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Adam Evans 20055959

6/11/2020

Engineering Maths Exam  
ACMA4006

Question 1

a) i)  $y = 8x^3 - 2x^2 - x + 1$

$$\frac{dy}{dx} = 8(3x^2) - 2(2x) - 1$$

$$\frac{dy}{dx} = 24x^2 - 4x - 1$$

ii)  $y = -3(x-5)^2$

$$y = -3(x^2 - 10x + 10)$$

$$y = -3x^2 + 30x - 30$$

$$\frac{dy}{dx} = -6x + 30$$

iii)  $y = \frac{7}{x^3} + 4e^{3x}$

$$y = 7x^{-3} + 4(e^{3x})$$

$$\frac{dy}{dx} = -21x^{-4} + 12e^{3x}$$

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$$\text{iv) } y = 3 \sin 2x - 2 \cos 2x + \tan \frac{x}{3}$$

$$\frac{dy}{dx} = 3(2 \cos 2x) - 2(-2 \sin 2x) + \frac{1}{3} \sec^2 \frac{x}{3}$$

$$\frac{dy}{dx} = 6 \cos 2x + 4 \sin 2x + \frac{1}{3} \sec^2 \frac{x}{3}$$

$$\text{v) } \begin{matrix} e^{2x} & \tan 3x \\ \uparrow & \uparrow \\ u & v \end{matrix}$$

$$\frac{dy}{dx} = v \frac{du}{dx} + u \frac{dv}{dx}$$

$$\frac{du}{dx} = 2e^{2x}$$

$$\frac{dv}{dx} = 3 \sec^2 3x$$

$$\frac{dy}{dx} = (\tan 3x)(2e^{2x}) + (e^{2x})(3 \sec^2 3x)$$

$$= 2e^{2x} \tan 3x + 3e^{2x} \sec^2 3x$$

$$\text{vi) } y = \frac{\sin 5x}{x^3 + 3x + 4}$$

$$\begin{matrix} \leftarrow u \\ \leftarrow v \end{matrix}$$

$$\frac{dy}{dx} = \frac{v \frac{du}{dx} - u \frac{dv}{dx}}{v^2}$$

$$\frac{du}{dx} = 5 \cos 5x$$

$$\frac{dv}{dx} = 3x^2 + 3$$

$$= \frac{(x^3 + 3x + 4)(5 \cos 5x) - (\sin 5x)(3x^2 + 3)}{(x^3 + 3x + 4)^2}$$

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vii)  $y = \sqrt{3x^3 + 2x + 5}$

$$y = (3x^3 + 2x + 5)^{0.5}$$

$$\frac{dy}{dx} = 0.5(3x^3 + 2x + 5)^{-0.5}$$

$$= 0.5(3x^3 + 2x + 5)^{-0.5} (9x^2 + 2)$$

b)  $y = \sin x$

$$y = 1 \cos x$$

c)  $z = 5x^3y^2 + 3x^2 + 4y^4$

$$\frac{dz}{dx} = 5(23x^2)y + (6x) + 4y^4$$

$$= 15x^2y + 24xy^4$$

$$\frac{dz}{dy} = 5x^3(2y) + 3x^2 + 4(4y^3)$$

$$= 5x^32y + 3x^2 + 16y^3$$

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(2)

$$a) i) \frac{2x+3}{6} = \frac{x}{3} + \frac{5x-1}{6} \quad \text{Common Factor 6}$$

$$6\left(\frac{2x+3}{6}\right) = \frac{6x}{3} + 6\left(\frac{5x-1}{6}\right)$$

$$1(2x+3) = 2x + 1(5x-1)$$

$$2x+3 = 2x + 5x - 1$$

$$2x+3 = 7x-1$$

~~2x + 2x~~

$$3+1 = 7x-2x$$

$$4 = 5x$$

$$x = \frac{5}{4}$$

$$ii) 2\ln(x+6) = \ln(x+3) + \ln(x+7)$$

$$\ln(x+6)^2 = \ln(x+3)(x+7)$$

$$x^2 + 12x + 36 = x^2 + 10x + 21$$

$$12x - 10x = 21 - 36$$

$$2x = -15$$

$$x = -7.5$$

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$$\text{iii) } 3^{x+5} = 2^x \times 6 \quad \leftarrow \log A^B = B \log A + 1^{\text{st}}$$

$$\log 3^{(x+5)} = \log 2^x \times \log 6$$

$$(x+5) \log 3 = x \log 2 + \log 6$$

$$(x+5) 0.4771 = 0.3010x + 0.7781$$

$$0.4771x + 2.3856 = 0.3010x + 0.7781$$

$$0.4771x - 0.3010x = 0.7781 - 2.3856$$

$$0.1761x = -1.6079$$

$$x = \frac{-1.6079}{0.1761} = \boxed{x = -9.1306}$$

$$\begin{aligned} 6) \quad y &= x^2 + 2x + 2 & \textcircled{1} \\ y &= 2x^2 + 11x + 10 & \textcircled{2} \end{aligned}$$

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$$c) \underset{\substack{\uparrow \\ a}}{9}x^2 - \underset{\substack{\uparrow \\ b}}{4}x - \underset{\substack{\uparrow \\ c}}{5} = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{4 \pm \sqrt{(4)^2 - 4(9)(-5)}}{2(9)}$$

$$x = \frac{4 \pm \sqrt{16 + 180}}{18}$$

$$x = \frac{4 \pm \sqrt{196}}{18}$$

$$x = \frac{4 \pm 14}{18}$$

$$x = \frac{4 + 14}{18}$$

$$x = 1$$

$$x = \frac{4 - 14}{18}$$

$$x = -0.55\bar{5}$$

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$$d) i) x^2 + 11x + 30 = 0$$

$$\begin{array}{cc} \uparrow & \uparrow \\ + & \times \end{array}$$

$$3 \times 10 = 30 \quad \times$$

$$10 \times 3 = 30 \quad \times$$

$$5 \times 6 = 30 = 11$$

$$6 \times 5 = 30 = 11$$

$$(x + 5)(x + 6) = 0$$

$$x^2 + 6x + 5x + 30$$

$$x^2 + 11x + 30 \quad \checkmark$$

$$x + 5 = 0$$

$$x = -5$$

$$x + 6 = 0$$

$$x = -6$$

$$ii) x^2 + 13x + 22 = 0$$

$$2 \times 11 = 22 = 13$$

$$11 \times 2 = 22 = 13$$

$$(x + 2)(x + 11) = 0$$

$$x^2 + 11x + 2x + 22 \quad \checkmark$$

$$x + 2 = 0$$

$$x = -2$$

$$x + 11 = 0$$

$$x = -11$$

$$iii) x^2 + 100 = 0$$

$$x + 10 = 0$$

$$x = -10$$

$$x + 10 = 0$$

$$x = -10$$

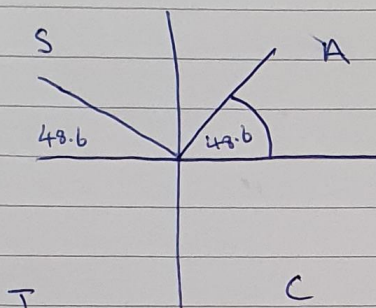
$$iv) 2x^2 + 7x + 5 = 0$$

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③

a) i)  $\sin x = 0.75$   
 $x = \sin^{-1}(0.75) = 48.6^\circ$

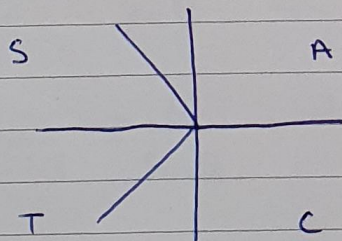


$$x = 180 - 48.6 = 131.4^\circ$$

ii)  $-5\cos x = 2$

$$\cos x = \frac{2}{5}$$

$$x = \cos^{-1}\left(\frac{2}{5}\right) x = 66.42$$



$$x = 180 - 66.42 = 113.58$$

$$x = 180 + 66.42 = 246.42$$