Write your answers on this sheet and on the answer book. Attach this sheet to the answer book and then submit it.

Instructions:

- All questions are compulsory.
- Figures to right indicate full marks.
- Assume suitable data wherever necessary and specify it clearly in your answers.
- Only calculator scientific calculator is allowed.

Section A: Multiple Choice Questions

Instruction: Select the correct option. No need to write the steps. The Rough work must be submitted along with the answer sheet. [24*2 = 48 Marks]

1) $\frac{d^2y}{dx^2} + (x^3 + 3x)y = 9$

(a) Order 1 degree 1
(b) Order 2 degree 2
(c) Order 1 degree 2
(d) Order 2 degree 1

2) $\frac{d^4y}{dx^4} + \left(\frac{d^2y}{dx^2}\right)^2 - 3\frac{dy}{dx} + y = 5$

(a) Order 4 degree 3
(b) Order 4 degree 1
(c) Order 1 degree 4
(d) Order 4 degree 4

3) In modelling draining of a tank while using Bernoulli's principle following assumption is made. (given that P_1 and V_1 are pressure and speed at the top level and P_2 and V_2 are pressure and speed at the hole)

(a) $P_1 > P_2$, $V_1 = V_2$
(b) $P_1 = P_2$, $V_1 > V_2$
(c) $P_1 < P_2$, $V_1 < V_2$
(d) $P_1 = P_2$, $V_1 < V_2$

4) In the following model of population growth

$$\frac{dN}{dt} = a\,N - b\,N^2$$

with a and b positive constants, starting with N=1, population after a long time will be approaching

(a) 0
(b) a/b
(c) b/a
(d) infinity

5) The equation $x - 3y = \log\left(\frac{dy}{dx}\right)$

(a) is partial differential equation
(b) is homogeneous differential equation
(c) is inhomogeneous differential equation
(d) has no defined order

6) In Newton's law of cooling

$$\frac{dT}{dx} = k\,(T - T_b)$$

(a) k > 0
(b) k < 0
(c) k = 1
(d) k depends on initial temperature

7) One model of population growth where birth rate is aN and death rate is bN is, (given a >0, b>0)
(a) dN/dt = (a-b) N
(b) dN/dt = -(a+b) N
(c) dN/dt = (a+b) N
(d) dN/dt = (b-a) N

8) The roots of the characteristic equation for y" + 3 y' + 2y = 0 are
(a) 3, 2
(b) 3, 1
(c) 2,1
(d) -2, -1

9) The roots of the characteristic equation for y" – 2 y' + y = 0 are
(a) 1, 2
(b) 1, 1
(c) 2 , -1
(d) -2, 1

10) The General solution of y' = sin(x) is
(a) y(x) = -cos(x) + c
(b) y(x) = $\sin^2(x)/2$ + c
(c) y(x)= cos(x) + c
(d) y(x) = sin(x/2) + c

11) The General solution of y' = x is
(a) y(x) = ln(x) + c
(b) y(x) = c
(c) y(x)= x^2 + c
(d) y(x) = $x^2/2$ + c

12) To solve the given differential equation using undermined coefficient. Assumed expression for y_p is (where c, c_o and c_1 are constants)

$$\frac{dy}{dx} + 5y = 6$$

(a) c
(b) $c_1x + c_o$
(c) $x + c$
(d) $x - c$

13) To solve the given differential equation using undermined coefficient. Assumed expression for y_p is (where c, c_o and c_1 are constants)

$$\frac{dy}{dx} + 5y = x$$

(a) c
(b) $c_1x + c_o$
(c) $x + c$
(d) $c\,e^x$

14) To solve the given differential equation using undermined coefficient. Assumed expression for y_p is (where b and c are constants)

$$\frac{dy}{dx} + 5y = e^{5x}$$

(a) $c\,e^{5x}$
(b) $(c + b\,x)\,e^{5x}$
(c) $c\,e^{-5x}$
(d) $c\,xe^{-5x}$

15) To solve the given differential equation using undermined coefficient. Assumed expression for y_p is (where b and c are constants)

$$\frac{dy}{dx} - 5y = e^{5x}$$

(a) $c\,e^{5x}$
(b) $(c + b\,x)\,e^{5x}$
(c) $c\,e^{-5x}$
(d) $c\,xe^{5x}$

16) If a radioactive material decays to half its initial mass in 2 minutes, the time required for it to decay to one eighth of its initial mass is,
(a) 8 minutes
(b) 4 minutes
(c) 6 minutes
(d) None of the given options

17) The differential equation for the family of curves $y = c\,x^2$ is
(a) $dy/dx = 2y/x$
(b) $dy/dx = 2x/y$
(c) $dy/dx = 2y$
(d) $dy/dx = 2x$

18) The differential equation for the family of curves $xy = c$ is
(a) $dy/dx = -y/x$
(b) $dy/dx = -x/y$
(c) $dy/dx = y/x$
(d) $dy/dx = x/y$

19) Integration factor for $y' - y = \sin(x)$ is
(a) $\sin(x)\, e^{-x}$
(b) $x\, e^{-x}$
(c) e^{-x}
(d) $x\, e^{x}$

20) Integration factor for $y' - y/x = e^x$ is
(a) e^{-x}
(b) $-\ln(x)$
(c) $1/x$
(d) x

21) If the Laplace transformation of the function $f(t)$ is given by $\frac{(s+3)}{(s+1)(s+2)}$, then $f(0)$ is:
a) 3/2
b) 1/2
c) 0
d) 1

22) Choose the characteristics equation, characteristic roots, basis for the given differential equations: $y'' + y' - 2y = 0;\ y(0) = 4;\ y' = -5$
a) $\lambda^2 + \lambda - 2 = 0;\ \{1, -2\};\ \{e^x, e^{-2x}\}$
b) $\lambda^2 + \lambda + 2 = 0;\ \{1, -2\};\ \{e^x, e^{-2x}\}$
c) $\lambda^2 + 2\lambda - 2 = 0;\ \{1, 2\};\ \{e^x, e^{2x}\}$
d) $\lambda^2 + 2\lambda + 2 = 0;\ \{1, 2\};\ \{e^x, e^{2x}\}$

23) What is the general solution of $(1 + x)\,dy - y\,dx = 0$.
a) $y = -c\,(1 - x)$
b) $y = c\,(1 - x)$
c) $y = -c\,(1 + x)$
d) $y = c\,(1 + x)$

24) What is the particular solution of $y' = -2xy$; $y(0) = 1.8$.

a) $y = 2.8\, e^{-x^2}$
b) $y = 1.8\, e^{-x^2}$
c) $y = 2.8\, e^{x^2}$
d) $y = 1.8\, e^{x^2}$

Section B: Subjective Questions

Instructions: Solve the given problems step by step and show each step clearly in the answer sheet.

Q.1. Find out the solution of given initial value problem using the Laplace Transformation. Also, verify the initial condition using the obtained solution. [10 Marks]

$$y' + 3y = e^{2t};\ y(0) = 1$$

Q.2. A tank has pure water flowing into it at 10 L/min. The contents of the tank are kept well mixed, and the contents flow out at 10 L/min. Initially, the tank contains 10 kg of slat in 100 L of water. [12 Marks]

a) Draw a neat and clean figure for the given problem.
b) Identify the initial condition.
c) Formulate the mathematical model to find out the amount of salt present in the tank.
d) Obtain the general solution using the variable separable method.
e) Particular solution.
f) How much salt will be there in the tank after 60 minutes?

AHMEDABAD UNIVERSITY
School of Engineering and Applied Science

ENR110 Differential Equations in Engineering
End-Term Examination
Wednesday, 31 December 2025. 12:00 - 2:00 PM

NAME:..... **Enrollment No.:**.....

Instructions:

- All questions are compulsory.
- Figures to right indicate full marks.
- Assume suitable data wherever necessary and specify it clearly in your answers.
- Only scientific calculator is allowed.
- Solve the given problems step by step and show each step clearly in the answer sheet. Without clear steps, no marks will be awarded even for the correct answers.

Q.1. Find out the general solution of the given equation: [10 Marks]

$$\frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 4y = 2e^{3x}$$

Q.2. Find out the solution of given initial value problem using the Laplace Transformation. Also, verify the initial condition using the obtained solution. [15 Marks]

$$\frac{dy}{dt} + 2y = 10e^{3t}; y(0) = 6$$

Q.3. Draw the solution curves for the given problems using direction fields and isoclines. Also verify if you are getting the same solutions using the above two methods. [15 Marks]

$$y' = -x$$

Q.4. Let's say we have an object with temperature T. Such an object is enclosed in a box having temperature T_B (5K). Assume that the temperature of the object is much greater than the temperature of the box ($T >> T_B$). Formulate a mathematical model for the system and answer the following:

a) Draw a neat and clean diagram describing the problem discussed above. [15 Marks]

b) What is the rate of cooling of this object?

c) Relate your model with Newton's Law of cooling.

d) If the initial temperature of the object is 10 K at t = 5s, demonstrate the Initial Condition.

e) If we reverse the case such that $T_B > T$, what will be the physical interpretation of the problem?

Q.5. A tank has pure water flowing into it at 10 L/min. The contents of the tank are kept well mixed, and the contents flow out at 10 L/min. Initially, the tank contains 10 kg of slat in 100 L of water.

[15 Marks]

a) Draw a neat and clean figure for the given problem.

b) Identify the initial condition.

c) Formulate the mathematical model to find out the amount of salt present in the tank.

d) Obtain the general solution using the variable separable method.

e) Particular solution.

f) How much salt will be there in the tank after 60 minutes?