



PATNA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH, NATURAL RESOURCES AND APPLIED SCIENCES

SCHOOL OF NATURAL AND APPLIED SCIENCES

DEPARTMENT OF BIOLOGY, CHEMISTRY AND PHYSICS

QUALIFICATION : BACHELOR OF SCIENCE	
QUALIFICATION CODE: 07BOSC	LEVEL: 7
COURSE CODE: MMP701S	COURSE NAME: MATHEMATICAL METHODS IN PHYSICS
SESSION: JUNE 2023	PAPER: THEORY
DURATION: 3 HOURS	MARKS: 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	Prof Dipti Ranjan Sahu
MODERATOR:	Prof S. C. Ray

INSTRUCTIONS
1. Answer ALL the questions. 2. Write clearly and neatly. 3. Number the answers clearly.

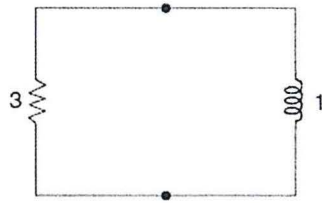
PERMISSIBLE MATERIALS

Non-programmable Calculators

THIS QUESTION PAPER CONSISTS OF 3 PAGES (Including this front page)

Question 1**[25]**

- 1.1 Consider the circuit as shown in the below figure with a 3Ω resistor and a 1-H inductor.



- 1.1.1 Write down the differential equation of the circuit where current i is flowing clockwise. (2)
 1.1.2 Solve the differential equation for the current as a function of time. (5)
 1.1.3 Determine the current as a function of time in this circuit given that its initial value is 6 A (3)

- 1.2 Solve the differential equation $(y^2-x) dx + 2ydy = 0$ (10)

- 1.3 Find the general solution of the differential equation.

$$\frac{dx}{dt} + t^2x = 0 \quad (5)$$

Question 2**[25]**

- 2.1 A 50g mass attached to a spring, moving in air with initial conditions $y(0) = 4$ cm and $y'(0) = 40$ cm/s. The spring is such that a 30 g mass stretches it 6 cm. Approximate the acceleration of gravity is 1000 cm/s².
 Formulate the differential equation and find the movement of the mass position at any time t . (10)

- 2.2 Find the general solution of $x'' - 3x' + 2x = 2t^2 + 1$ (10)

- 2.3 Find a particular solution of $x'' - x = 3e^{-t}$ (5)

Question 3**[25]**

- 3.1 Use matrices to find the solution for the set of equation as given below (10)

$$4x + 8y + z = -6$$

$$2x - 3y + 2z = 0$$

$$x + 7y - 3z = -8$$

- 3.2 Find the eigen values of the matrix A given as (10)

$$A = \begin{pmatrix} 1 & -3 & 3 \\ 3 & -5 & 3 \\ 6 & -6 & 4 \end{pmatrix}$$

- 3.3 Find k if (5)

$$A = \begin{bmatrix} k-2 & 1 \\ 5 & k+2 \end{bmatrix} \text{ is singular}$$

Question 4**[25]**

4.1 Show that for inner product space $C[-\pi, \pi]$, the functions $\sin t$ and $\cos t$ are orthogonal. (5)

4.2 Obtain an orthogonal basis for the subspace of R^4 spanned by $x_1 = (1, 0, 1, 0)$, $x_2 = (1, 1, 1, 1)$, $x_3 = (-1, 2, 0, 1)$ using Gram-Schmidt process. (10)

4.3 Using the Laplace transform find the solution for the following equation (5)

$$\frac{\partial y(t)}{\partial x} - 5 y(t) = e^{(5t)} \text{ with initial conditions } y(0) = 0 \text{ and } Dy(0) = b$$

4.4 Obtain the value of $P_3(x)$ using Rodrigues' formula (5)

$$P_n(x) = \frac{1}{(2^n)n!} \frac{d^n}{dx^n} (x^2 - 1)^n$$

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