2022

Physics

[HONOURS]

(CBCS)

(B.Sc. Third Semester End Examinations-2022)

PAPER-CC5P

(PRACTICAL)

Full Marks: 20 ***Time: 02 Hrs***

The figures in the right hand margin indicate marks

Candidates are required to give their answers in their own words as far as practicable

Illustrate the answers wherever necessary

Distribution of marks:- (program: 15+LNB: 02 + Viva-Voce : 03)

Write the necessary formula

Write the computer code in PYTHON clearly.

Print the input and output.

Attempt any one set of questions from the following:-

1. A) Use mat plotlib. Pyplot.plot to product a plot of the function $f(x) = e^{-x/10}\sin(\pi x)$ and $g(x) = xe^{-x/3}$ over the interval (0,10).

   Include labels for the x and y axes and a legend explaining which line is which the plot. Save the plot as a jpg file and print a copy with your work.

b) If the eigen values and the eigen vectors of $\begin{pmatrix} 0 & \frac{1}{\sqrt{2}} & 0 \\ \frac{1}{\sqrt{2}} & 0 & \frac{1}{\sqrt{2}} \\ 0 & \frac{1}{\sqrt{2}} & 0 \end{pmatrix}$

using Numpy. 10+5

2. a) Numerically show using scipy the following identity:-

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

b) Given point :- (-2,0), (0,3), (4,4).

i)Find the least –squares exponential

$f(x) = ae^x + b$ for the points.

ii) Plot $f(x)$ along with the points

iii) use $f(x)$ to estimate $f(x)$. 7+8

3. a) Consider the average heights and weight of persons aged 8 to 16 stared in the following two lists:

heights = [121.9, 124.5, 129.5, 134.6, 139.7, 147.3, 152.4, 157.5, 162.6]

weight= [19.7, 21.3, 23.5, 25.9, 28.5, 32.1, 35.7, 39.6, 43.2]

Let us plot a line chart where :-

i) x axis will represent weight

ii) y axis will represent height

iii) x axis label should be 'weight in kg'.

iv) y axis label should be 'height in cm'.

v) Color of the line should be green use * as marker.

vi) Marker size as 10

vii) The title of the chart should be "Average weight with respect to average height"

viii) Line style should be dashed.

ix) Line width should be 2.

b) If $\vec{a} = \hat{i} + \hat{j} + \hat{k}, \vec{b} = 2\hat{i} - \hat{j}, \vec{c} = \hat{i} - 2\hat{j} + \hat{k}$

using Numpy determine the followings:-

i) Prove that $\vec{a}.(\vec{b} + \vec{c}) = \vec{a}.\vec{b} + \vec{a}.\vec{c}$.

ii) Check the vectors are coplanar or not?

iii) Prove that $|\vec{a}.\vec{b}| \le |\vec{a}|.|\vec{b}|$ (Cauchy- Schwartz inequality)

12+3

4. a) Fit a second order polynomial to the following data:-

i	1	2	3	4	5	6
x	0	0.5	1.0	1.5	2.0	2.5
y	0	0.25	1.0	2.25	4.0	6.25

b) Solve the following equation:- $\frac{\delta^2 n}{\delta t} = \frac{\delta^2 n}{\delta x^2}, 0 < x < \pi, t > 0.$

With initial and boundary conditions:-

$u(x,0) = 1, \frac{\delta n(x,0)}{\delta t} = 0$ 8+7

$u(o,t) = 0, u(0,t) = 0, u(\pi,t) = 0$

5. a) Let, $A = \begin{pmatrix} 1 & 2 & 3 \\ 1 & 2 & 1 \\ 0 & 1 & 2 \end{pmatrix}$, $B = \begin{pmatrix} 1 \\ 6 \\ -2 \end{pmatrix}$, $v = \begin{pmatrix} 8 \\ 0 \\ -3 \end{pmatrix}$

Compute $B + v, B.v, Av$ *and* $B^T Av$

b) Given a set of data (in appropriate units) from a measurement,

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

Try to fit with a polynomial, first by 1st order and then by 2nd order. Check graphically which fits better and comment. 5+10

6. a) Consider the set of measured values

x	1	2	3	4	5
y	0.5	3.8	7.9	16.5	27.3

b) Consider the Cauchy problem:

$$\frac{\delta u}{\delta t} = x\frac{\delta u}{\delta x} - u + 1, -\alpha < x < \alpha, t \geq 0$$

$$n(x,0) = Sinx, (-\alpha < x < \alpha)$$

Solve this problem and discuss the behaviour of the solution for large time. 8+7

7. a) Analysis by Kirchhoff's laws over an electrical resistor network, We get the following set of equation:-

$$R_1 I_1 + R_2(I_1 - I_3) + R_3(I_1 - I_2) = 0$$
$$R_4 I_2 + R_3(I_2 - I_1) + R_5(I_2 - I_3) = 1$$
$$R_6 I_3 + R_5(I_3 - I_2) + R_2(I_3 - I_1) = E_2$$

The resistance in the circuit are

$R_1 = R_2 = R_3 = 2\Omega$, $R_4 = R_5 = R_6 = 3\Omega$ and the voltages are

$E_1 = E_2 = 5V$. Find the currents I_1, I_2, I_3.

(b) Write a computer programme to evaluate f(15). Given the following table of values :

X	10	20	30	40	50
Y=f(x)	46	66	81	93	101

8+7

8. a) For a cart sliding down an inclined plane the relation between the distance (d) in cm and time (t) in see are given by $d = \frac{1}{2} gSin\theta t^2$ Write a program to fit this data set. If you know the angle of inclination, $\theta - 30^0$. How do you find the acceleration of gravity (g), from the measurement with your filling exercise? Measurement

T	0.7	1.3	1.9	2.5	3.1	4.1	4.9	5.6	6.1	6.7	7.5
d	1	4	9	16	25	49	64	81	100	121	144

b) using scipy, verify the following identity in trigonometry:

$$\frac{Sin(n+1)\theta}{Sin\theta} = \sum_{i=1}^{n} P_i(\cos\theta) P_{n-1}(\cos\theta).$$

9. a) Using Scipy, compute the double integral $\iint 30xydxdy$ over the region R bounded by $y=x$ and $y=x^2$.Take the limit of x as (0,1).

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

x	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2
F(x)	6.05 0	7.38 9	9.02 5	11.02 3	13.46 4	16.44 5	20.08 6	24.53 3

7+8

10. a) Prove that $\int_{\alpha}^{t\alpha} \delta(x-a)g(x) = g(a)$.

Taking $g(x) = x^2 + 5, a = 2$ we can take T sufficient small and check.

b) The differential equations governing the loop current i and charge Q on the compailar of the electric circuit:

$$Lc\frac{di}{dt} + Rci + Q = e(T), \frac{dQ}{dt} = i$$

If the applied voltage E is suddenly increased from OV to 9V, plot the resulting loop current during the first 10 seconds use $R = 1.0\pi, L = 2H, C = 0.45F$. 5+10

11. a) Find the eigen value and eigen rectors of the matrix

$$\begin{pmatrix} 1 & 2 & 3 \\ 2 & 4 & 6 \\ 3 & 6 & 9 \end{pmatrix}$$

b) Plot legendre polynomial, $P_3(x) = \frac{1}{2}(5x^2 - 3x)$,

$P_5(r) = \frac{1}{8}(63x^5 - 70x^3 + 15x)$.

i) Locate roughly the zeros from the graph.

ii) Find out atleast one zero from each of the above polynomial using bisect function from Scipy.

iv) Find the inner product of these two vectors using Scipy integrate quad over the range $x \in (-1,1)$. 5+10

12. A) Write a computer program to solve the differential equation for damped harmaric motion:- $\frac{d^2y}{dx^2} + \frac{2dy}{dx} + y = 0$ with $y(0) = 0, x(0) = 0, y(0) = 1.0$.

Print the value of (x,y) in a data file and plot the graph through matplotlib.(Computer code may be written following Euler's method or RKZ or RKY.

b) Solve the differential equation: $\frac{d^2x}{dt^2} = -w^2x, x(0) = 1, x(0)$ using Eulers formula as scipy integrate odeint( ). Take W as input. Solve for t upto 0 T. ($T \rightarrow time\ period, \frac{2\pi}{w}$). Plot the trajectory in the phase space for both the cases. 8+7

13. a Evaluate error function, $erf(x) = \frac{2}{\sqrt{\pi}}\int_0^x e^{-t^2}dt$ for x values between (1,1) and plot. Complete the value of π from the formula: $\frac{\pi}{4} = \int_0^1 \frac{dx}{1+x^2}$ use composite Simpsons $\frac{1}{3}$ rule to evaluate with an accuracy of the order of 10^{-5}.

b) Fit a curve of the form $y = ab^x$ to the following data.

Year(x)	1951	1952	1953	1954	1956	1957
Production in tone (y)	201	263	314	395	504	612

8+7

14. a) Determine the constants'a' and 'b' by the method of least squares such that $y = ae^{bx}$ fits the following data:

X	2	4	6	8	10
y	4.077	11.084	30.128	81.897	222.62

b) i) Compute Bessel function of order 0,1,2 in the range $x \in [0,10]$ using Scipy. Special. Jv( )

ii) plot them on a single fig.

iii) Estimate roughly the position of the first zero of Jo(x).

Iv Use scipy. Optimize. Newton() to find the value of this zero.

15 a) The magnetic flux ϕ in the ion core of a current containing a resistance is given by the defferential equation:

$\frac{d\phi}{dt} + 1.8\phi + 0.01\phi^3 = 20, \phi(0) = 0$ compute ϕ in different t starting from 0 sec to1 sec, in steps of 0.2 sec.

b) Write a computer program, to calculate f(15) given the following table of values:

X	10	20	30	40	50
Y f(x)	46	66	81	93	101

7+8

16. a) The temperature θ of a well stirred liquid by the isothermal heating coil is given by the equation $\frac{d\theta}{dt} = k(1000)$. Where k is a constant of the system. Write a computer program to solve the equation by Range kutta fourth order method to find θ at t=1.0 secd and for k=2.5.

b) Initial condition: θ = 25^0C at t=0 sec. Expand the function, $f(x)=x+x^2$ in Fourier series in the interval $(-\pi, \pi)$. 8+7

17. a) Find the solution of $\frac{d^2y}{dx^2} + \frac{3dy}{dx} + 2y = e^{-x}$ that satisfies the initial conditions: $y = 0, \frac{dy}{dx} = 0 \, at \, x = 0$

b) Evaluate $\iiint \sqrt{x^2 + y^2} \, dxdydz$ where v is the region bounded by $Z=x^2+y^2$ and $Z= 8-x^2-y^2$. 8+7

18 a) Solve the following set of linear equations:

$$x_1 + 2x_2 - x_3 = 1$$
$$2x_1 + x_2 + 4x_3 = 2$$
$$3x_1 + 3x_2 + 4x_3 = 1$$

b) Create 100000 random integers, either 0 or 1. Think of o as Tail and 1 as Head of a coin. Find out how many 'Head' comes out in your collection of numbers(Total trial). Complete the fraction of head and that of tail. 8+7

LNB – 02

VIVA - 03
