int_{-1}^{1} x^2 e^x dx$$

correct upto 2 decimal places.
(Flow chart/Algorithm - 4, Program - 10, Result - 4)

2018

PHYSICS - HONOURS - PRACTICAL

Eighth Paper

(Group B)

Full Marks - 50

Set 1

Date of Examination: 12.03.2018

Programming Language : C or Fortran

Print the output of your programs at the terminals

Group A

A1 Search from 50 onwards and find the first five prime numbers. Store them in an array and calculate the sum of those five numbers.
(Flow chart / Algorithm -2, Program -8, Result -2)

A2 Sort the following ten numbers using any type of sorting algorithm in ascending order :
$1, -4.5, 6.9, -0.1, 2.3, 5, 9, 1.63, 2.76, 8.1$
(Flow chart / Algorithm -2, Program -8, Result -2)

A3 Calculate the value of ln (3) from the series expansion

$$\ln\left(\frac{1+x}{1-x}\right) = 2x + \frac{2}{3}x^3 + \frac{2}{5}x^5 + \frac{2}{7}x^7 + \cdots$$

(for $-1 < x < 1$) up to an accuracy of three decimal places.
(Flow chart / Algorithm -2, Program -8, Result -2)

A4 Find the factors of the number 4158. Separate the prime factors from the list and print them.
(Flow chart / Algorithm -2, Program -8, Result -2)

A5 Consider the series

$$\frac{1}{2\cdot 3} + \frac{2}{3\cdot 4} + \frac{3}{4\cdot 5} + \cdots$$

Calculate the sum of the series up to 8 terms.
(Flow chart / Algorithm -2, Program -8, Result -2)

[Turn Over]

A6 Take the two lists $a(1) = 2, a(2) = 2.3, a(3) = 3, a(4) = 3.4, a(5) = 4$ and $b(1) = 7, b(2) = 7.2, b(3) = 7.3, b(4) = 7.4, b(5) = 7.5$. After taking the input from the screen and storing two lists create a separate (say c) list of 10 elements taking one from the lists a and b alternatively. i.e.,
$c(1) = a(1), c(2) = b(1), c(3) = a(2), c(4) = b(2) \ldots\ldots, c(9) = a(5), c(10) = b(5)$
Print the three lists.
(Flow chart / Algorithm -2, Program -8, Result -2)

A7 It is given that $A = \begin{pmatrix} 3 & 5 \\ 1 & 2 \end{pmatrix}$ and $B = \begin{pmatrix} 2 & -5 \\ -1 & 3 \end{pmatrix}$. Find the products AB and BA.
(Flow chart / Algorithm -2, Program -8, Result -2)

A8 If $A = \begin{pmatrix} -3 & 1 \\ -4 & 2 \end{pmatrix}$, calculate $A^2 + A$.
(Flow chart / Algorithm -2, Program -8, Result -2)

Group B

B1 Use the *Gauss-Seidel* method (without rearrangement or refinement) to solve the simultaneous equations

$$\begin{aligned} 8x_1 + 4x_2 - 2x_3 &= 3 \\ 2x_1 - 4x_2 + x_3 &= 1 \\ 3x_1 + x_2 + 7x_3 &= 11 \end{aligned}$$

(Flow chart / Algorithm -4, Program -10, Result -4)

B2 Find the value of $f(x)$ for $x = 3.5$ using Lagrange's interpolation formula using all the data.

x	1.3	2.7	3.1	3.9	4.2	5.3
$f(x)$	3.901	60.759	88.763	171.747	213.624	427.541

(Flow chart / Algorithm -4, Program -10, Result -4)

B3 Using the following data, calculate the values of m and c for *least square fit* to a straight line $y = mx + c$.

x	1.5	1.75	2.27	2.81	3.19	4.7	5.32	7.24
y	19.14	19.00	18.70	18.40	18.18	17.32	16.90	15.87

(Flow chart / Algorithm -4, Program -10, Result -4)

B4 Using the following data, calculate the value of m for *least square fit* to a straight line $y = mx$

x	-5.2	-4.1	-3.5	-2.1	1.68	4.6	7.4
y	-27.04	-21.32	-18.2	-10.9	8.74	23.9	38.48

(Flow chart / Algorithm -4, Program -10, Result -4)

B5 Using the *bisection* method, find the root of the equation

$$2(x-5)^2 - 10x = 11$$

that lies in the range $1.0 < x < 2.5$, correct up to the third decimal place.
(Flow chart / Algorithm -4, Program -10, Result -4)

B6 Using the *Newton-Raphson* method, find the root of the equation

$$x^3 + (x+1)^2 + 4x = 20$$

that lies in the range $1.0 < x < 2.5$, correct up to three decimal places, by choosing the initial point suitably.
(Flow chart / Algorithm -4, Program -10, Result -4)

B7 Using *trapezoidal* rule, calculate

$$\int_0^5 e^{-x^2} x^2 dx$$

correct up to 2 decimal places.
(Flow chart / Algorithm -4, Program -10, Result -4)

B8 Using *Simpson's one-third rule*, calculate

$$\int_{-2}^{2} x^3 e^{-x} dx$$

correct up to 2 decimal places.
(Flow chart / Algorithm -4, Program -10, Result -4)

2018

PHYSICS - HONOURS - PRACTICAL

Eighth Paper

(Group B)

Full Marks - 50

Set 2

Date of Examination: 13.03.2018

Programming Language : C or Fortran

Print the output of your programs at the terminals

Group A

A1 Start from 3993 and find six consecutive prime numbers less than 3993. Store them in an array and find the sum of those six numbers.
(Flow chart / Algorithm -2, Program -8, Result -2)

A2 Sort the following ten numbers using any type of sorting algorithm in ascending order:
$2.3, 5.6, -8.4, 10.6, -2.5, 8.7, 9.44, 11.25, 50.24, 1.5$.
(Flow chart / Algorithm -2, Program -8, Result -2)

A3 Generate the Fibonacci sequence $F_{i+1} = F_i + F_{i-1}$. ($i \geq 2$, $F_2 = 1$ and $F_1 = 1$). and calculate the reciprocal Fibonacci series

$$S = \sum_i \frac{1}{F_i}$$

up to an accuracy of four decimal places.
(Flow chart / Algorithm -2, Program -8, Result -2)

A4 Factories 168 and calculate the product of all the non-prime factors.
(Flow chart / Algorithm -2, Program -8, Result -2)

A5 It is known that

$$\sum_{n=1}^{\infty} \frac{1}{n^2} = \frac{\pi^2}{6}$$

Calculate the partial sum S_n and determine the number of terms for which $\frac{\pi^2}{6} - S_n = 0.0001$.
(Flow chart / Algorithm -2, Program -8, Result -2)

[Turn Over]

A6 A list of numbers is given below
$3.1, -6.4, 5.21, 7.2, -9.11, -11.1, 3.45, -4.52, -2.53, -8.87$
Accept the numbers from the screen and store in an array. Then form two separate lists such that one contains the negative numbers and other contains the positive numbers. (No need to arrange them.)
Print the three lists.
(Flow chart / Algorithm -2, Program -8, Result -2)

A7 A matrix is defined as $A = \begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix}$, where $\theta = 30^0$. Construct $B = A^T$ and find the product BA.
(Flow chart / Algorithm -2, Program -8, Result -2)

A8 If $A = \begin{pmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{pmatrix}$, calculate $A^2 - 4A$.
(Flow chart / Algorithm -2, Program -8, Result -2)

Group B

B1 Use the *Gauss-Seidel* method (without rearrangement or refinement) to solve the simultaneous equations

$$\begin{aligned} 12x_1 + 3x_2 - 5x_3 &= 1 \\ x_1 + 5x_2 + 3x_3 &= 28 \\ 3x_1 + 7x_2 + 13x_3 &= 76 \end{aligned}$$

(Flow chart / Algorithm -4, Program -10, Result -4)

B2 Find the value of $f(x)$ for $x = -2.5$ using Lagrange's interpolation formula using all the data.

x	-3.5	-3.0	-2.75	-2.1	-1.9	-1.7
$f(x)$	-3.125	-14.0	-17.703	-22.739	-23.141	-23.087

(Flow chart / Algorithm -4, Program -10, Result -4)

B3 Using the following data, calculate the values of m and c for *least square fit* to a straight line $y = mx + c$.

x	-2.0	-1.5	2.1	4.44	5.17	6.85	7.53
y	6.92	6.86	6.0	5.44	5.25	4.86	4.72

(Flow chart / Algorithm -4, Program -10, Result -4)

B4 Using the following data, calculate the value of m for *least square fit* to a straight line $y = mx$:

x	6.31	7.2	8.3	9.1	10.6	11.2	13.6
y	19.5	22.32	25.73	28.27	32.86	34.72	42.16

(Flow chart / Algorithm -4, Program -10, Result -4)

B5 Using the *bisection* method, find the root of the equation

$$(x+5)^2 + 10x - 11 = 0$$

that lies in the range $-1.5 < x < 0$, correct up to the third decimal place.
(Flow chart / Algorithm -4, Program -10; Result -4)

B6 Using the *Newton-Raphson* method, find the root of the equation

$$e^x + 20x^6 - 25x + 2 = 0$$

that lies in the range $-0.5 < x < 0.5$, correct up to three decimal places, by choosing the initial point suitably.
(Flow chart / Algorithm -4, Program -10, Result -4)

B7 Using *trapezoidal* rule, calculate

$$\int_1^{3\pi} \frac{\sin x}{x^2} dx$$

correct up to 3 decimal places.
(Flow chart / Algorithm -4, Program -10, Result -4)

B8 Using *Simpson's one-third rule*, calculate

$$\int_0^1 x\sqrt{1-x^2}dx$$

correct up to 3 decimal places.
(Flow chart / Algorithm -4, Program -10, Result -4)

2018

PHYSICS - HONOURS - PRACTICAL

Eighth Paper

(Group B)

Full Marks - 50

Set 4
Date of Examination: 15.03.2018

Programming Language : C or Fortran

Print the output of your programs at the terminals

Group A

A1 Find the first three prime numbers n greater than 4 and check whether $2^n - 1$ is prime.
(Flow chart / Algorithm -2, Program -8, Result -2)

A2 Sort the following ten numbers using any type of sorting algorithm in ascending order:
99.23, 44.55, 65.21, 88.44, 23.21, 35.47, 15.46, 111.2, 77.52, 10.24
(Flow chart / Algorithm -2, Program -8, Result -2)

A3 Calculate the sum

$$\sum_{k=0}^{\infty} \frac{1}{n^k}$$

for $n = 2$ with an accuracy of three decimal places.
(Flow chart / Algorithm -2, Program -8, Result -2)

A4 Find the factors of the number 30030 and calculate the sum of all the prime factors.
(Flow chart / Algorithm -2, Program -8, Result -2)

A5 It is known that

$$1 - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \cdots\cdots = \frac{\pi^2}{12}$$

Calculate the partial sum S_n and determine the number of terms for which $\frac{\pi^2}{12} - S_n =$ 0.0001.
(Flow chart / Algorithm -2, Program -8, Result -2)

[Turn Over]

A6 Accept any twelve numbers from the screen and store them in an array [$a(i)$ say].
Create two separate lists $b(i)$ and $c(i)$ in the following way:
$b(1) = a(6), b(2) = a(5), \dots \dots\ b(6) = a(1)$ and
$c(1) = a(12), c(2) = a(11), \dots \dots\ c(6) = a(7)$
Print the three lists.
(Flow chart / Algorithm -2, Program -8, Result -2)

A7 $A = \begin{pmatrix} 1 & 2 & 1 \\ 2 & 2 & 5 \\ 1 & 5 & 2 \end{pmatrix}$, $B = \begin{pmatrix} 1 & 3 & 2 \\ -3 & 1 & -1 \\ -2 & 1 & 1 \end{pmatrix}$. Calculate the sum of all the elements of AB.
(Flow chart / Algorithm -2, Program -8, Result -2)

A8 $A = \frac{1}{2}\begin{pmatrix} -1 & \sqrt{3} \\ \sqrt{3} & 1 \end{pmatrix}$, $B = \frac{1}{2}\begin{pmatrix} -1 & -\sqrt{3} \\ -\sqrt{3} & 1 \end{pmatrix}$. Calculate A^2 and B^2.
(Flow chart / Algorithm -2, Program -8, Result -2)

Group B

B1 Use the *Gauss-Seidel* method (without rearrangement or refinement) to solve the simultaneous equations

$$\begin{aligned} 12x_1 + 3x_2 - 2x_3 &= 8 \\ x_1 - 9x + 2x_3 &= 7 \\ x_1 + 5x_2 + 7x_3 &= -5 \end{aligned}$$

(Flow chart / Algorithm -4, Program -10, Result -4)

B2 Find the value of $f(x)$ for $x = -3.5$ using Lagerange's interpolation formula using all the data.

x	-5	-4.8	-4.2	-3.7	-3.22	-2.95
$f(x)$	57.0	54.968	46.472	37.357	27.609	21.950

(Flow chart / Algorithm -4, Program -10, Result -4)

B3 Using the following data, calculate the values of m and c for *least square fit* to a straight line $y = mx + c$.

x	2	3	4	5	6	7	8
y	-8.7	-10.4	-12.1	-13.8	-15.5	-17.2	-18.9

(Flow chart / Algorithm -4, Program -10, Result -4)

B4 Using the following data, calculate the value of m for *least square fit* to a straight line $y = mx$

x	-16.2	-9.67	-4.3	10.9	18.7	21.3	23.8
y	37.81	22.57	10.04	-25.44	-43.64	-49.72	-55.54

(Flow chart / Algorithm -4, Program -10, Result -4)

B5 Using the *bisection* method, find the root of the equation

$$\cos^2 x - 5.6x^2 + x + 20 = 0$$

that lies in the range $1 < x < 2.5$, correct up to the third decimal place.
(Flow chart / Algorithm -4, Program -10, Result -4)

B6 Using the *Newton-Raphson* method, find the root of the equation

$$\sin^2 x - 5x + 9 = 0$$

that lies in the range $1 < x < 2.5$, correct up to three decimal places, by choosing the initial point suitably.
(Flow chart / Algorithm -4, Program -10, Result -4)

B7 Using *trapezoidal* rule, calculate

$$\int_{-1}^{2} xe^{-x^2} dx$$

correct up to 3 decimal places.
(Flow chart / Algorithm -4, Program -10, Result -4)

B8 Using *Simpson's one-third rule*, calculate

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

correct up to 3 decimal places.
(Flow chart / Algorithm -4, Program -10, Result -4)

2018

PHYSICS - HONOURS - PRACTICAL

Eighth Paper

(Group B)

Full Marks - 50

Set 3
Date of Examination: 14.03.2018

Programming Language : C or Fortran

Print the output of your programs at the terminals

Group A

A1 Find the first three prime numbers greater than 4000 and the first three prime numbers less than 4000. Add the six numbers.
(Flow chart / Algorithm -2, Program -8, Result -2)

A2 Sort the following ten numbers using any type of sorting algorithm in ascending order.
$-5.6, -4.9, -9.6, 4.56, 6.58, 2.54, -8.95, 19.52, 7.15, 13.45$
(Flow chart / Algorithm -2, Program -8, Result -2)

A3 Evaluate the sum

$$S = \sum_{n=1}^{\infty}\left(\frac{1}{n+0.5} - \frac{1}{n+1.3}\right)$$

correct up to third place of decimal.
(Flow chart / Algorithm -2, Program -8, Result -2)

A4 Factories 168 and calculate the product of all the prime factors.
(Flow chart / Algorithm -2, Program -8, Result -2)

A5 It is known that

$$1 - \frac{1}{3^3} + \frac{1}{5^3} - \frac{1}{7^3} + \cdots\cdots = \frac{\pi^3}{32}$$

Calculate the partial sum S_n and determine the number of terms for which $\frac{\pi^3}{32} - S_n = 0.0001$.
(Flow chart / Algorithm -2, Program -8, Result -2)

A6 Accept any twelve numbers from the screen and store them in an array [$a(i)$ say]. Create two separate lists $b(i)$ and $c(i)$ in the following way:
b contains the square root of the odd elements i.e., $b(1) = \sqrt{a(1)}, b(2) = \sqrt{a(3)} \ldots$
$\ldots$
c contains the square of the even elements i.e., $c(1) = a^2(2), c(2) = a^2(4), \ldots \ldots$
Print the three lists.
(Flow chart / Algorithm -2, Program -8, Result -2)

A7 $A = \begin{pmatrix} 1 & 0 & 2 \\ 3 & 2 & 1 \\ 1 & 5 & 2 \end{pmatrix}; B = \begin{pmatrix} 1 & 3 & 2 \\ 4 & 1 & 3 \\ 2 & 1 & 1 \end{pmatrix}$. Calculate the trace of AB.
(Flow chart / Algorithm -2, Program -8, Result -2)

A8 It is given that $P=\begin{pmatrix} 1 & 4 \\ -1 & 1 \end{pmatrix}, P^{-1} = \frac{1}{5}\begin{pmatrix} 1 & -4 \\ 1 & 1 \end{pmatrix}$ and $A = \begin{pmatrix} 5 & 4 \\ 1 & 2 \end{pmatrix}$. Evaluate $P^{-1}AP$.
(Flow chart / Algorithm -2, Program -8, Result -2)

Group B

B1 Use the *Gauss-Seidel* method (without rearrangement or refinement) to solve the simultaneous equations

$$\begin{aligned} 3x_1 + x_2 - x_3 &= 7 \\ x_1 - 5x_2 + x_3 &= -1 \\ 2x_1 + x_2 + 6x_3 &= 4 \end{aligned}$$

(Flow chart / Algorithm -4, Program -10, Result -4)

B2 Find the value of $f(x)$ for $x = 3.5$ using Lagrange's interpolation formula using all the data:

x	2.5	2.89	3.21	3.67	3.92	4.14
$f(x)$	-1.625	-6.237	-11.976	-23.731	-32.036	-40.558

(Flow chart / Algorithm -4, Program -10, Result -4)

B3 Using the following data, calculate the values of m and c for ***least square fit*** to a straight line $y = mx + c$.

x	9.56	10.62	11.45	12.01	13.89	14.23	17.5
y	7.05	6.88	6.75	6.66	6.38	6.33	5.82

(Flow chart / Algorithm -4, Program -10, Result -4)

B4
B5
B6
B
B

x	-4.4	-3.3	-2.2	-1.1	1.05	2.4	3.12
y	5.28	3.96	2.64	1.32	-1.26	-2.88	-3.74

(Flow chart / Algorithm -4, Program -10, Result -4)

B5 Using the *bisection* method, find the root of the equation

$$3\sin x - 3.5 = 5\cos x$$

that lies in the range $3 < x < 4$, correct up to the third decimal place.
(Flow chart / Algorithm -4, Program -10, Result -4)

B6 Using the *Newton-Raphson* method, find the root of the equation

$$3\cos x + x^3 = 0$$

that lies in the range $-1.5 < x < -0$, correct up to three decimal places, by choosing the initial point suitably.
(Flow chart / Algorithm -4, Program -10, Result -4)

B7 Using *trapezoidal* rule, calculate

$$\int_2^{3.7} x^4 \ln x\, dx$$

correct up to 3 significant digits.
(Flow chart / Algorithm -4, Program -10, Result -4)

B8 Using *Simpson's one-third rule*, calculate

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

correct up to 3 decimal places.
(Flow chart / Algorithm -4, Program -10, Result -4)

2019

PHYSICS — HONOURS — PRACTICAL

Eighth Paper

(Group – B)

Full Marks : 50

(under 1+1+1 system)

Date of Examination : 05.03.2019

Programming Language : C or Fortran.

Print the output of your programs at the terminals.

SET – 1

Group – A

A1. Write a program to find the first N prime numbers (2, 3, 5,...). Write your output for $N = 10, 17, 23$.
(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A2. Sort the following ten numbers using any type of sorting algorithm in ascending order :
$1, (4.5)^2, 6.9, -0.1, 2.3, 5, 5, 9, \sqrt{1.63}, 2.76, 8.1^3$
(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A3. Calculate the value of ln(1.5) from the series expansion

$$\ln(1+x) = x - \frac{x^2}{2} + \frac{x^3}{3} + \ldots$$

up to an accuracy of three decimal places.
(Flowchart / Algorithm – 2, Program – 8, Result – 2)

Please Turn Over

A4. Find the largest prime number below 5000.
(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A5. Write a program to compute

$$S = \frac{1.2}{3.4} + \frac{5.6}{7.8} + \frac{9.10}{11.12} + \ldots$$

up to n terms. Find the value of S for $n = 10$.
(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A6. Fibonacci numbers $F_1, F_2, \ldots$ are defined by the recursion relation $F_{n+1} = F_n + F_{n-1}$ with the initial values $F_1 = 1$ and $F_2 = 1$. Find the ratio $\lim_{n\to\infty}(F_{n+1}/F_n)$ correct up to second decimal place.
(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A7. Compute and print M^T and Trace $(I - M^2)$ where I is the identity matrix and

$$M = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 1 & 2 \\ 3 & 4 & 1 \end{pmatrix}$$

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A8. Calculate the commutator $[A, B]$, where

$$A = \begin{pmatrix} 1 & 2 & 3 \\ 2 & 3 & 4 \\ 3 & 4 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} 11 & 12 & 13 \\ 12 & 13 & 14 \\ 13 & 14 & 11 \end{pmatrix}$$

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

Group – B

B1. Use the *Gauss-Seidel* method (without rearrangement or refinement) to solve the simultaneous equations

$$10x_1 - 2x_2 - x_3 - x_4 = 3$$
$$-2x_1 + 10x_2 - x_3 - x_4 = 15$$
$$-x_1 - x_2 + 10x_3 - 2x_4 = 27$$
$$-x_1 - x_2 - 2x_3 + 10x_4 = -9$$

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B2. Find the value of $f(x)$ for $x = 3.5$ using *Lagrange's interpolation formula* using all the data.

x	1.3	2.7	3.5	3.9	4.4
$f(x)$	3.901	60.759	166.763	171.747	231.92

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B3. Using the following data, calculate the values of m and c for *least square fit* to a straight line $y = mx + c$.

x	1	2	3	4	5	6
$f(x)$	–2.95	–1.15	0.90	3.15	4.95	7.05

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B4. Using the following data, calculate the values of m and c for *least square fit* to a straight line $y = mx + c$:

x	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
y	– 1.26	– 1.10	– 0.91	– 0.67	– 0.54	– 0.32	– 0.10	0.08	0.33	0.51

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B5. Using the *bisection* method, find the root of the equation

$$x \sin x + (x-2)\cos x = 0$$

that lies in the range $2 < x < 5$, correct up to the third decimal place.

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B6. Using the *Newton-Raphson* method, find the root of the equation

$$(1-x^2)\tan x - x = 0$$

that lies in the range $2 < x < 3$, correct up to the third decimal place.

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B7. Using *trapezoidal* rule, calculate

$$\int_0^1 \sqrt{1-x^2}\, dx$$

correct upto 3 decimal places.

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B8. Using *Simpson's one-third rule*, calculate

$$\int_0^3 \frac{x}{1+x^5}\, dx$$

correct up to 3 significant digits.

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

2019

PHYSICS — HONOURS — PRACTICAL

Eighth Paper

(Group – B)

Full Marks : 50

(Under 1+1+1 system)

Date of Examination : 06.03.2019

Programming Language : C or Fortran.

Print the output of your programs at the terminals.

SET – 2

Group – A

A1. Given an integer M (say, 3), find the smallest integer n for which the series

$$1+\frac{1}{2}+\frac{1}{3}+\ldots+\frac{1}{n}$$

is larger than M.

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A2. Read 10 numbers and write a program to arrange them in descending order. Test your program for the following numbers :

1.2, –2.9, 2.1, 6.9, –9.8, 8.7, 5.1, 1.8, –3.5, –4.7

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A3. Each term of a sequence $\{a_1, a_2, a_3, \ldots\}$ is generated by taking the sum of the previous three terms. If the first three terms are 0 and 1 and 2, find the ratio a_{n+1} / a_n correct to three decimal places for $n \to \infty$.

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A4. Find the prime numbers less than or equal to 89 and count them.

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A5. Zeta function is defined as $\zeta(n) = \sum_{k=1}^{\infty} \frac{1}{k^n}$

Given that $\zeta(4) = \pi^4/90$ estimate a value of π correct up to 3 significant digits. How many terms are needed in the series for this?

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A6. Find the *prime number* lying between 3980 and 3990. (There will be only one such number.)

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A7. Write a program to calculate Trace(M^2) where

$$M = \begin{pmatrix} 1 & 2 & 3 & 4 \\ 4 & 1 & 2 & 3 \\ 3 & 4 & 1 & 2 \\ 2 & 3 & 4 & 1 \end{pmatrix}$$

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A8. For

$$M = \begin{pmatrix} 1 & 2 & 3 & 4 \\ 4 & 1 & 2 & 3 \\ 3 & 4 & 1 & 2 \\ 2 & 3 & 4 & 1 \end{pmatrix} \quad \textit{and} \quad V = \begin{pmatrix} 1 \\ -1 \\ 1 \\ -1 \end{pmatrix}$$

calculate $\frac{1}{2} MV + V$.

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

Group – B

B1. Use the *Gauss-Seidel* method (without rearrangement or refinement) to solve the simultaneous equations

$$12x_1 + 3x_2 - 5x_3 = 1$$
$$x_1 + 5x_2 + 3x_3 = 28$$
$$3x_1 + 7x_2 + 13x_3 = 76$$

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B2. Given the data

x	0.1	0.2	0.3	0.45	0.5	0.6
$f(x)$	0.545	0.333	0.275	0.258	0.242	0.235

find the value of $f(x)$ for $x = 0.25$ using *Lagrange's interpolation formula* using all the points.
(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B3. Using the following data, calculate the values of m and c for *least square fit* to a straight line of $y = mx + c$.

x	1	2	3	4	5	6	7	8	9	10
y	0.94	0.82	0.72	0.58	0.49	0.32	0.21	0.08	0.04	0.01

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B4. Using the *bisection* method, find the root of the equation

$$(x - 2.1)^{1/4} - (4.1 - x)^{1/3} = 0$$

that lies in the range $2 < x < 4$, correct up to the third decimal place.
(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B5. Using the *bisection* method, find the root of the equation

$$\tan x = \frac{x}{1 - x^2}$$

that lies in the range $5 < x < 7$, correct up to three significant digits.
(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B6. Using the *Newton-Raphson* method, find the root of the equation

$$e^x + 20x^6 - 25x + 2 = 0$$

that lies in the range $-0.5 < x < 0.5$, correct up to three decimal places, by choosing the initial point suitably.

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B7. Using *trapezoidal* rule, calculate

$$\int_1^{3\pi} \frac{\sin x}{x^2}\, dx$$

correct up to 3 decimal places.

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B8. Using *Simpson's one-third rule*, calculate

$$\int_0^1 x\sqrt{1-x^2}\, dx$$

correct up to 3 decimal places.

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

2019

PHYSICS — HONOURS — PRACTICAL

Eighth Paper

(Group – B)

Full Marks : 50

(Under 1+1+1 system)

Date of Examination : 07.03.2019

Programming Language : C or Fortran

Print the output of your programs at the terminals.

SET – 3

Group – A

A1. Write a program to find the first 20 prime numbers after 97 and find the average of those prime numbers.

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A2. Read 11 numbers and write a program to *arrange them in descending order*. Test your program for the following numbers :

3.2, 9.8, –5.4, 1.2, 7.6, –8.7, 4.3, 2.5, –0.3, –5.4, 3.2

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A3. The series expansion for $\log_e(x)$ in the range $x > 1$ is

$$\log_e(x) = \frac{x-1}{x} + \frac{1}{2}\left(\frac{x-1}{x}\right)^2 + \frac{1}{3}\left(\frac{x-1}{x}\right)^3 + \ldots$$

Evaluate $\log_e(x)$ for $x = \pi$ up to three decimal places by using this expansion.

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

Please Turn Over

A4. Calculate log(100!) by using the relation

$$\log(n!) = \sum_{i=2}^{n} \log(i)$$

Also print the value obtained from Stirling's approximation

$$\log n! = n\log(n) - n$$

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A5. Write down a program to find all the *factors* of a given integer N. Check your program for $N = 3604$.

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A6. The matrix elements $A_{m,n}$ of a 3×3 matrix A are given by the formula

$$A_{mn} = \sqrt{\frac{n}{2}}\delta_{m,n-1} + \sqrt{\frac{(n+1)}{2}}\delta_{m,n+1}$$

Generate and print the matrix.

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A7. Calculate the matrix $A^T B$, where

$$A = \begin{pmatrix} 1 & 2 & 3 & 4 \\ 2 & 3 & 4 & 1 \\ 3 & 4 & 1 & 2 \\ 4 & 1 & 2 & 3 \end{pmatrix}, \quad B = \begin{pmatrix} 1.1 & 1.2 & 1.3 & 1.4 \\ 1.2 & 1.3 & 1.4 & 1.1 \\ 1.3 & 1.4 & 1.1 & 1.2 \\ 1.4 & 1.1 & 1.2 & 1.3 \end{pmatrix}$$

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

A8. Compute and print Trace$(M)I - M + M^T$ where I is the identity matrix and

$$M = \begin{pmatrix} 1 & 3 & 5 \\ 3 & 3 & 9 \\ 11 & 15 & 11 \end{pmatrix}$$

(Flowchart / Algorithm – 2, Program – 8, Result – 2)

Group – B

B1. Use the *Gauss-Seidel* method (without rearrangement or refinement) to solve the simultaneous equations

$$5x+3y+2z=17$$
$$2x+3y-z=5$$
$$x-2y-3z=-12$$

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B2. Find the value of $f(x)$ for $x=3.5$ using Lagrange's interpolation formula using all the data.

x	0.1	0.2	0.3	0.4	0.5	0.6
$f(x)$	0.545	0.331	0.275	0.258	0.240	0.235

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B3. Using the following data, calculate the values of m and c for *least square fit* to a straight line $y=mx+c$:

x	1	2	3	4	5	6	7	8	9	10
y	–0.94	–0.82	–0.72	–0.58	–0.49	–0.32	–0.21	–0.08	0.06	0.20

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B4. Using the *bisection* method, find the root of the equation

$$20-2.5x-0.01x^3=0$$

correct up to 3 significant digits. (This equation has only one root, that lies in the range $0<x<10$.)

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B5. Using the *Newton-Raphson* method, find the root of the equation

$$x^2 \ln x = 5.72$$

correct up to the third decimal place.

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B6. Using the *Newton-Raphson* method, find the root of the equation

$$x^2 - 2\exp(-x) = 0$$

correct up to 3 significant digits. (This equation has only one root, that lies in the range $0 < x < 1$.)

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B7. Using *trapezoidal* rule, calculate

$$\int_0^{\pi} \sqrt{x} \exp x \, dx$$

correct up to 3 significant digits.

(Flowchart / Algorithm – 4, Program – 10, Result – 4)

B8. Using *Simpson's one-third rule*, calculate

$$\int_0^{\pi} e^{-x^2} \sin x \, dx$$

correct up to 3 significant digits.

(Flowchart / Algorithm – 4, Program – 10, Result – 4)