MATHS

BOOKS - RS AGGARWAL MATHS (HINGLISH)

DIFFERENTIAL EQUATIONS AND THEIR FORMATION

Solved Examples

1. Write the order and the degree of the differential equation $\frac{d^2y}{dx^2} + 5\frac{dy}{dx} + 3y = 0.$

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2. Write the order and the degree of the diffential equation

$$x\left(\frac{d^3y}{dx^3}\right)^2 + \left(\frac{dy}{dx}\right)^4 + y^2 = 0.$$

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3. Write the order and degree of the differential equation $y = x\frac{dy}{dx} + \sqrt{1 + \left(\frac{dy}{dx}\right)^2}$.

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4. Write the order and degree of the differential equation

$$\left\{1 + \left(\frac{dy}{dx}\right)^2\right\}^{3/2} = k\left(\frac{d^2y}{dx^2}\right).$$

A. order = 2 and degree =2

B. order = 3 and degree =2

C. order = 1 and degree =2

D. order = 2 and degree not exist

Answer: A

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5. Determine the order and degree of each of the following differential equation. State also whether they are linear or non-linear: $y = px + \sqrt{a^2p^2 + b^2},\ where\ p = \dfrac{dy}{dx}$

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6. Find the order and degree (if any) of each of the differential equations given

$(i)\ \frac{dy}{dx} - \tan x = 0$ $(ii)\left(\frac{dy}{dx}\right)^2 + y = e^x$

$(iii)\ \frac{d^2y}{dx^2} = \sin 3x + \cos 3x$ $(iv)(y'')^2 + \cos y' = 0$

$(v) y + 2y' + \sin y = 0$ $(vi)\ \frac{d^4y}{dx^4} + \sin\left(\frac{d^3y}{dx^3}\right) = 0$

$(vii) y'' + y^2 + e^{y'} = 0$ $(viii) 3\frac{d^2y}{dx^2} + 5\left(\frac{dy}{dx}\right)^2 = \log x$

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7. Verify that $y = A\cos x - B\sin x$ is a solution of the differential equation $\dfrac{d^2y}{dx^2} + y = 0$

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8. Show that $y = ae^{2x} + be^{-x}$ is a solution of the differential equation $\frac{d^2y}{dx^2} - 2y = 0.$

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9. Show that $y = Ax + \frac{B}{x}, x \neq 0$ is a solution of the differential equation $x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} - y = 0$

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10. Prove that the differential equation for $a\cos(\log x) + b\sin(\log x)$ is $x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} + y = 0$

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11. Verify that $y = e^{m\sin^{-1}x}$ is a solution of the differential equation $(1-x^2)\frac{d^2y}{dx^2} - x\frac{dy}{dx} - m^2y = 0.$

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12. Show that, $v = \frac{A}{r} + B$ satisfies the differential equation $\frac{d^2v}{dr^2} + \frac{2}{r}.\frac{dv}{dr} = 0$

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13. Prove that $x^2 - y^2 = c\left(x^2 + y^2\right)^2$ is the general solution of differential equation $\left(x^3 - 2xy^2\right)dx = \left(y^3 - 3x^2y\right)dy$, where c is a parameter.

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14. Prove that $xy = ae^x + be^{-x} + x^2$ is the general solution of the differential equation $x\frac{d^2y}{dx^2} + 2\frac{dy}{dx} - xy + x^2 - 2 = 0.$

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15. Verify that the function $y = c_1 eax \cos bx + c_2 eax \sin bx$, where c_1, c_2 are arbitrary constants is a solution of the differential equation. $\frac{d^2y}{dx^2} - 2a\frac{dy}{dx} + (a^2 + b^2)y = 0$

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16. Write the differential equation representing the family of curves $y = mx,$ where m is an arbitrary constant.

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17. Find the differential equartion of the family of curves $y = Ae^x + Be^{-x},$ where A and B are arbitrary constants.

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18. The differential equation of the family of curves $y = e^x(A\cos x + B\sin x)$, where A and B are arbitrary constants is (a) $(b)(c)(d)\frac{(e)(f)d^{(g)2(h)}(i)y}{j}\Big((k)d(l)x^{(m)2(n)}(o)\Big)(p)(q) - 2(r)\frac{(s)dy}{t}((u)$ (y) (z) *[Math Processing Error]* (xx) (yy) *[Math Processing Error]* (eeee) (ffff) *[Math Processing Error]* (ddddd)

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19. Find the differential equation of the family of all straight lines.

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20. Obtain the differential equation of all circles of radius r.

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21. From the differential equation of the family of all circles in first quadrant and touching the coordinate axes.

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22. Form the differential equation of the family of circles touching the x-axis at origin.

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23. From the differential equation of the family of all parabolas having vertex at the origin and axis along the positive direction of the x-axis is given by

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24. Form the differential equation representing the family of ellipses having foci on x-axis and centre at the origin.

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25. From the differential equation for the family of the curves $(y-b)^2 = 4(x-a)$, where a and b are parameters.

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26. From the differential equation for the family of the curves $ay^2 = (x-c)^3$, where c is a parameter.

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27. From the differential equation for the family of the curves $y^2 = a(b^2 - x^2)$, where a and b are arbitrary constants.

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Exercise 18 A

1. Write order and degree (if defined) of each of the following differential equations.

$$\left(\frac{dy}{dx}\right)^4 + 3y\left(\frac{d^2y}{dx^2}\right) = 0$$

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2. Write order and degree (if defined) of each of the following differential equations.

$$x^3\left(\frac{d^2y}{dx^2}\right)^2 + x\left(\frac{dy}{dx}\right)^4 = 0$$

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3. Write order and degree (if defined) of each of the following differential equations.

$$\left(\frac{d^2y}{dt^2}\right)^2 + x\left(\frac{ds}{dt}\right)^3 + 4 = 0$$

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4. Write order and degree (if defined) of each of the following differential equations.

$$\left(\frac{d^3y}{dx^3}\right) + \left(\frac{d^2y}{dx^2}\right)^3 + \left(\frac{dy}{dx}\right)^4 + y^5 = 0$$

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5. Write order and degree (if defined) of each of the following differential equations.

$$\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^2 + 2y = 0$$

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6. Write order and degree (if defined) of each of the following differential equations.

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

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7. Write order and degree (if defined) of each of the following differential equations.

$$\frac{d^2y}{dx^2} + y^2 + e^{(dy/dx)} = 0$$

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8. Write order and degree (if defined) of each of the following differential equations.

$$\frac{dy}{dx} + \sin\left(\frac{dy}{dx}\right) = 0$$

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9. Write order and degree (if defined) of each of the following differential equations.

$$\frac{d^4y}{dx^4} - \cos\left(\frac{d^3y}{dx^3}\right) = 0$$

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10. Write order and degree (if defined) of each of the following differential equations.

$$\frac{d^2y}{dx} + 5x\left(\frac{dy}{dx}\right)^2 - 6y = \log x$$

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11. Write order and degree (if defined) of each of the following differential equations.

$$\left(\frac{dy}{dx}\right)^3 - 4\left(\frac{dy}{dx}\right)^2 + 7y = \sin x$$

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12. Write order and degree (if defined) of each of the following differential equations.

$$\frac{d^3y}{dx^3} + 2\frac{d^2y}{dx^2} + \frac{dy}{dx} = 0$$

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13. Write order and degree (if defined) of each of the following differential equations.

$$x\left(\frac{dh}{dx}\right) + \frac{2}{\left(\frac{dy}{dx}\right)} + 9 = y^2$$

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14. Write order and degree (if defined) of each of the following differential equations.

$$\sqrt{1 - \left(\frac{dy}{dx}\right)^2} = \left(a\frac{d^2y}{dx^2}\right)^{1/3}$$

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15. Write order and degree (if defined) of each of the following differential equations.

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

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16. Write order and degree (if defined) of each of the following differential equations.

$(y')^3+(y')^2+\sin y'+1=0$

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17. Write order and degree (if defined) of each of the following differential equations.

$(3x+5y)dy-4x^2dx=0$

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18. Write order and degree (if defined) of each of the following differential equations.

$$y = \frac{dy}{dx} + \frac{5}{\left(\frac{dy}{dx}\right)}$$

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Exercise 18 B

1. Verify that $x^2 = 2y^2 \log y$ is a solution of the differential equation $\left(x^2 + y^2\right)\frac{dy}{dx} - xy = 0.$

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2. Verify tht $y = e^x$ cos bx is a solution of the differential equation $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 2y = 0.$

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3. Verify that $y = e^{m\cos^{-1}x}$ satisfies the differential equation $(1-x^2)\frac{d^2y}{dx^2} - x\frac{dy}{dx} - m^2y = 0$

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4. Verify that $y = (a+bc)e^{2x}$ is the general solution of the differential equation $\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y = 0.$

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5. Show that $y = e^x(A\cos x + B\sin x)$ is the solution of the differential equation $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 2y = 0.$

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6. Verify that $y = A\cos 2x - B\sin 2x$ is the general solution of the differential equation $\frac{d^2y}{dx^2} + 4y = 0.$

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7. Show that $y = ae^{2x} + be^{-x}$ is a solution of the differential equation $\frac{d^2y}{dx^2} - 2y = 0.$

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8. Show that $y = e^x(A\cos x + B\sin x)$ is the solution of the differential equation $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 2y = 0.$

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9. Verify that $y = ce^{tan-1_x}$ is a solution of differential equation $(1+x^2)\frac{d^2y}{dx^2} + x\frac{dy}{dx} = 0.$

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10. Verify that $y = ce^{tan-1_x}$ is a solution of differential equation $(1+x^2)\frac{d^2y}{dx^2} + x\frac{dy}{dx} = 0.$

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11. Show that $y = Ae^{Bx}$ is as solution of the differential equation $\frac{d^2y}{dx^2} = \frac{1}{y}\left(\frac{dy}{dx}\right)^2.$

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12. Verify that $y = \frac{a}{x} + b$ is a solution of the differential equation $\frac{d^2y}{dx^2} + \frac{2}{x}\left(\frac{dy}{dx}\right) = 0.$

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13. Verify the solution problems: Show that $y = e^{-x} + ax + b$ is solution of the differential equation $e^x\frac{d^y}{dx^2} = 1$

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14. Show that $Ax^2 + By^2 = 1$ is a solution of the differential equation $x\left\{y\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^2\right\} = y\frac{dy}{dx}$.

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15. Verify that $y = \frac{c - x}{1 + cx}$ is a solution of the differential equation $\left(1 + x^2\right)\frac{dy}{dx} + \left(1 + y^2\right) = 0$.

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16. Verify that $y = \log\left(x + \sqrt{x^2 + a^2}\right)$ satisfies the differential equation $d^2\frac{y}{dx^2} + x\frac{dy}{dx} = 0$

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17. Verify that the function $y = e^{-3x}$ is a solution of the differential equation $\frac{d^2y}{dx^2} + \frac{dy}{dx} - 6y = 0$

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Exercise 18 C

1. Write the differential equation formed from the equation $y = mx + c$, here m and c are arbitrary constants.

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2. From the differential equation of the family of concentric circles $x^2 + y^2 = a^2, where a > 0$ and a is a parameter.

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3. From the differential equation of the family of curves, $y = a\sin(bx + c)$, where a and c are parameters.

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4. Find the differential equation of the family of curves, $x = A\cos nt + B\sin nt$, where A and B are arbitrary constants.

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5. Form the differential equation of the family of curves $\mathrm{y} = \mathrm{A}\ \mathrm{e}^{\mathrm{B\,x}}$ where A and B are constants.

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6. From the differential equation of the family of curves $y^2 = m\left(a^2 - x^2\right)$, where a and m are parameters.

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7. Form the differential equation representing the family of curves given by $(x-a)^2+2y^2=a^2$, where a is an arbitrary constant.

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8. From the differential equation of the family of curves given by $x^2+y^2-2ay=a^2$, where a is an arbitrary constant.

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9. Form the differential equation of the family of circles touching the y-axis at origin.

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10. Form a differential equation of family of all circles having center on the x - axis and radius 2 units.

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11. Form the differential equation of the family of circles in the second quadrant and touching the coordinate axes.

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12. From the differential equaiton of the family of circles having coentres on the x-axis and radius unity.

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13. Obtain the differential equation of the family of circles passing through the point (a,0) and (-a,0).

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14. Form the differential equation of the family of parabolas having vertex at origin and axis along positive y-axis.

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15. Form the differential equation of the family of ellipses having foci on y-axis and centre at origin.

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16. Form the differential equation of the family of hyperbola having foci on x-axis and center at the origin.

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