

MATHS

BOOKS - KC SINHA ENGLISH

DIFFERENTIAL EQUATIONS - FOR BOARDS

Solved Examples

1. Find the order and degree of the following differential

equation:
$$\left(rac{d^3y}{dx^3}
ight)^2 - x \left(rac{dy}{dx}
ight)^3.$$

2. Determine the order and degree of the differential equation $\frac{d^2y}{dx^2} = \sqrt{1 + \left(\frac{dy}{dx}\right)^2}$ Watch Video Solution

3. Determine the order and degree of each of the following

differential equation. State also whether they are linear or

non-linear:
$$y=px+\sqrt{a^2p^2+b^2}, \;where\; p=rac{dy}{dx}$$

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4. Find the order and degree of the differential equation

$$rac{dy}{dx} + \sin\!\left(rac{dy}{dx}
ight) = 0$$

5. Find the order and degree of the differential equation

$$\log_e\!\left(1+rac{d^2y}{dx^2}
ight)=x$$

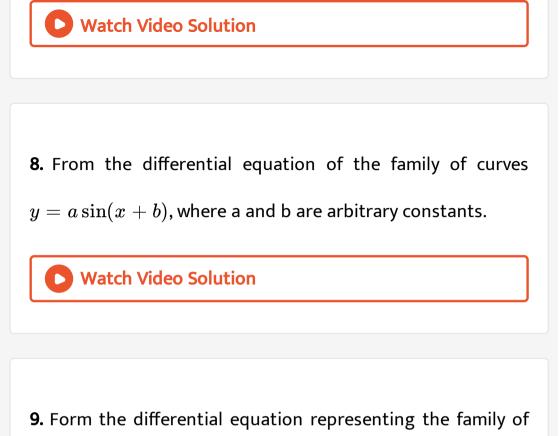
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6. The differential equation representing the family of curves

 $y^2=2cig(x+\sqrt{c}ig),\,$ where c is a positive parameter, is of (a) order 1 (b) order 2 (c) degree 3 (d) degree 4



7. Obtain the differential equation of the family of curves represented by $y = Ae^x + Be^{-x} + x^2$, where A and B are arbitrary constants.



curves $y = A \cos(x + B)$ where AS and B are parameters.

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10. Find the differential equation of the family of curves

 $y = Ae^x + Be^{-x}$, where A and B are arbitrary constants.



11. Form the differential equation corresponding to

 $y^2 = a(b-x)(b+x)$ by eliminating parameters $aandb_{-}$

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12. Show that the differential equation of all parabolas $y^2 = 4a(x-b)$ is given by

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13. Form the differential equation corresponding to $y^2 = a(b-x)^2$,where a and b are arbitrary constant.

14. Find the differential equation of the family of curves given

by
$$x^2+y^2=2ax$$

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15. Form the differential equation representing the family of

curves $y^2 - 2ay + x^2 = a^2$, where a is an arbitrary constant.

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16. Show that the differential equation representing one

parameter family of curves $(x^2-y^2)=cig(x^2+y^2ig)^2is\ ig(x^3-3xy^2ig)dx=ig(y^3-3x^2yig)dy$

17. Form the differential equation of all concentric circles at

the origin.

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

passing through the origin .

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19. Form the differential equation representing the family of parabolas having vertex at origin and axis along positive direction of x-axis.





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

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21. Form the differential equation of the family of circles in

the second quadrant and touching the coordinate axes.

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

23. Show that the function $y = (A + Bx)e^{3x}$ is a solution of

the equation
$$\displaystyle rac{d^2y}{dx^2} - 6 \displaystyle rac{dy}{dx} + 9y = 0.$$

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24. Verify that $y = ae^{3x} + be^{-x}$ is a solution of differential

equation
$$rac{d^2y}{dx^2} - 2rac{dy}{dx} - 3y = 0$$

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25. Show that $y=Ax+rac{B}{x}, x
eq 0$ is a solution of the differential equation $x^2rac{d^2y}{dx^2}+xrac{dy}{dx}-y=0$

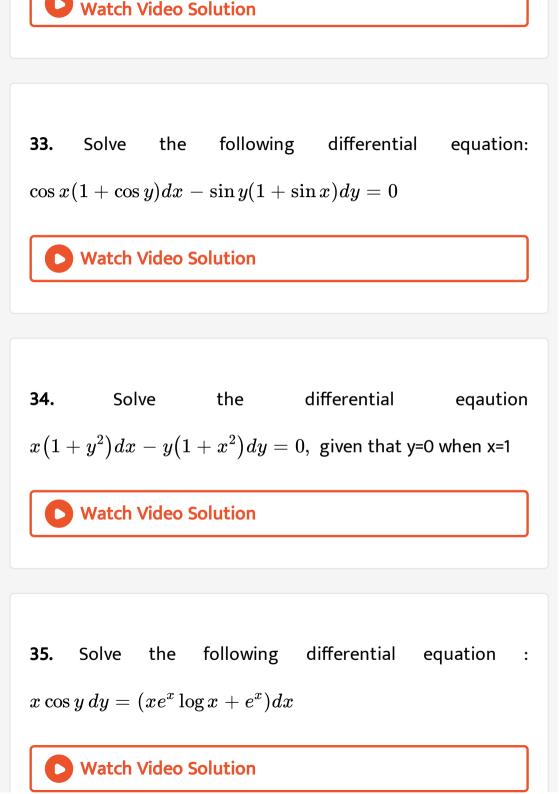
26. Show that, $v=rac{A}{r}+B$ satisfies the differential equation $rac{d^2v}{dr^2}+rac{2}{r}.rac{dv}{dr}=0$

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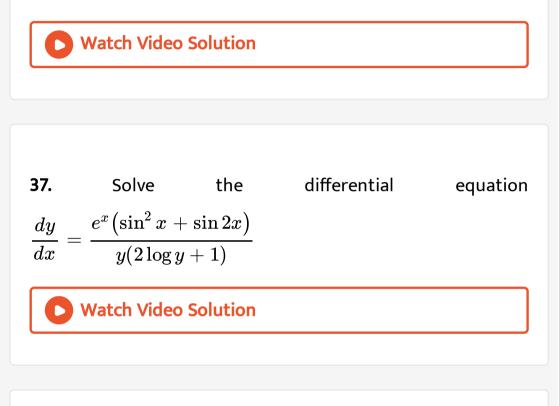
27. solve the differential equation
$$rac{dy}{dx}=e^{x+y}+x^2e^y$$

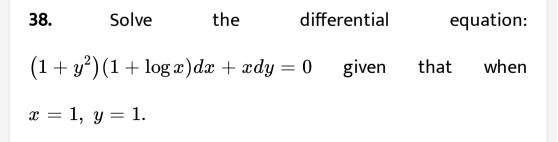
28. Solve the differential equation
$$\frac{dy}{dx} = \sqrt{4 - y^2}, -2 < y < 2$$
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29. Solve the differential equation $(\sqrt{a+x})rac{dy}{dx} + x = 0$ Watch Video Solution **30.** Solve the differential equation $\frac{dy}{dx} = \frac{1+y^2}{1+x^2}$ Watch Video Solution **31.** Solve the differential equation $\frac{dy}{dx} = \sin^{-1} x$ Watch Video Solution **32.** Solve the following differential equation: $(1+e^{2x})dy+(1+y^2)e^xdx=0$



36. Solve the differential equation $rac{dy}{dx} = \log(x+1)$





39. Solve:
$$(x+y)^2 rac{dy}{dx} = a^2$$

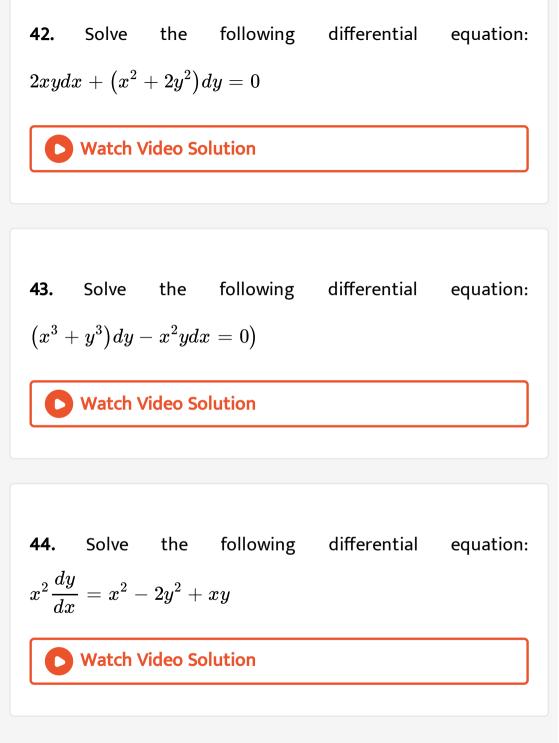
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40. Solve the differential equation:

$$\sin^{-1}\left(rac{dy}{dx}
ight) = x+y.$$

41. Solve the following differential equation
$$(x^2 + xy)dy = (x^2 + y^2)dx$$

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45. solve the differential equation $(y+x)rac{dy}{dx}=y-x$

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46. Solve :

$$\Big\{x\cos\Big(rac{y}{x}\Big)+y\sin\Big(rac{y}{x}\Big)\Big\}ydx=\Big\{y\sin\Big(rac{y}{x}\Big)-x\cos\Big(rac{y}{x}\Big)\Big\}xdy$$

47. Solve
$$\Big(1+2e^{x\,/\,y}\Big)dx+2e^{x\,/\,y}(1-x\,/\,y)dy=0.$$



48. Solve the following differential equation: $y \, dx + x \log \left(\frac{y}{x} \right) dy = 2x \, dy$

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49. Solve each of the following initial value problem: $2xy + y^2 - 2x^2 \frac{dy}{dx} = 0, \ y(1) = 2$

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50. Solve the differential equation $x\frac{dy}{dx} - y = x \tan\left(\frac{y}{x}\right)$, given $y = \frac{\pi}{2}$ when x = 1.

51. Solve the following differential equation:

$$\frac{dy}{dx} + \sec x \cdot y = \tan x \left(0 \le x < \frac{\pi}{2} \right)$$

D

52. Solve the following differential equation:

$$\frac{dy}{dx} + 2\tan x \cdot y = \sin x$$
 Also find the particular solution if
 $y = 0$ when $x = \frac{\pi}{3}$

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53. Solve:
$$x \log x \frac{dy}{dx} + y = 2 \log x$$

54. Solve the following differential equation :

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

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55. Solve the following differential equations:
 $(1 + x^2) \frac{dy}{dx} - 2xy = (x^2 + 2)(x^2 + 1)$
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56. Solve the differential equation
$$\left[\frac{e^{-2\sqrt{x}}}{\sqrt{x}} - \frac{y}{\sqrt{x}}\right]\frac{dx}{dy} = 1(x \neq 0)$$

57. Solve the differential equation :

$$xrac{dy}{dx}+y-x+xy \operatorname{cot} x=0, x
eq 0.$$

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58. Solve the differential equation: $rac{dy}{dx}+rac{y}{x}=e^x, x>0$

59. Solve:
$$rac{dy}{dx} - 2y = \cos 3x$$



60. Find the general solution of the differential equations:

$$x\log xrac{dy}{dx}+y=rac{2}{x}\log x$$

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61. Find the particular solution of the differential equation

$$rac{dy}{dx}+y\cot x=2x+x^2\cot x(x
eq 0)$$
given that $y=0$ when $x=rac{\pi}{2}.$

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62. Solve the following differential equation, given that y = 1

when
$$x=2$$
: $xrac{dy}{dx}+y=x^3$

63. Solve the differential equation $\frac{dy}{dx} - 3y \cot x = \sin 2x$ given y = 2 when $x = \frac{\pi}{2}$. Watch Video Solution

64. The differential equations, find a particular solution

satisfying the given condition:
$$ig(1+x^2ig)rac{dy}{dx}+2xy=rac{1}{1+x^2};y=0$$
when $x=1$

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65. Find the particular solution of the differential equation. $\frac{dy}{dx} + y \cot x = 4x \ \cos ec x, \ (x \neq 0), \ \text{given that} \ y = 0$ when $x = \frac{\pi}{2}$.

66. Solve:
$$\left(x+2y^3
ight)rac{dy}{dx}=y.$$

67. Solve the following differential equation:

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

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68. Solve the following differential equation:
$$\displaystyle rac{dy}{dx} + \displaystyle rac{y}{x} = x^3$$



69. Solve the following differential equation:
$$\tan y \cdot \frac{dy}{dx} + \tan x = \cos y \cos^2 x$$

70. The Integrating Factor of the differential equation $\left(1-y^2
ight)rac{dx}{dy}+yx=ay$

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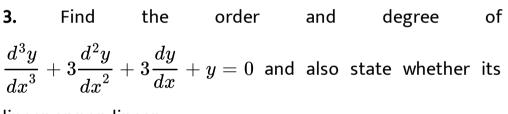


1. Find the order and degree of $\displaystyle rac{d^2y}{dx^2} + 4x = 0$ and also state

whether its linear or non-linear.

2.
$$a=rac{\left[1+\left(rac{dy}{dx}
ight)^2
ight]^{3/2}}{rac{d^2y}{dx^2}}$$
, where a is constant.

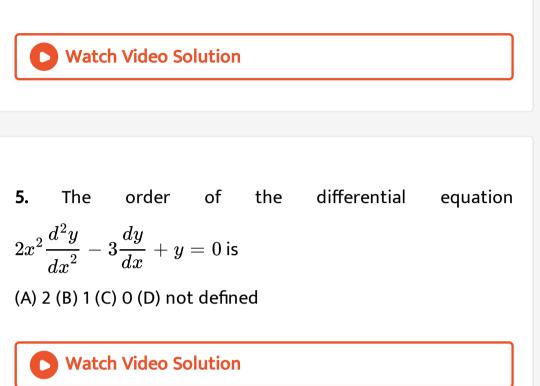
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linear or non-linear.

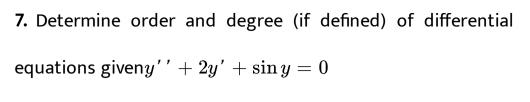
4. Find the order and degree of
$$x^2 \left(\frac{d^2y}{dx^2}\right)^3 + y \left(\frac{dy}{dx}\right)^4 + y^4 = 0$$
 and also state whether its

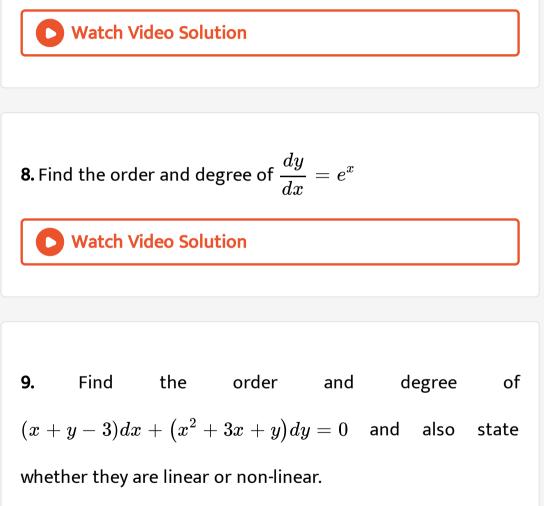
linear or non-linear.



6. Determine order and degree (if defined) of differential

equations given $y' + y = e^x$





10. Find the order and degree of
$$\frac{d^3y}{dx^3} + \left(\frac{d^2y}{dx^2}\right)^3 + \frac{dy}{dx} + 4y = \sin x$$
 and also state

whether they are linear or non-linear.

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11. Find the order and degree of
$$5rac{d^2y}{dx^2} = \left[1 + \left(rac{dy}{dx}
ight)^2
ight]^{rac{3}{2}}$$

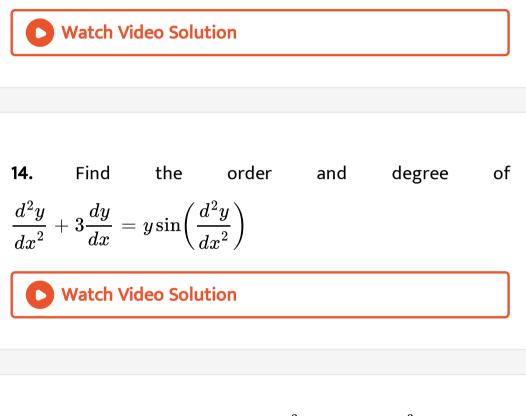
and also state whether they are linear or non-linear.

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12. Determine order and degree (if defined) of differential

equations given
$$\left(rac{ds}{dt}
ight)^4+3srac{d^2s}{dt^2}=0$$

13. Find the order and degree of y ''' $+y^2+e^{y'}=0$



15. Find the order and degree of
$$rac{d^3y}{dx^3} - 2\siniggl(rac{d^3y}{dx^3}iggr) = 0$$

16. Form a differential equation for the family of curves represented by $ax^2 + by^2 = 1$, where a and b are arbitrary constants.

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17. The differential equation satisfying all the curves $y = ae^{2x} + be^{-3x}$, where a and b are arbitrary constants, is

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18. If a is arbitrary constant, find the differential equation of

$$x^2+y^2=a^2$$

19. Form a differential equation representing the given family of curves by eliminating arbitrary constants a and b. $y = ae^{3x} + be^{-2x}$

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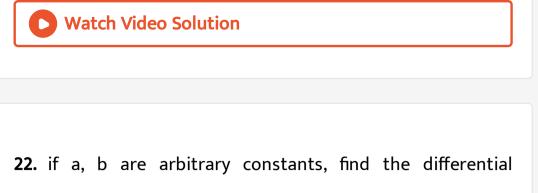
20. Form a differential equation representing the given family of curves by eliminating arbitrary constants a and b. $\frac{x}{a} + \frac{y}{b} = 1$

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21. Form a differential equation representing the given family

of curves by eliminating arbitrary constants a and b.

$$y = e^{2x}(a + bx)$$



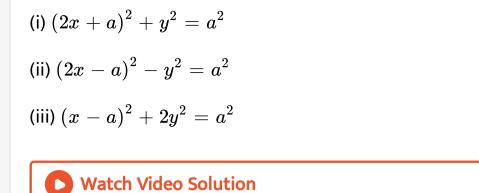
equation of $y = a \cos nx + b \sin nx$

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23. Find the differential equation of the family of curves $y = A \cos x + B \sin x$, where A, B are parameters.

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24. Form the differential equation of the family of curves represented by the equation (a being the parameter):



25. Find the differential equation of the family of curves $(x + a)^2 - 2y^2 = a^2$, where a is an arbitrary constant.

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

27. Show that the differential equation of which
$$y = 2(x^2 - 1) + ce^{-x} \cdot 2$$
 is a solution, is $\frac{dy}{dx} + 2xy = 4x^3$.

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28. Form the differential equation of simple harmonic motion

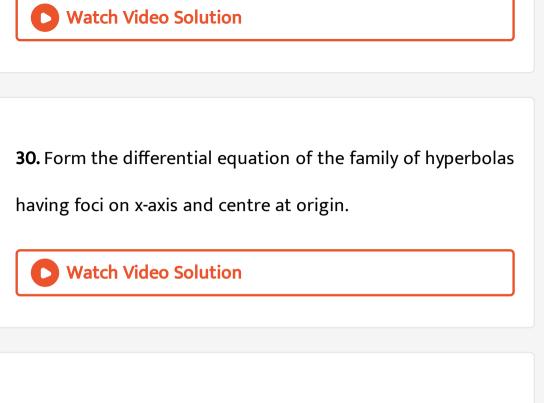
given by $x = A\cos(nt + \alpha)$, where n is fixed and A, α are

parameters.



29. Form the differential equation of the family of circles

having centre on y-axis and radius 3 units.



31. Find the differential equation of all the circles which pass

thorough the origin and whose centres lie on x-axis.

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32. about to only mathematics



33. 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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34. Verify that the given functions (explicit or implicit) is a solution of the corresponding differential equation: $y = e^x + 1: y'' - y' = 0$ Watch Video Solution

35. Verify that the given functions (explicit or implicit) is a solution of the corresponding differential equation :

$$y=Ax$$
 : $xy'=y(x
eq 0)$

36. Verify that the given functions (explicit or implicit) is a solution of the corresponding differential equation: $y = \cos x + C : y' + \sin x = 0$



37. In each of the following verify that the given function (explicit or implicit) is a solution of the corresponding differentia equation: $y = x \sin x$ ii. $y = \sqrt{a^2 - x^2}$



38. Verify that the given functions (explicit or implicit) is a solution of the corresponding differential equation: $xy = \log y + C : y' = \frac{y^2}{1 - xy} (xy \neq 1)$ Watch Video Solution

39. Verify that the given functions (explicit or implicit) is a solution of the corresponding differential equation: $x + y = \tan^{-1} y : y^2 y' + y^2 + 1 = 0$

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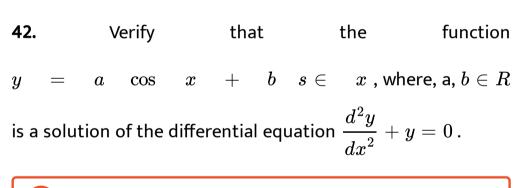
40. Verify that $y = 4 \sin 3x$ is a solution of the differential

equation
$$rac{d^2y}{dx^2}+9y=0.$$



41. Show that the function $y = A \cos 2x + B \sin 2x$ is a solution of the differential equation $\frac{d^2y}{dx^2} + 4y = 0$

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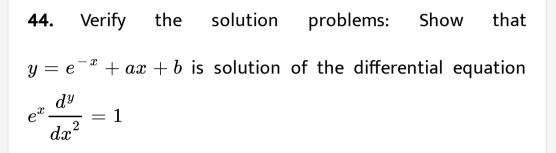


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43. Show that the differential equation of which $y=2ig(x^2-1ig)+ce^{-x}$ ^2 is a solution, is

$$rac{dy}{dx}+2xy=4x^3$$
 .





45. Show that $y = e^x (A \cos x + B \sin x)$ is the solution of

the differential equation
$$rac{d^2y}{dx^2} - 2rac{dy}{dx} + 2y = 0.$$

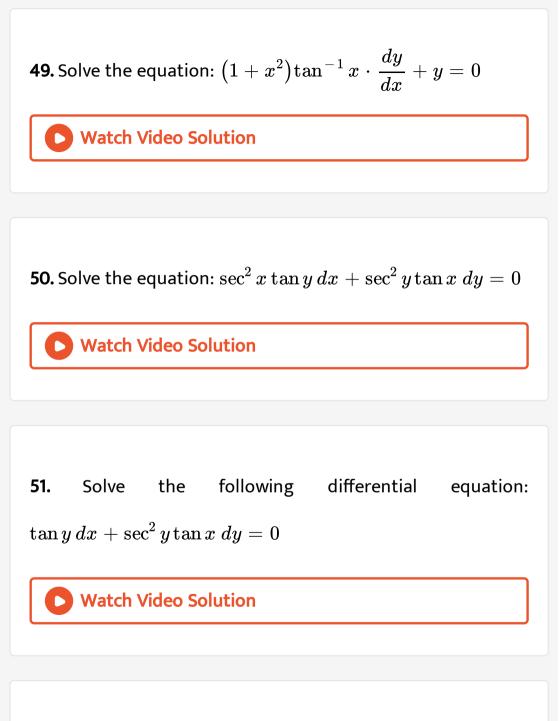
46. Verify that $y=ce^{tan-1_x}$ is a solution of differential equation $(1+x^2)rac{d^2y}{dx^2}+xrac{dy}{dx}=0.$

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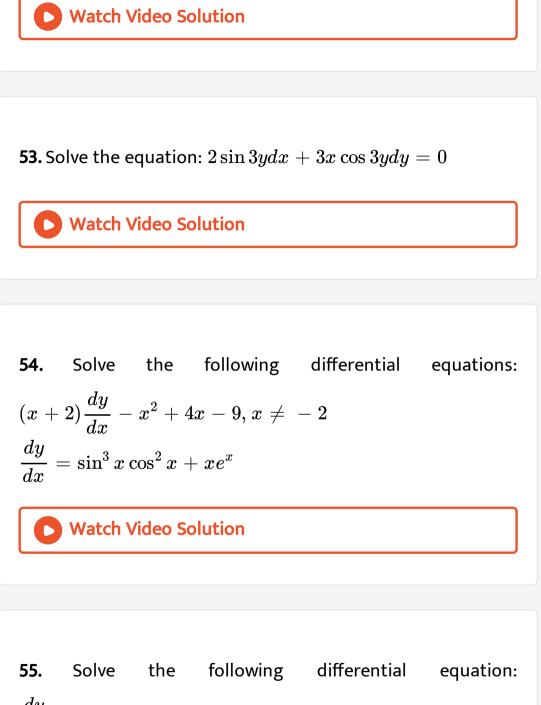
47. Verify that the function

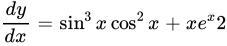
$$y = C_1 e^{ax} \cos bx + C2ax \sin bx$$
, C_1, C_2 , are arbitrary
constants is a solution of the differentia equation
 $\frac{d^2y}{dx^2} - 2a\frac{dy}{dx} + (a^2 + b^2)y = 0$
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48. Solve the following differential equation: $rac{dy}{dx} = (e^x + 1)y$



52. Solve :
$$ig(x^2-yx^2ig)dy+ig(y^2+x^2y^2ig)dx=0$$







56. Solve the differential equation: $rac{dy}{dx} = rac{1-\cos x}{1+\cos x}$

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57. Solve:
$$\displaystyle rac{dy}{dx} + y = 1$$

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58. Solve the equation:
$$(x+1)\frac{dy}{dx} = 2xy$$

59. Solve:
$$e^x\sqrt{1-y^2}dx+rac{y}{x}dy=0$$

60. Solve the following differential equation:

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

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61. Solve
$$rac{dy}{dx} = xy + x + y + 1$$



62. Solve the following differential equations.

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

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63. Solve the initial value problem
$$y' = y \cot 2x, y\left(\frac{\pi}{4}\right) = 2.$$

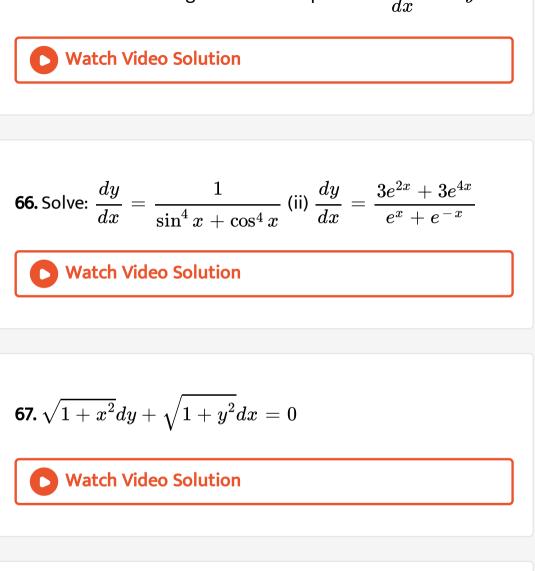
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64. Solve the following differential equation:

$$xy(y+1)dy = (x^2 = 1)dx$$

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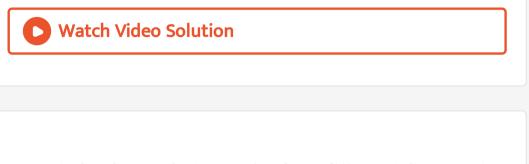
65. Solve the following differential equation: $5 \frac{dy}{dx} = e^x y^4$



68.
$$\frac{dy}{dx} \tan y = \sin(x+y) + \sin(x-y)$$

69. Solve the differential equation $x \left(x^2 - 1
ight) rac{dy}{dx} = 1$, given

that when x = 2, y = 0.



70. Find the solution of the differential equation $\cos y dy + \cos x \sin y dx = 0$ given that $y = \pi/2$, when $x = \pi/2$.

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71. Solve the differential equation $(x-1)rac{dy}{dx}=2xy$, given

that y(2) = 1

72. The differential equations, find a particular solution

satisfying the given condition:
$$\cos{\left(rac{dy}{dx}
ight)}=a(a\in R);y=2$$
 when x=0

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73. Find the equation of the curve passing through the point

(1, 1) whose differential equation is $xdy=ig(2x^2+1ig)dx(x
eq 0ig).$

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74. The volume of spherical balloon being inflated changes at a constant rate. If initially its radius is 3 units and after 3

seconds it is 6 units. Find the radius of balloon after t seconds.

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75. Solve:
$$(x-y)^2 rac{dy}{dx} = 1$$

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76. Solve:
$$rac{dy}{dx} = \cos(x+y)$$

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77. Solve the equation
$$(x+y+1)igg(rac{dy}{dx}igg)=1$$

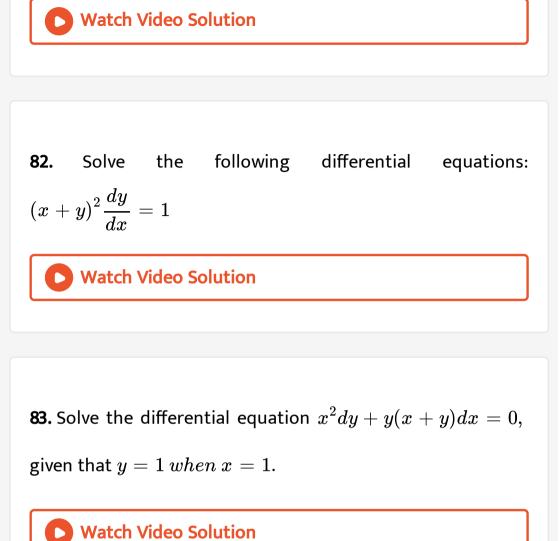
78. Solve the differential equation $rac{dy}{dx}+1=e^{x+y}$

79. Solve
$$rac{dy}{dx} = \cos(x+y) + \sin(x+y)$$

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80. Solve:
$$ig(x^2+2xy+y^2+1ig)rac{dy}{dx}=2(x+y)$$

81. Solve:
$$\left(x-y
ight)^2 rac{dy}{dx} = a^2$$



84. Solve the following differential equations: $rac{dy}{dx} - rac{y-x}{y+x}$

85. Solve:
$$2xyrac{dy}{dx}=x^2+y^2$$

86. Solve:
$$xyrac{dy}{dx}=x^2-y^2$$

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87. Solve the differential equation (x+y)dy = (x-y)dx

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88. Show that the differential equation $2xy\frac{dy}{dx} = x^2 + 3y^2$

is homogeneousand solve it.



89.
$$\displaystyle rac{dy}{dx} + \displaystyle rac{x-2y}{2x-y} = 0$$

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90.
$$y^2 + x^2 rac{dy}{dx} = xy rac{dy}{dx}$$

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91. Solve
$$xigg(rac{dy}{dx}igg) = y(\log y - \log x + 1)$$

92. Solve:
$$(x-y)rac{dy}{dx}=x+3y$$



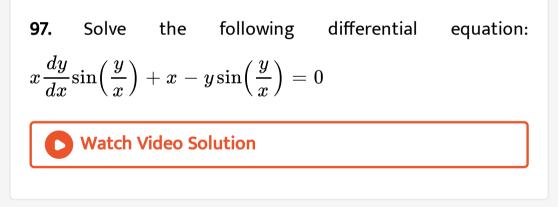
93.
$$ig(x^3+3xy^2ig) dx + ig(y^3+3x^2yig) dy = 0$$

94. Solve:
$$\left(x-\sqrt{xy}
ight)dy=ydx$$

95. Solve the following differential equation:
$$x \frac{dy}{dx} - y = 2 \sqrt{y^2 - x^2}$$

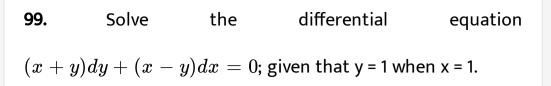
96. Solve:
$$y^2 dx + ig(x^2 + xy + y^2ig) dy = 0$$

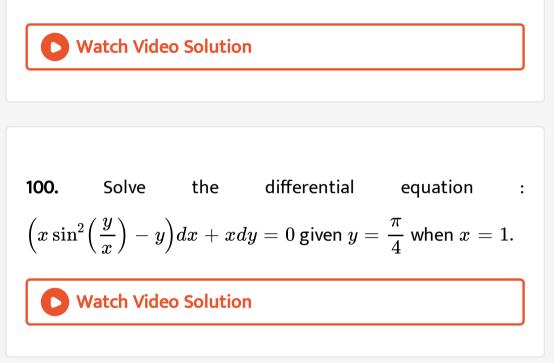




98. Solve the differential equation $x^2 dy + y(x+y) dx = 0$,

given that y = 1 when x = 1.

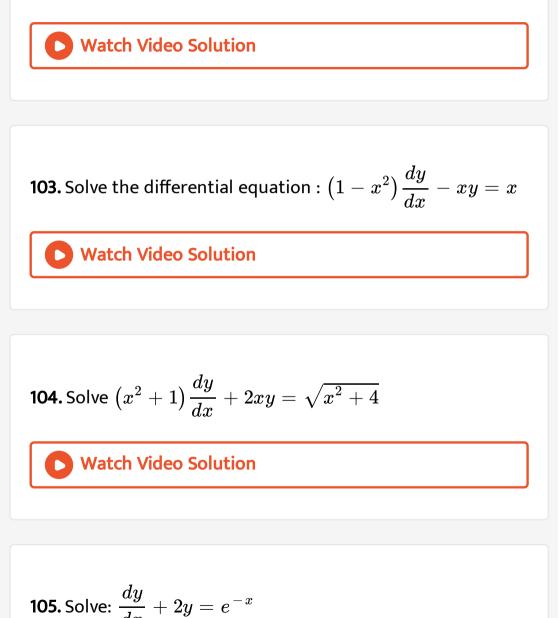


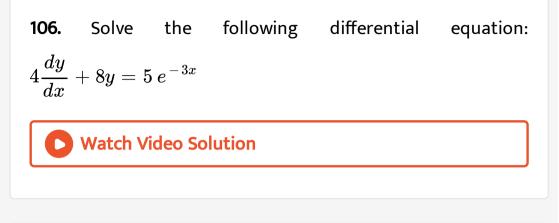


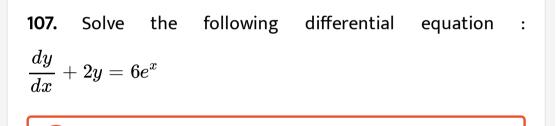
101. Find the particular solution of the differential equation

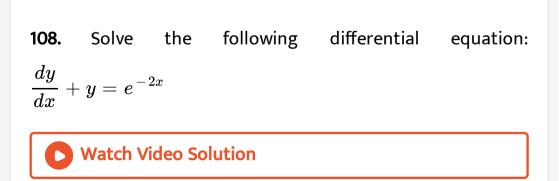
$$xrac{dy}{dx}-y+x\cos ec \Big(rac{y}{x}\Big)=0;$$
 given that $y=0$ when $x=1.$

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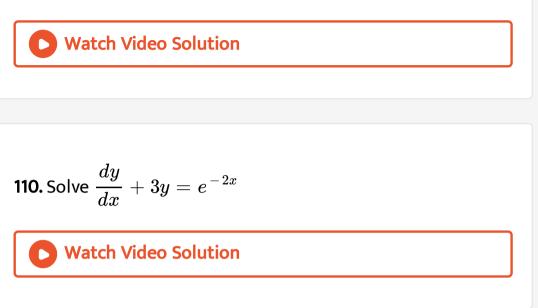








109. Solve the following differential equations: $x \frac{dy}{dx} = x + y$



111. Solve the each of the following differential equation:

$$xrac{dy}{dx}+2y=x^2,\;x
eq 0$$

112. Solve:
$$rac{dy}{dx} + y = \cos x$$

113. Solve:
$$\displaystyle rac{dy}{dx} + y = e^x$$

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114. Solve:
$$xrac{dy}{dx}-y=x+1$$

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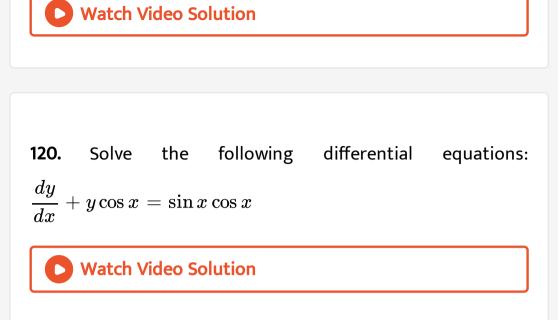
115. Solve:
$$rac{dy}{dx} + y = \cos x = \sin x$$

116. Solve:
$$\frac{dy}{dx} + \frac{y}{x} = x^n$$

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117. Solve the following differential equation:
 $\frac{dy}{dx} - y \tan x = e^x \sec x$
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118. Solve:
$$ig(1+x^2ig)rac{dy}{dx}+2xy=\cos x$$

119. Solve:
$$(\sec x) \frac{dy}{dx} = y + \sin x$$



121. Solve:
$$rac{dy}{dx}+2y\cot x=3x^2\cos ec^2x$$

122. Solve:
$$rac{dy}{dx} + y an x = 2x + x^2 an x$$
 .

123. Solve:
$$x rac{dy}{dx} = y(\log y - \log x - 1)$$

124.
$$\left(1-x^2
ight)rac{dy}{dx}+xy=ax$$

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125. Find the particular solution of the differential equation

$$rac{dy}{dx} + y \cot x = 2x + x^2 \cot x (x
eq 0)$$
given that $y = 0$ when $x = rac{\pi}{2}.$

126. Solve
$$ydx + ig(x-y^2ig)dy = 0$$



127. Solve the each of the following differential equation:

$$ig(x+3y^2ig)rac{dy}{dx}=y$$

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128. Solve:
$$ig(x-y^3ig)rac{dy}{dx}+y=0$$

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129. Solve:
$$rac{dy}{dx} + x \sin 2y = x^3 \cos^2 y = \sin x$$

130. Solve
$$x rac{dy}{dx} + y = y^2 \ln x.$$

131.
$$rac{dy}{dx} = x^3y^3 - xy$$

