

S.No. : 614

BAS 3201

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Following Paper ID and Roll No. to be filled in your Answer Book.

PAPER ID : 39906

Roll No. 

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## B. Tech. Examination 2022-23

(Even Semester)

### DIFFERENTIAL EQUATIONS AND FOURIER ANALYSIS

Time : Three Hours]

[Maximum Marks : 60

Note :- Attempt all questions.

#### SECTION - A

1. Attempt all parts of the following:  $8 \times 1 = 8$

(a) Find the order and degree of the differential equation:

$$\frac{dy^2}{dx^2} - \sqrt{1 + \frac{dy}{dx}} = 0$$

(b) Reduce the differential equation:

$$x^2 \frac{dy^2}{dx^2} - x \frac{dy}{dx} - 3y = x^2 \log x$$

to a differential equation with constant coefficients.

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(c) Evaluate:

$$\int_{-1}^1 x^3 P_3(x) dx$$

(d) Show that:

$$\frac{d}{dx} [J_0(x)] = -J_1(x)$$

(e) Write Dirichlet's conditions for a Fourier series.

(f) If  $f(x) = 1$  is expanded in Fourier sine series in  $(0, \pi)$  then find the value of  $b_n$ .

(g) Form the partial differential equation by eliminating the arbitrary constants  $a$  and  $b$  from  $z = ax + by$ .

(h) Classify the partial differential equation:

$$2 \frac{\partial^2 u}{\partial x^2} + 6 \frac{\partial^2 u}{\partial x \partial y} + 3 \frac{\partial^2 u}{\partial y^2} = 0$$

#### SECTION - B

2. Attempt any two parts of the following:  $2 \times 6 = 12$

(a) Solve the differential equation:

$$x \frac{dy^2}{dx^2} + (4x^2 - 1) \frac{dy}{dx} + 4x^3 y = 2x^3$$

by changing the independent variable.

- (b) Find the power series solution of:

$$(1-x^2) \frac{d^2 y}{dx^2} - 2x \frac{dy}{dx} + 2y = 0$$

about  $x = 0$ .

- (c) Find the Fourier series of the function:

$$f(x) = \frac{1}{4}(\pi - x)^2$$

in the interval  $0 \leq x \leq 2\pi$ . Hence obtain the relation:

$$\frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{3^2} + \dots \dots \dots \frac{\pi^2}{6}$$

- (d) A string is stretched and fastened to two points  $\ell$  apart. Motion is started by displacing the string in the form  $y = a \sin\left(\frac{\pi x}{\ell}\right)$  from which it is released at a time  $t = 0$ . Show that the displacement of any point at a distance  $x$  from one end at time  $t$  is given by:

$$y(x, t) = a \sin\left(\frac{\pi x}{\ell}\right) \cos\left(\frac{\pi c t}{\ell}\right)$$

### SECTION - C

**Note :-** Attempt all questions. Attempt any two parts from each question.  $5 \times 8 = 40$

[P.T.O.]

3. (a) Solve:

$$\frac{dy}{dx} - 2 \frac{dy}{dx} + y = x e^x \cos x$$

- (b) Apply method of variation of parameters to solve:

$$\frac{dy}{dx} + y = \sec x$$

- (c) Solve the simultaneous differential equations:

$$\frac{dx}{dt} = 3x + 8y$$

$$\frac{dy}{dt} = -x - 3y$$

with  $x(0) = 6$  and  $y(0) = -2$ .

4. (a) Prove that:

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

- (b) Prove that:

$$J_{1/2}(x) = \sqrt{\frac{2}{\pi x}} \sin x$$

- (c) Prove that:

$$n P_n(x) = x P_n'(x) - P_{n-1}'(x)$$

5. (a) Find the half range Fourier sine series of  $f(x)$  defined over the range  $0 < x < 4$  as :

$$f(x) = \begin{cases} x, & 0 < x < 2 \\ 4 - x, & 2 < x < 4 \end{cases}$$

- (b) Obtain Fourier series of the function :

$$f(x) = \begin{cases} 0, & -\pi < x < 0 \\ x, & 0 < x < \pi \end{cases}$$

- (c) Find the half range cosine series expansion of  $f(x) = x - x^2$  in  $0 < x < 1$ .

6. (a) Solve :

$$\frac{\partial^3 z}{\partial x^3} - 2 \frac{\partial^3 z}{\partial x^2 \partial y} = 2 e^{2x}$$

- (b) Solve :

$$(D^2 - D D' - 2 D) z = \cos(3x + 4y)$$

- (c) Using the method of separation of variables, solve :

$$\frac{\partial u}{\partial x} = 2 \frac{\partial u}{\partial t} + u$$

where  $u(x, 0) = 6 e^{-3x}$ .

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