



# 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

$$x igg( rac{d^3y}{dx^3} igg)^2 + igg( rac{dy}{dx} igg)^4 + y^2 = 0.$$

3. Write the order and degree of the differential equation

$$y=xrac{dy}{dx}+\sqrt{1+\left(rac{dy}{dx}
ight)^2}.$$

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4. Write the order and degree of the differential equation

$$igg\{1+\left(rac{dy}{dx}
ight)^2igg\}^{3/2}=kigg(rac{d^2y}{dx^2}igg).$$

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

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  $p = \frac{dy}{dx}$ 

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

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

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

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

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

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7. Verify that  $y = A \cos x - B \sin x$  is a solution of the differential

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

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

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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

$$x^2rac{d^2y}{dx^2}+xrac{dy}{dx}+y=0$$

11. Verify that  $y = e^{m \sin^{-1} x}$  is a solution of the differential equation

$$ig(1-x^2)rac{d^2y}{dx^2}-xrac{dy}{dx}-m^2y=0.$$

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

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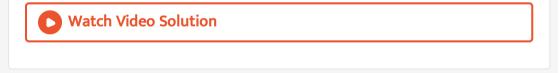
13. Prove that  $x^2-y^2=cig(x^2+y^2ig)^2$  is the general solution of differential equation  $ig(x^3-2xy^2ig)dx=ig(y^3-3x^2yig)dy$  , where c is a parameter.

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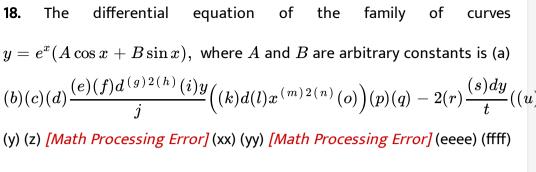
14. Prove that  $xy = ae^x + be^{-x} + x^2$  is the general solution of the differential equation  $xrac{d^2y}{dx^2} + 2rac{dy}{dx} - xy + x^2 - 2 = 0.$ 

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.  $\frac{d^2y}{dx^2} - 2a\frac{dy}{dx} + (a^2 + b^2)y = 0$ Watch Video Solution

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



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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**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  $r_{\cdot}$ 

**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



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



**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  $y^2=aig(b^2-x^2ig),$  where a and b are arbitrary constants.





#### Exercise 18 A

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

equations.

$$\left(rac{dy}{dx}
ight)^4 + 3y igg(rac{d^2y}{dx^2}igg) = 0$$

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

equations.

$$x^3 igg( rac{d^2 y}{dx^2} igg)^2 + x igg( rac{dy}{dx} igg)^4 = 0$$

equations.

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

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

equations.

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

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

equations.

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

equations.

$$rac{dy}{dx}+y=e^x$$

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

equations.

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

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

equations.

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

equations.

$$rac{d^4y}{dx^4}-\cosiggl(rac{d^3y}{dx^3}iggr)=0$$

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

$$rac{d^2y}{dx}+5xiggl(rac{dy}{dx}iggr)^2-6y=\log x$$

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

equations.

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

equations.

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

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

equations.

$$xigg(rac{dh}{dx}igg)+rac{2}{igg(rac{dy}{dx}igg)}+9=y^2$$

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

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

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.

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

equations.

$$y=rac{dy}{dx}+rac{5}{\left(rac{dy}{dx}
ight)}$$

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## Exercise 18 B

1. Verify that  $x^2 = 2y^2\log y$  is a solution of the differential equation

$$ig(x^2+y^2ig)rac{dy}{dx}-xy=0.$$

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

3. Verify that 
$$y = e^{m \cos^{-1} x}$$
 satisfies the differential equation  
 $(1 - x^2) \frac{d^2 y}{dx^2} - x \frac{dy}{dx} - m^2 y = 0$   
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**4.** Verify that  $y = (a + bc)e^{2x}$  is the general solution of the differential

equation 
$$rac{d^2y}{dx^2} - 4rac{dy}{dx} + 4y = 0.$$

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

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

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



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

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

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

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

10. 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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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 
$$e^x rac{d^y}{dx^2} = 1$$

14. Show that  $Ax^2 + By^2 = 1$  is a solution of the differential equation

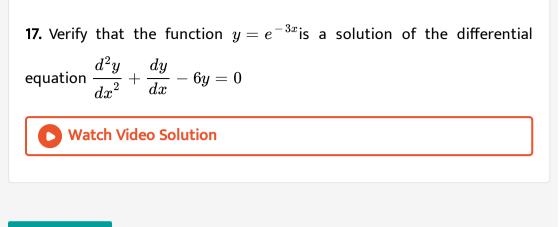
$$x igg\{ y \, rac{d^2 y}{dx^2} + \left( rac{dy}{dx} 
ight)^2 igg\} = y rac{dy}{dx} .$$

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

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



1. Write the differential equation formed from the equation y=mx+c ,

here m and c are arbitrary constants.



Exercise 18 C

2. From the differential equation of the family of concentric circles

 $x^2+y^2=a^2, wherea>0$  and a is a parameter.

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



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  $y=A\;e^{B\,x}$  where

A and B are constants.



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

7. Form the differential equation representing the family of curves given

by  $\left(x-a
ight)^2+2y^2=a^2$  , 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.



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



10. Form a differential equation of family of all circles having center on

the x - axis and radius 2 units.



**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.



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



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.