MATHS

BOOKS - V PUBLICATION

DIFFERENTIAL EQUATIONS

Question Bank

1. Find the order and degree, if defined, of each of the following differential equations:

i) $\frac{dy}{dx} - \cos x = 0$

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

iii) $y''' + y^2 + e^y = 0$

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2. Find the order and degree (if defined) of the following differential equations. $\frac{d^4y}{dx^4} + \sin(y''') = 0$

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3. Find the order and degree (if defined) of the following differential equations. $y' + 5y = 0$

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4. Find the order and degree (if defined) of the following differential equations. $\left(\frac{ds}{dt}\right)^4 + 3s\frac{d^2s}{dt^2} = 0$

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5. Find the order and degree (if defined) of the following differential equations. $\left(\frac{d^2y}{dx^2}\right)^2 + \cos\left(\frac{dy}{dx}\right) = 0$

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6. Find the order and degree (if defined) of the following differential equations. $\frac{d^2y}{dx^2} = \cos 3x + \sin 3x$

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7. Determine order and degree (if defined) of the following differential equations . $(y''')^2 + (y'')^3 + (y')^4 + y^5 = 0$

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8. Determine order and degree (if defined) of the following differential equations y''' + 2y'' + y' = 0

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9. Determine order and degree (if defined) of the following differential equations y' +y =e^x

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10. Determine order and degree (if defined) of the following differential equations y'' + $(y')^2$ + 2y = 0

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11. Determine order and degree (if defined) of the following differential equations y'' + 2y' + sin y = 0

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12. Choose the correct answer. The degree of the differential equation $\left(\frac{d^2y}{dx^2}\right)^3 + \left(\frac{dy}{dx}\right)^2 + \sin\left(\frac{dy}{dx}\right) + 1 = 0$

A. 3

B. 2

C. 1

D. not defined

Answer: C

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13. Choose the correct answer. The degree of the differential equation $2x^2\frac{d^2y}{dx^2} - 3\left(\frac{dy}{dx}\right) + y = 0$ is

A. 2

B. 1

C. 0

D. not defined

Answer: A

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14. Check whether $y = e^{-3x}$ is a solution of the differential equation $\frac{d^2y}{dx^2} + \frac{dy}{dx} - 6y = 0$

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15. $y = a\cos x + b\sin x$ is the solution of the differential equation

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

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16. Verify that the given function (explicit or implicit) isa solution of the corresponeding differential equation : $y = e^x + 1$: y'' - y' = 0

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17. Verify that the given function (explicit or implicit) isa solution of the corresponeding differential equation : $y = x^2 + 2x + c$:y' - 2x - 2 = 0

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18. Verify that the given function (explicit or implicit) isa solution of the corresponeding differential equation : y = cos x + c : y' + sin x = 0

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19. Verify that the given function (explicit or implicit) isa solution of the corresponeding differential equation : $y = \sqrt{1 + x^2} : y' = \frac{xy}{1 + x^2}$

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20. Verify that the given function (explicit or implicit) is a solution of the correseponding differential equation : y = Ax : $xy' = y(x \neq 0)$

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21. Verify that the given function(explicit or implicit) is a solution of the corresponding differential equations $xy = \log y + C : y' = \frac{y^2}{1 - xy}, (xy \neq 1)$

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22. Verify that the given function (explicit or implicit) is a solution of the corresponding differential equation

$y - \cos y = x : (y \sin y + \cos y + x)y' = y$

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

$(x + y) = \tan^{-1} y, y^2 y' + y^2 + 1 = 0$

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

$y = \sqrt{a^2 - x^2}, x \in (-a, a) : x + y\frac{dy}{dx} = 0 (y \neq 0)$

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25. Choose the correct answer. The number of arbitrary constains in the general solution of a differential equation of fourth order is

A. 0

B. 2

C. 3

D. 4

Answer: D

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26. Choose the correct answer. The number of arbitrary constants in the perticular solution of a different equation of third order is

A. 3

B. 2

C. 1

D. 0

Answer: D

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27. Form the differential equation corresponding to the curve $y = mx$

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28. From the differential equation representing the family of curves $y = a\sin(x + b)$,where a and b are arbitrary constants.

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29. Form the DE of the family of ellipse having foci on the x-axis and centre at the origin.

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30. Form the DE of the family of circles

touching the x-axix at origin.

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31. Form the DE representing the family of

parabolas having vertex at origin and axis

along positive direction of x-axis.

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32. Find the slope of the line $\frac{x}{a}+\frac{y}{b}=1$

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33. Find the Differential equation satisfying the family of curves $y^2 = a\left(b^2 - x^2\right)$,a and b are arbitrary constants.

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34. Form the DE corresponding to the function $y = ae^{3x} + be^{-2x}$

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35. Form the DE corresponding to the function $y = e^{2x}(a + bx)$

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36. Form the DE corresponding to the function $y = e^x(a\cos x + b\sin x)$

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

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

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

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40. Form the DE of the family of ellipse having foci on the x-axis and centre at the origin.

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41. Form a differential equation of the family of circles having centre on y-axis and radius 3 units.

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42. Choose the correct answer . Which of the following differential equation has $y = c_1 e^x + c_2 e^{-x}$ as the general solution ?

A. ((d^2 y)/(d x^2))+y=0'

B. ((d^2 y)/(d x^2))-y=0'

C. ((d^2 y)/(d x^2))+1=0'

D. ((d^2 y)/(d x^2))-1=0'

Answer: B

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43. Choose the correct answer . Which of the following differential equation has y = x as one of its particular solution ?

A. ((d^2 y)/(d x^-2))(-x)^2 (dy)/(dx)+x y=x'

B. ((d^2 y/(d x^2))+x (dy)/(dx)+x y=x'

C. ((d^2 y)/(d x^2))(-x)^2 (dy)/(dx)+x y=0'

D. ((d^2 y)/(d x^2))+x (dy)/(dx)+x y=0'

Answer: C

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44. Find the general solution of the differential equation $\frac{dy}{dx} = \frac{x+1}{2-y}, (y \neq 2)$

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45. Find the general solution of the differential equation $\frac{dy}{dx} = \frac{1+y^2}{1+x^2}$

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46. Find the particular solution of the differential equation $\frac{dy}{dx} = -4xy^2$ given that $y = 1$, when $x = 0$

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47. Find the equation of the curve passing through the point $(1, 1)$ whose differential equation is $xdy = (2x^2 + 1)dx (x \neq 0)$

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48. Find the equation of a curve passing through the point $(-2, 3)$, given that the slope of the tangent to the curve at any point (x, y) is $\frac{2x}{y^2}$

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49. In a bank, principal increases continuously at the rate 5% per year. In how many years Rs 1000 double itself?

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50. $\frac{dy}{dx} = \frac{1 - \cos x}{1 + \cos x}$

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51. Find the general solution of the following differential equations

$$\frac{dy}{dx} = \sqrt{4 - y^2}(-2 < y < 2)$$

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52. Integrate the following: $\frac{dy}{dx} + y = 1, (y \neq 1)$

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53. Find the general solution of the differential equation

$$\sec^2 x \tan y dx + \sec^2 y \tan x dy = 0$$

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54. $\left(e^{x}+e^{-x}\right)dy-\left(e^{x}-e^{-x}\right)dx=0$

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55. $\frac{dy}{dx}=\left(1+x^{2}\right)\left(1+y^{2}\right)$

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56. $y\log ydx-xdy=0$

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57. x^5 (dy)/(dx)=(-y)^5'

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58. Find the general solution of $\frac{dy}{dx} = \sin^{-1} x$

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59. $e^x \tan y dx + (1 - e^x)(\sec^2 y) dy = 0$

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60. Find a particular solution satisfying the given condition.$(x^3 + x^2 + x + 1)\frac{dy}{dx} = 2x^2 + x$ when $y = 1, x = 0$

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61. For the following differential equation find a particular solution satisfying the given condition.

$x\left(x^2-1\right)\frac{dy}{dx}=1$, y = 0 when x = 2

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62. $\cos\left(\frac{dy}{dx}\right)=a,\ (a\in R)\ ,y=1$, when $x=0$

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63. $\frac{dy}{dx}=y\tan x$, y=1 when x=0

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64. Find the equation of a curve passing through (0,0) and whose differential equation is y' = $e^x \sin x$.

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65. For the DE $xy\frac{dy}{dx} = (x+2)(y+2)$,find the solution curve passing through the point (1,-1).

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66. Find the equation of a curve passing through the point $(2, -2)$ given that at any point (x, y) on the curve the product of the slope of its tangent and y coordinate of the point is equal to the x - coordinate of the point.

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67. At any point (x,y) of a curve, the slope of the tangent is twice the slope of the line segment, joining the point of contact to the point (-4,-3). Find the equation of the curve given that it passes through (-2,1).

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68. The volume of spherical ballon being inflated at a constant rate. If initially its radius is 3 units and after 3 seconds it is 6 units. Find the radius of the balloon after t seconds.

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69. In a bank, principal increases continuosly at the rate of $r\ \%$ per year. Find the valueof r if Rs. 100 double itself in 10 years. $(\log_e 2 = 0.6931)$

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70. In a bank, principal increases continuosly at the rate of $5\ \%$ per year. An amount of Rs. 1000 is deposited with this bank. How much will it worth after 10 years $\left(e^{0.5} = 1.648\right)$

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71. In a culture , the bacteria count is 1,00,000. The number is increased by $10\ \%$ in 2 hours. In how many hours will the

count reach 2,00,000. If the rate of growth of bacteria is proportional to the number present ?

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72. The general solution of the differential equation $\frac{dy}{dx} = e^{x+y}$ is

A. e^x+e^(-y)= C'

B. e^x+e^y=C'

C. e^(-x)+e^y=c'

D. e^(-x)+e^(-y)=C'

Answer: A

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73. Show that the differential equation x cos(y/x)$\frac{dy}{dx}$ = y cos(y/x) + x is homogeneous and solve it.

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74. solve the differential equation $(x^2 + xy)dy = (x^2 + y^2)dx$

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75. Show that the following equations are homogeneous and solve each of them.

$y' = \frac{x + y}{x}$

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76. Show that the following equations are homogeneous and solve each of them.

(x - y)dy - (x + y)dx = 0

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77. solve the differential equation $\left(x^2 - y^2\right)dx + 2xydy = 0$

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78. solve $x^2 \frac{dy}{dx} = x^2 - 2y^2 + xy$

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79. Consider the DE $xdy - ydx = \sqrt{x^2 + y^2}dx$

Find the general solution.

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80.

$$\left\{x\cos\left(\frac{y}{x}\right) + y\sin\left(\frac{y}{x}\right)\right\}ydx = \left\{y\sin\left(\frac{y}{x}\right) - (x)\cos\left(\frac{y}{x}\right)\right\}xdy$$

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81. $x\frac{dy}{dx} - y + x\sin\left(\frac{y}{x}\right) = 0$

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82. solve $ydx + x\log\left(\frac{y}{x}\right)dy - 2xdy = 0$

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83. Show that the following equations are homogeneous and solve each of them.

$$\left(1+e^{\frac{x}{y}}\right)dx+e^{\frac{x}{y}}\left(1-\frac{x}{y}\right)dy=0$$

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84. solve $(x+y)dy+(x-y)dx=0, y=1$ when $x=1$

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85. solve $x^2dy+\left(xy+y^2\right)dx=0, y=1$ when $x=1$

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86. Find the particular solution of the following equation satisfying the given condition.

$\left[x \sin^2\left(\frac{y}{x}\right) - y\right] dx + x dy = 0, y = \frac{\pi}{4}$ when x = 1

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87. solve $\frac{dy}{dx} - \frac{y}{x} + \cos ec\left(\frac{y}{x}\right) = 0 y = 0$ when $x = 1$

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88. $2xy + y^2 - 2x^2 \frac{dy}{dx} = 0, y = 2$ when $x = 1$

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89. A homogeneous differential equation of the form $\frac{dx}{dy} = h\left(\frac{x}{y}\right)$ can be solved by making the substitution. a) y= vx b)v= yx c)x = vy d)x = v

A. ' y=v x'

B. v=y x'

C. x=v y^''

D. ' x=v'

Answer: C

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90. Which of the following is a homogeneous differential equation? $(4x + 6y + 5)dy - (3y + 2x + 4)dx = 0$

$xydx - \left(x^3 + y^3\right)dy = 0$

$\left(x^3 + 2y^2\right)dx + 2xydy = 0$

$y^2dx + \left(x^2 - xy - y^2\right)dy = 0$

A. '(4 x+6 y+5) d y^6-(3 y+2 x+4) d x=0'

B. x y d x-(x^3+y^3) d y=0'

C. (x^3+2 y^2) d x+2 x y d y=0'

D. 'y^2 d x+(x^2(-x) y-y^2) d y=0'

Answer: D

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91. Find the general solution of the differential equation $\frac{dy}{dx} - y = \cos x.$

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92. Find the general solution of the differential equation.

$x\frac{dy}{dx} + 2y = x^2 (x \neq 0)$

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93. Find the general solution of the differential equation

$ydx - \left(x + 2y^2\right)dy = 0$

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94. Find the particular solution of the differential equation.

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

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95. Find the equation of a curve passing through the point (0,1). If the slope of the tangent to the curve at any point (x,y) is equal to the sum of the x coordinate (abscissa) and the product of the x coordinate and y coordinate of that point.

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96. Solve the following differential equations $\frac{dy}{dx} + 2y = \sin x$

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97. find general solution $\frac{dy}{dx} + 3y = e^{-2x}$

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98. Solve the following differential equations $\frac{dy}{dx} + \frac{y}{x} = x^2$

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99. Solve the following differential equations $\frac{dy}{dx} + \sec xy = \tan x \left(0 \leq x < \frac{\pi}{2}\right)$

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100. Solve the following differential equations $\cos^2 x \frac{dy}{dx} + y = \tan x \left(0 \leq x < \frac{\pi}{2}\right)$

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101. Find the general solution of the differential equation

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

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102. Solve the following differential equations

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

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103. Solve the following differential equations

$$\left(1 + x^2\right)dy + 2xydx = \cot x dx (x \neq 0)$$

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104. Solve the following differential equations

$x\frac{dy}{dx} + y - x + xy\cot x = 0(x \neq 0)$

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105. Solve the following differential equations $(x + y)\frac{dy}{dx} = 1$

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106. Solve the following differential equations

$ydx + \left(x - y^2\right)dy = 0$

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107. Solve the following differential equations

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

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108. For each of the following differential equations, find a particular solution

satisfying the given conditions.

$$\frac{dy}{dx}+2y\tan x=\sin x, \text{y = 0 when x = } \frac{\pi}{3}$$

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109. Find the particular solution of the

differential equation

$(1+x^2)\frac{dy}{dx}+2xy=\frac{1}{1+x^2}$,when $y=0$, $x=1$.

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110. For each of the following differential equations, find a particular solution satisfying the given conditions.

$\frac{dy}{dx}-3y\cot x=\sin 2x$, y = 2 when x = $\frac{\pi}{2}$

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111. Find the equation of a curve passing through the origin given that the slope of the tangent to the curve at any point (x,y) is equal to the sum of the coordinate of the point.

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112. Find the equation of a curve passing through the point (0,2) given that the sum of the coordinates of any point on the curve exceeds the magnitude of the slope of the tangent to the curve at that point by 5.

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113. The Integrating Factor of the differential equation $x\frac{dy}{dx} - y = 2x^2$ is

A. e^{-x}

B. e^{-y}

C. $\frac{1}{x}$

D. x

Answer: C

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114. The intergrating factor of the differential equation $\left(1-y^2\right)\frac{dx}{dy}+yx=ay\,(-1<y<1)$ is

A. 1/(y^2-1)'

B. '1/(sqrt(y^2-1))'

C. 1/(1-y^2)'

D. 1/(sqrt(1-y^2))'

Answer: D

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115. Verify that the function $y = c_1 e^{ax} \cos bx + c_2 e^{ax} \sin bx$, where c_1, c_2 are arbitrary constants is a solution of the differential equation.

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

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

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117. Find the particular solution of the differential equation $\log\left(\frac{dy}{dx}\right) = 3x + 4y$ given that $y = 0$ when $x = 0$

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118. Solve the differential equation

$$(xdy - ydx)y\sin\left(\frac{y}{x}\right) = (ydx + xdy)x\cos\left(\frac{y}{x}\right)$$

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119. Solve the differential equation

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

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120. For each of the differential equations given below, indicate its order and degree (if defined)

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

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

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

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121. Verify that the given fuction (implicit or explicit) is a solution of the corresponding differential equation.

$xy = ae^x + be^{-x} + x^2 : x\frac{d^2y}{dx^2} + 2\frac{dy}{dx} - xy + x^2 - 2 = 0$

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

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124. Form the differential equation of the family of circles in the first quadrant which touch the coordinate axes.

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125. Find the general solution of the differential equation. $\frac{dy}{dx} + \sqrt{\frac{1 - y^2}{1 - x^2}} = 0$

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126. Show that the general solution of the differential equation $\frac{dy}{dx} + \frac{y^2 + y + 1}{x^2 + x + 1} = 0$ is given by $((x + y) + 1) = A(1 - x - y - 2xy)$, where A is parameter.

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127. Find the equation of the curve passing through the point $\left(0, \frac{\pi}{4}\right)$ whose differential equation is $\sin x \cos y dx + \cos x \sin y dy = 0$

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128. Find the particular solution of the differential equation $\left(1 + e^{2x}\right) dy + \left(1 + y^2\right) e^x dx = 0$ given that $y = 1$ when

$x = 0$

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129. Solve the differential equation $ye^{\frac{x}{y}}dx = \left(xe^{\frac{x}{y}} + y^2\right)dy(y \neq 0)$

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130. Find a particular solution of the differential equation $(x - y)(dx + dy) = dx - dy$, given that $y = -1$, when $x = 0$

(Hint: Put x-y=t)

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131. Solve the differential equation

$$\left[\left(\frac{e^{-2\sqrt{x}}}{\sqrt{x}}\right)-\left(\frac{y}{\sqrt{x}}\right)\right]\left(\frac{dx}{dy}\right)=1(x\neq 0)$$

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

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133. Find the general solution of the differential equation

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

given that y = 0 when x = 0.

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134. The population of a village increases continuously at the rate. proportional to the number of its inhabitants present at any time. If the population of the village was 20000 in 1999 and 25000 in the year 2004, what will be the population of the village in 2009 ?

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135. The general solution of the differential equation $\frac{ydx - xdy}{y} = 0.$

A. x y=C'

B. x=C y^2'

C. y=c x'

D. y=C x^2'

Answer: C

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136. Choose the correct answer. The general solution of a differential equation of the type $\frac{dx}{dy} + P_1 x = Q_1$ is a) $ye^{\int P_1 dy} = \int \left(Q_1 e^{\int P_1 dy} \right) dy + c$ b) $ye^{\int P_1 dx} = \int \left(Q_1 e^{\int P_1 dx} \right) dy + c$ c) $xe^{\int P_1 dy} = \int \left(Q_1 e^{\int P_1 dy} \right) dy + c$ d) $xe^{\int P_1 dx} = \int \left(Q_1 e^{\int P_1 dx} \right) dx + c$

A. 'y . e^(int_(p d y))=int(Q_1 e^(int_(p d y)) d y+C'

B. y e^(int(_p, d x))=int(Q_1 e^(int(p_1 d x))) d x+C'

C. x_0 e^(int_(p d)y)=int(Q_s e^(int_p d y)) d y+C'

D. x, e^(int_(p, d x))=int(Q_1 e^(int(p_1 d x)) d x+C'

Answer: C

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137. Choose the correct answer. The general solution of a differential equation $e^x dy + (ye^x + 2x)dx = 0$ is... a) $xe^x + x^2 = c$ b) $xe^y + y^2 = c$ c) $xe^y + y^2 = c$ d) $ye^x + x^2 = c$

A. x e^y+x^2=C'

B. x e^y+y^2=c'

C. y e^x+x^2=c'

D. y_i e^y+x_i^2=C'.

Answer: C

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138. Form the differential equation corresponding to $y = ax^2 + bx + c$

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139. Verify that $y = ae^{-x}$, (a is a parameter) is the general solution of $y' + y = 0$

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140. Solve the differential equation $3e^x \tan y dx - (1 + e^x)\left(\sec^2 y\right) dy = 0$

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141. Find the curve in the xy plane that passes through $(0, 3)$ and whose tangent line at a point (x, y) has slope $\frac{2x}{y}$

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142. Solve $\frac{dy}{dx} = \frac{xy}{x^2 + y^2}, x^2 + y^2 \neq 0$

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143. Solve $y' = \frac{y(x-2y)}{x(x-3y)}, x \neq 0, x \neq 3y$

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144. Solve the initial value problem $\left(xe^{\frac{y}{x}} + y\right)\Big)dx = xdy, y(1) = 0.$

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145. solve $\frac{dy}{dx} - xy = x$

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146. Solve $y' + y = \cos(e^x)$

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147. Solve $y' + y\cos x = e^{\sin x}\cos x$

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148. Solve the following differential equations $(x+y)\dfrac{dy}{dx} = 1$

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149. a)Equation of family of circles touching the y -axis at origin is

$x^2 + y^2 - 2ax = 0$

Find the differential equation of all circles

b) Solve the differential equation

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

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