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Mechanical Engineering

MAT 104

i) $y = t^3 - \frac{t^2}{2} - 2t + 4$

ii) $\frac{dy}{dt} = 3t^2 - 2t - 2$

At stationary point $\frac{dy}{dt} = 0$

$3t^2 - 2t - 2 = 0$

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

$t = \frac{-(-2) \pm \sqrt{4 + 24}}{6}$

$t = \frac{2 \pm \sqrt{28}}{6}$

$t = \frac{2 + \sqrt{28}}{6}$ or $t = \frac{2 - \sqrt{28}}{6}$

$t = \frac{2 + 5.29}{6}$ or $t = \frac{2 - 5.29}{6}$

$t = 1.22$ or $t = -0.55$

ii) When $t = 1.22$

$y = (1.22)^3 - \frac{(1.22)^2}{2} - 2(1.22) + 4$

$y = 1.82 - 0.74 - 2.44 + 4$

$y = 2.64$

When $t = -0.55$

$y = (-0.55)^3 - \frac{(-0.55)^2}{2} - 2(-0.55) + 4$

$y = \cancel{0 \cdot 30} - 0 \cdot 17 - 0 \cdot 15 + 1 \cdot 1 + 4$

$y = 4 \cdot 78$

The coordinates are $(1 \cdot 22, 2 \cdot 64)$, and $(-0 \cdot 55, 4 \cdot 78)$

iii) $\frac{d^2y}{dt^2} = 6t - 2$

when $t = 1 \cdot 22$

$\frac{d^2y}{dt^2} = 6(1 \cdot 22) - 2$

$= 7 \cdot 32 - 2$

$= 5 \cdot 32$

At $(1 \cdot 22, 2 \cdot 64)$, it is a minimum point

when $t = -0 \cdot 55$

$\frac{d^2y}{dt^2} = 6(-0 \cdot 55) - 2$

$= -5 \cdot 3$

At $(-0 \cdot 55, 4 \cdot 78)$, it is a maximum point

2) $2y^2 - 5x^4 - 2 - 7y^3 = 0$, with respect to $x$

$2y^2 - 5x^4 - 7y^3 = 2$

$4y\frac{dy}{dx} - 20x^3 - 21y^2\frac{dy}{dx} = 0$

$4y\frac{dy}{dx} - 21y^2\frac{dy}{dx} - 20x^3 = 0$

$\frac{(4y - 21y^2)\frac{dy}{dx}}{4y - 21y^2} = \frac{-20x^3}{4y - 21y^2}$

$\frac{dy}{dx} = \frac{-20x^3}{4y - 21y^2}$

3) ~~$x - 4x^2 + 2y$~~

3) $4x^2 + 2xy^3 - 5y^2 = 0$

$8x + 2y^3 + 3y^2\frac{dy}{dx} 2x - 10y\frac{dy}{dx} = 0$

$8x + 2y^3 + 6xy^2\frac{dy}{dx} - 10y\frac{dy}{dx} = 0$

$6xy^2\frac{dy}{dx} - 10y\frac{dy}{dx} + 8x + 2y^3 = 0$

$(6xy^2 - 10y)\frac{dy}{dx} + 8x + 2y^3 = 0$

$\frac{dy}{dx} = \frac{-8x + 2y^3}{6xy^2 - 10y}$

when $x = 1, y = 2$

$\frac{dy}{dx} = \frac{-8(1) - 2(2)^3}{6(1)(2) - 10(2)}$

$= \frac{-8 - 16}{12 - 20}$

$= \frac{-24}{-8}$

$= 3$