**SRM Institute of Science and Technology**
**Ramapuram campus**
**Department of Mathematics**
**18MAB101T - Calculus and Linear Algebra**

**Year/Sem: I/I** **Part – A Branch: Common to ALL Branches**

## Unit – III Ordinary Differential Equations

| | | | |
|---|---|---|---|
| 1. | The order and degree of $\frac{d^2y}{dx^2}+3\frac{dy}{dx}+2y=e^{-2x}$ are | 1 Mark | |
| | a)2, 1 b) 1, 2 c) 2, 2 d)1, 1 | Ans (a) | (CLO-3 Remember) |
| 2. | The order and degree of $\frac{d^2y}{dx^2}+3\left(\frac{dy}{dx}\right)^2+2y=\sin 3x$ are | 1 Mark | |
| | a) 1, 2 b) 2, 1 c) 2, 2 d) 1, 1 | Ans (b) | (CLO-3 Remember) |
| 3. | The order and degree of $\left(\frac{d^2y}{dx^2}\right)^2+2\frac{dy}{dx}+y=5x$ are | 1 Mark | |
| | a) 1, 2 b) 2, 1 c) 2, 2 d) 1, 1 | Ans (c) | (CLO-3 Remember) |
| 4. | The order and degree of $\frac{dy}{dx}+3y=5x$ are | 1 Mark | |
| | a) 1, 2 b) 2, 1 c) 2, 2 d) 1, 1 | Ans (d) | (CLO-3 Remember) |
| 5. | The number of arbitrary constants in the solution of a differential equation is equal to the _____ of that differential equation. | 1 Mark | |
| | a) degree b) number of variables<br>c) order d) number of terms | Ans (b) | (CLO-3 Remember) |
| 6. | The number of arbitrary constants in the most general solution of $n^{th}$ order differential equation is _____ | 1 Mark | |
| | a) 1 b) n – 1 c) n d) n + 1 | Ans (c) | (CLO-3 Remember) |
| 7. | The solution of $(D^3 – D^2 + D – 1)y = 0$ is | 1 Mark | |
| | a) $y = Ae^x + B \cos x + C \sin x$<br>b) $y = Ae^x + B \cos x – C \sin x$<br>c) $y = Ae^{-x} + B \cos x + C \sin x$<br>d) $y = Ae^x + B \cosh x + C \sinh x$ | Ans (a) | (CLO-3 Remember) |
| 8. | The complementary function of $(D^2 + D + 1)y = 0$ is | 1 Mark | |

| | | | |
|---|---|---|---|
| | a) $e^{\frac{1}{2x}}\left(C_1\cos\frac{\sqrt{3}}{2}x+C_2\sin\frac{\sqrt{3}}{2}x\right)$ b) -1, 2<br>c) $e^{\frac{-1}{2x}}\left(C_1\cos\frac{\sqrt{3}}{2}x+C_2\sin\frac{\sqrt{3}}{2}x\right)$ d) $\cos x+i\sin x$ | Ans (c) | (CLO-3 Remember) |
| 9. | The complementary function of $\frac{d^2y}{dx^2}-8\frac{dy}{dx}+15y=0$ | 1 Mark | |
| | a) $C_1e^{-5x}+C_2e^{-3x}$ b) $C_1e^{4x}+C_2e^{4x}$<br>c) $C_1e^{5x}+C_2e^{3x}$ d) $C_1e^{2x}+C_2e^{6x}$ | Ans (c) | (CLO-3 Remember) |
| 10. | The complementary function of $\frac{d^2y}{dx^2}+6\frac{dy}{dx}+9y=3e^{4x}$ | 1 Mark | |
| | a) $C_1e^{-3x}+C_2e^{-3x}$ b) $C_1e^{3x}+C_2e^{3x}$<br>c) $(C_1+C_2x)e^{-3x}$ d) $(C_1+C_2x)e^{3x}$ | Ans (c) | (CLO-3 Remember) |
| 11. | The complementary function of $(D^2 + 4)y = x \sin x$ is | 1 Mark | |
| | a) $C_1e^{-3x}+C_2e^{-3x}$ b) $C_1e^{3x}+C_2e^{3x}$<br>c) $(C_1\cos 2x+C_2\sin 2x)$ d) $(C_1+C_2x)e^{3x}$ | Ans (c) | (CLO-3 Remember) |
| 12. | The particular integral of $(D^3 – D^2 + D - 1)y = 0$ is | 1 Mark | |
| | a) 0 b) $y = Ae^x + B\cos x – C\sin x$<br>c) $B\cos x + C\sin x$ d) $y = Ae^x + B\cosh x + C\sinh x$ | Ans (a) | (CLO-3 Remember) |
| 13. | The particular integral of $(D^2 + 2D + 1)y = 5$ is | 1 Mark | |
| | a) 0 b) 5 c) 2 d) 1 | Ans (b) | (CLO-3 Remember) |
| 14. | The particular integral of $(D^2 + 9)y = e^{-2x}$ is | 1 Mark | |
| | a) $\frac{e^{-2x}}{15}$ b) $\frac{e^{2x}}{15}$ c) $\frac{e^{-2x}}{13}$ d) $\frac{e^{-2x}}{14}$ | Ans (c) | (CLO-3 Remember) |
| 15. | The particular integral of $(D^2 + 16)y = e^{-4x}$ is | 1 Mark | |
| | a) $\frac{x}{32}e^{-4x}$ b) $\frac{1}{32}e^{-4x}$ c) $\frac{x}{16}e^{-4x}$ d) $\frac{1}{16}e^{-4x}$ | Ans (a) | (CLO-3 Remember) |
| 16. | The particular integral of $(D - 1)^2 y = e^x$ is | 1 Mark | |
| | a) $\frac{x}{32}e^{-4x}$ b) $\frac{x^2}{2}e^{x}$ c) $\frac{x}{16}e^{-4x}$ d) $\frac{1}{16}e^{-4x}$ | Ans (b) | (CLO-3 Remember) |
| 17. | The particular integral of $(D^2 + a^2)y = \cos ax$ is | 1 Mark | |

| | | | |
|---|---|---|---|
| | a) $\frac{-x}{2a}\sin ax$ b) $\frac{-x}{2a}\cos ax$ c) $\frac{x}{2a}\cos ax$ d) $\frac{x}{2a}\sin ax$ | Ans (d) | (CLO-3 Remember) |
| 18. | The particular integral of $(D^2 + 4)y = \sin 2x$ is | 1 Mark | |
| | a) $\frac{x}{2}\sin x$ b) $\frac{-x}{2}\sin x$ c) $\frac{-x}{4}\cos 2x$ d) $\frac{x}{4}\cos 2x$ | Ans (c) | (CLO-3 Remember) |
| 19. | The particular integral of $(D^2 + 2)y = x^2$ is | 1 Mark | |
| | a) $\frac{1}{2}x^2$ b) $\frac{1}{2}(x^2-1)$ c) $\frac{1}{2}(x^2+1)$ d) $\frac{-1}{2}x^2$ | Ans (b) | (CLO-3 Remember) |
| 20. | The method of variation of parameters is used to find the particular integral of a second order differential equation whose _____ is known. | 1 Mark | |
| | a) Complementary function b) constant c) variable d) degree | Ans (a) | (CLO-3 Remember) |
| 21. | The order and degree of $\left(\frac{d^2y}{dx^2}\right)^2 + 3\frac{dy}{dx} + 2y = e^x$ are | 1 Mark | |
| | a) 2, 1 b) 1, 2 c) 2, 2 d) 1, 1 | Ans (c) | (CLO-3 Remember) |
| 22. | The order and degree of $\left(\frac{d^2y}{dx^2}\right)^2 + 3\left(\frac{dy}{dx}\right)^4 + 2y = Sin2x$ are | 1 Mark | |
| | a) 2, 1 b) 1, 2 c) 2, 2 d) 1, 1 | Ans (c) | (CLO-3 Remember) |
| 23. | The particular integral of$(D^3 – D^2 + D - 1)y = 0$ is | 1 Mark | |
| | a) 0 b) $Ae^x + B\cosh x$ c) $A\cos x + B\sin x$ d) $Ae^x + B\cosh x + C\sinh x$ | Ans (a) | (CLO-3 Remember) |
| 24. | The particular integral of $(D^2 + 2D + 1)y = 1$ is | 1 Mark | |
| | a) 0 b) 5 c) 2 d) 1 | Ans (d) | (CLO-3 Remember) |
| 25. | The particular integral of $(D^2 + 2)y = x$ is | 1 Mark | |
| | a) $\frac{1}{2}x$ b) $\frac{1}{2}(x^2-1)$ c) $\frac{1}{2}(x^2+1)$ d) $\frac{-1}{2}x^2$ | Ans (a) | (CLO-3 Remember) |
| 26. | The particular integral of $(D^2 + 4)y = \text{Cos } 2x$ is | 1 Mark | |

| | | | |
|---|---|---|---|
| | a) $\frac{x}{2}\sin x$ b) $\frac{-x}{2}\sin x$ c) $\frac{-x}{4}\cos 2x$ d) $\frac{x}{4}\sin 2x$ | Ans (d) | (CLO-3 Remember) |
| 27. | The particular integral of $(D^2 + 1)y = \text{Cos } 2x$ is | 1 Mark | |
| | a) $\frac{x}{2}\sin x$ b) $\frac{-x}{3}\cos 2x$ c) $\frac{-x}{4}\cos 2x$ d) $\frac{x}{4}\sin 2x$ | Ans (b) | (CLO-3 Remember) |
| 28. | The complementary function of $\frac{d^2y}{dx^2}+8\frac{dy}{dx}+15y=0$ | 1 Mark | |
| | a) $C_1e^{-5x}+C_2e^{-3x}$ b) $C_1e^{4x}+C_2e^{4x}$<br>c) $C_1e^{5x}+C_2e^{3x}$ d) $C_1e^{2x}+C_2e^{6x}$ | Ans (a) | (CLO-3 Remember) |
| 29. | The complementary function of $(D^2 + 4)y = \sin x$ is | 1 Mark | |
| | a) $C_1e^{-3x}+C_2e^{-3x}$ b) $C_1e^{3x}+C_2e^{3x}$<br>c) $(C_1\cos 2x+C_2\sin 2x)$ d) $(C_1+C_2x)e^{3x}$ | Ans (c) | (CLO-3 Remember) |
| 30. | The complementary function of $\frac{d^2y}{dx^2}-6\frac{dy}{dx}+9y=e^{4x}$ | 1 Mark | |
| | a) $C_1e^{-3x}+C_2e^{-3x}$ b) $C_1e^{3x}+C_2e^{3x}$<br>c) $(C_1+C_2x)e^{-3x}$ d) $(C_1+C_2x)e^{3x}$ | Ans (d) | (CLO-3 Remember) |
| 31. | The particular integral of $(D - 1)^2 y = e^{-x}$ is | 1 Mark | |
| | a) $\frac{x}{32}e^{-4x}$ b) $\frac{x^2}{2}e^{x}$ c) $\frac{x}{16}e^{-4x}$ d) $\frac{1}{4}e^{-x}$ | Ans (d) | (CLO-3 Remember) |
| 32. | The complementary function of $(D - 1)^2y = e^{-x}$ is | 1 Mark | |
| | a) $C_1e^{-x}+C_2e^{-x}$ b) $C_1e^{x}+C_2e^{x}$<br>c) $(C_1+C_2x)e^{x}$ d) $(C_1+C_2x)e^{-x}$ | Ans (c) | (CLO-3 Remember) |
| 33. | The complementary function of $(D - 1)^2y = e^{-5x}$ is | 1 Mark | |
| | a) $C_1e^{-x}+C_2e^{-x}$ b) $C_1e^{x}+C_2e^{x}$<br>c) $(C_1+C_2x)e^{x}$ d) $(C_1+C_2x)e^{-x}$ | Ans (c) | (CLO-3 Remember) |
| 34. | The particular integral of $(D + 1)^2 y = e^{-5x}$ is | 1 Mark | |
| | a) $\frac{1}{36}e^{-5x}$ b) $\frac{x^2}{2}e^{x}$ c) $\frac{x}{36}e^{-5x}$ d) $\frac{1}{4}e^{-x}$ | Ans (a) | (CLO-3 Remember) |
| 35. | The particular integral of $(D^2 + 1)y = \cos x$ is | 1 Mark | |

| | | | |
|---|---|---|---|
| | a) $\frac{x}{2}\sin x$ b) $\frac{-x}{3}\cos 2x$ c) $\frac{-x}{4}\cos 2x$ d) $\frac{x}{4}\sin 2x$ | Ans (a) | (CLO-3 Remember) |
| 36. | The particular integral of $(D^2 + 9)y = \sin 3x$ is | 1 Mark | |
| | a) $\frac{x}{2}\sin x$ b) $\frac{-x}{6}\cos 3x$ c) $\frac{-x}{4}\cos 2x$ d) $\frac{x}{4}\sin 2x$ | Ans (b) | (CLO-3 Remember) |

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**Unit – III**

# ORDINARY DIFFERENTIAL EQUATIONS

**Part – B**

1. Solve $\left(D^2 - 7D + 12\right)y = 0$.

$(a)\, y = Ae^{3x} + Be^{4x}$ $(b)\, y = Ae^{-3x} + Be^{4x}$

$(c)\, y = Ae^{3x} + Be^{-4x}$ $(d)\, y = Ae^{-3x} + Be^{-4x}$

$m^2 - 7m + 12 = 0$
$(m-3)(m-4) = 0$
$m = 3, 4$
$y = Ae^{3x} + Be^{4x}$ **(Option (a))**

2. Find the particular integral of $\left(D^2 - 9\right)y = e^{-2x}$.

$(a)\, PI = \frac{1}{13}e^{-2x}$ $(b)\, PI = -\frac{1}{5}e^{-2x}$

$(c)\, PI = \frac{x}{5}e^{-2x}$ $(d)\, PI = \frac{1}{5}e^{-2x}$

$$PI = \frac{1}{D^2 - 9} e^{-2x}$$
$$= \frac{1}{4 - 9} e^{-2x}$$
$$= -\frac{1}{5} e^{-2x}$$ **(Option (b))**

3. Find the particular integral of $(D^2 + 3D + 2)y = e^{-2x}$.

$(a) PI = -xe^{-2x}$ $(b) PI = xe^{-2x}$

$(c) PI = \frac{e^{-2x}}{12}$ $(d) PI = \frac{xe^{-2x}}{12}$

$$PI = \frac{1}{D^2 + 3D + 2} e^{-2x}$$
$$= \frac{1}{4 - 6 + 2} e^{-2x}$$
$$= x.\frac{1}{2D + 3} e^{-2x}$$
$$PI = -xe^{-2x}$$ **(Option (a))**

4. Find the particular integral of $(D^2 + 4)y = \sin 2x$.

$(a) PI = -\frac{x \cos 2x}{4}$ $(b) PI = -\frac{\sin 2x}{8}$

$(c) PI = \frac{x \sin 2x}{4}$ $(d) PI = \frac{\sin 2x}{8}$

$$PI = \frac{1}{D^2+4}\sin 2x$$
$$= x.\frac{1}{2D}\sin 2x$$
$$= -x.\frac{\cos 2x}{4}$$ **(Option (a))**

5. Find the particular integral of $(D^2+D+1)y = 3x-1$.

$(a) PI = 3x-4$ $(b) PI = 3x$

$(c) PI = 3x-1$ $(d) PI = 3x^2-4$

$$PI = \frac{1}{D^2+D+1}(3x-1)$$
$$= [1+(D+D^2)]^{-1}(3x-1)$$
$$= (3x-1) - D(3x-1)$$
$$PI = 3x-4$$ **(Option (a))**

**6.** Find the particular integral of $(D^2+D+1)y = x$

$(a) PI = 3x-4$ $(b) PI = 3x$

$(c) PI = x-1$ $(d) PI = 3x^2-4$

$$PI = \frac{1}{D^2+D+1}(x)$$
$$= [1+(D+D^2)]^{-1}(x)$$
$$= [1-(D+D^2)](x)$$
$$= (x-D(x)) \quad = x-1$$
$$PI = x-1$$

**(Option C)**

7**. Solve** $(D^3 - 6D^2 + 11D - 6)y = 0$

$(a)\, y = Ae^x + Be^{2x} + Ce^{3x}$ $(b)\, y = Ae^x + Be^{-2x} + Ce^{3x}$

$(c)\, y = Ae^x + Be^{2x} + Ce^{-3x}$ $(d)\, y = Ae^x + Be^{-2x} + Ce^{-3x}$

$m^3 - 6m^2 + 11m - 6 = 0$

$(m-1)(m-2)(m-3) = 0$

$m = 1,2,3$

$C.F = Ae^x + Be^{2x} + Ce^{3x}$

*Hence*

$y = Ae^x + Be^{2x} + Ce^{3x}$

**(Option A)**

8**.** Find the particular integral of $(D^2 + D - 2)y = Sinx$

$(a)\, PI = \frac{-1}{10}(\cos x + 3\sin x)$ $(b)\, PI = \frac{1}{10}(\cos x + 3\sin x)$

$(c)\, PI = \frac{-1}{10}(\sin x + 3\cos x)$ $(d)\, PI = \frac{-1}{10}(\sin x - 3\cos x)$

$\text{P.I} = \frac{1}{D-3}\sin x = \frac{D+3}{D^2-9}\sin x$ , Rationalizing the denominator

$= \frac{(D+3)\sin x}{-10}$, Putting $D^2 = -1$

$\therefore \text{P.I.} = \frac{-1}{10}(D\sin x + 3\sin x)$

$= \frac{-1}{10}(\cos x + 3\sin x)$

**(Option A)**

9. Find the complementary function of $(D^2+1)y = \cos ec\, x$.

$(a) CF = (A+Bx)e^x$ $(b) CF = (A+Bx)e^x$

$(c) CF = A\cos x + B\sin x$ $(d) CF = (A\cos x + B\sin x)e^x$

$m^2 + 1 = 0 \Rightarrow m = \pm i$

$CF = A\cos x + B\sin x$ **(Option (c))**

10. Solve $(D^2 + 4D + 4)y = 0$.

$(a) y = Ae^{-2z} + Be^{-2z}$ $(b) y = (A+Bx)e^{-2x}$

$(c) y = \frac{A}{x} + \frac{B}{x^2}$ $(d) y = Ax + Bx^2$

$m^2 + 4m + 4 = 0$

$m = -2, -2$

$y = (A+Bx)e^{-2x}$ **(Option (B))**

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# ORDINARY DIFFERENTIAL EQUATIONS

**Part – C**

**1. Find the particular integral of** $(D^2+3D+2)y=e^{-x}$

**Ans:**

$$PI=\frac{1}{D^2+3D+2}e^{-x}$$
$$=\frac{1}{1-3+2}e^{-x}$$
$$=x.\frac{1}{2D+3}e^{-x}$$
$$=x.\frac{1}{1}e^{-x}$$
$$PI=xe^{-x}$$

**2. Solve** $x^2\frac{d^2y}{dx^2}-7x\frac{dy}{dx}+12y=0$

**Ans:**

$Let\ x=e^z \Rightarrow z=\log x$

$subsitute\ \mathrm{xD}=\mathrm{D}';x^2D^2=\mathrm{D}'(\mathrm{D}'-1)$

$(\mathrm{D}'^2-8\mathrm{D}'+12)\mathrm{y}=0$

$\mathrm{m}^2-8m+12=0\Rightarrow m=2,6$

$C.F=Ae^{2z}+Be^{6z}$

$y=Ax^2+Bx^6$

**3. Find the particular integral of** $\frac{d^2y}{dx^2}+\frac{dy}{dx}-2y=e^x$.

**Ans:**

$$\text{P.I.}=\frac{1}{f(D)}F(x)=\frac{1}{f(D)}e^x \text{, putting } D=1, f(1)=0$$

$$\therefore \text{P.I}= x\frac{1}{f'(D)}e^x \qquad \because \text{P. I.}= x\frac{1}{f'(a)}e^{ax} \text{ if } f(a)=0$$

$$\Rightarrow \text{P.I.}= x\frac{1}{2D+1}e^x=\frac{1}{f'(1)}e^x \text{, } f'(1)\neq 0$$

$$\Rightarrow \text{P.I.}=\frac{xe^x}{3}$$

**4. Find the particular integral of** $(D^2+4)y=Cos2x$

**Ans:**

$$PI=\frac{1}{D^2+4}\cos 2x$$

$$=\frac{1}{-4+4}\cos 2x$$

$$=x.\frac{1}{2D}\cos 2x$$

$$=\frac{x}{4}\sin 2x$$

$$PI=\frac{x}{4}\sin 2x$$

**5. Find the particular integral of** $(D^2+9)y = x\cos x$

**Ans:**

$$\text{P.I.} = \frac{1}{f(D)}F(x) = \frac{1}{D^2+9}x\cos x$$

$$= x\frac{1}{D^2+9}\cos x + \frac{-2D}{(D^2+9)^2}\cos x$$

$$= x\frac{1}{-1+9}\cos x + \frac{-2D}{(-1+9)^2}\cos x, \qquad \text{Putting } D^2 = -1$$

$$= \frac{x\cos x}{8} - \frac{2D\cos x}{64}$$

$$= \frac{x\cos x}{8} - \frac{2D\cos x}{64}$$

$$\therefore \text{P.I.} = \frac{x\cos x}{8} + \frac{\sin x}{32}$$

**6. Find the particular integral of** $\frac{d^2y}{dx^2} - y = 5x - 2.$

**Ans:**

$$\text{P.I.} = \frac{1}{f(D)}F(x) = \frac{1}{D^2-1}(5x-2)$$

$$= \frac{1}{-(1-D^2)}(5x-2)$$

$$= -(1-D^2)^{-1}(5x-2)$$

$$= -[1+D^2+\cdots](5x-2)$$

$$= -(5x-2)$$

7. Solve $x^2\frac{d^2y}{dx^2}-4x\frac{dy}{dx}+6y=0$

**Ans:**

$Let\ x=e^z \Rightarrow z=\log x$

$subsitute\ \mathrm{xD}=\mathrm{D}';x^2D^2=\mathrm{D}'(\mathrm{D}'-1)$

$(\mathrm{D}'^2-5\mathrm{D}'+6)\mathrm{y}=0$

$\mathrm{m}^2-5m+6=0\Rightarrow m=-2,-3$

$C.F=Ae^{-2z}+Be^{-3z}$

$y=\frac{A}{x^2}+\frac{A}{x^3}$

8. Solve $x^2\frac{d^2y}{dx^2}-x\frac{dy}{dx}+y=0$.

**Ans:**

$(\mathrm{D}'^2-2\mathrm{D}'+1)\mathrm{y}=0$

$\mathrm{m}^2-2m+1=0\Rightarrow m=1,1$

$C.F=(A+Bz)e^z$

$y=(A+B\log x)x$

9. Solve $x\frac{dy}{dx}+2y=0$

**Ans:**

$(\mathrm{D}'+2)\mathrm{y}=0$

$m+2=0\Rightarrow m=-2$

$y=\frac{A}{x^2}$

10. Find the particular integral of $(x^2D^2 + xD - 1)y = \sin(\log\ x)$.

**Ans**

$$PI = \frac{1}{D'^2 - 1}\sin z$$
$$= \frac{\sin z}{-2}$$
$$= -\frac{\sin(\log\ x)}{2}$$

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