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# Scheme & Solution of Model Question paper-1

## Calculus and Differential Equations (ZIMATII)

### Module-1

1a) With usual notations prove that  $\tan \phi = r \frac{d\theta}{dr}$

Sol<sup>n</sup>: Explanation with figure & proof

2+4

Note: For proof one can refer previous video link provided in the description.

1b) Find the angle b/w the curves  $r = a(1 + \cos \theta)$  &  $r = b(1 - \cos \theta)$



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is the required pedal equation.

20) Find the radius of curvature of the curve  $x^3 + y^3 = 3axy$  at  $(\frac{3a}{2}, \frac{3a}{2})$ .

Sol<sup>n</sup>: Given  $x^3 + y^3 = 3axy$

$$\text{Diff w.r.t } x \Rightarrow 3x^2 + 3y^2 y_1 = 3a(xy_1 + y)$$

$$\Rightarrow y_1 = \frac{ay - x^2}{y^2 - ax} \rightarrow \textcircled{1}$$

$$y_1 \left( \frac{3a}{2}, \frac{3a}{2} \right) = -1$$

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10. If  $x + y + z = u$ ,  $y + z = uv$  &  $z = uvw$

find  $\frac{\partial(x, y, z)}{\partial(u, v, w)}$

Sol<sup>n</sup>: Given  $z = uvw \Rightarrow y = uv - uvw$  &  $x = u - uv$

$$\frac{\partial(x, y, z)}{\partial(u, v, w)} = \begin{vmatrix} x_u & x_v & x_w \\ y_u & y_v & y_w \\ z_u & z_v & z_w \end{vmatrix} = \begin{vmatrix} 1-v & -u & 0 \\ v-vw & u-uw & -uv \\ vw & uw & uv \end{vmatrix}$$

$$= (1-v) \{ u^2v - u^2vw + u^2vw \} + u \{ uv^2 - uv^2w + uv^2w \} + 0$$

$$= u^2v$$

be the temperature of the ball after 40min from the original?

Soln:  $T = t_2 + (t_1 - t_2) e^{-kt}$

where  $t_1 = 80^\circ\text{C}$ ,  $t_2 = 40^\circ\text{C}$ ,  $T = 60^\circ\text{C}$ ,  $T = 40\text{min}$ ?

$$T = 40 + 40 e^{-kt}$$

$$60 = 40 + 40 e^{-20k}$$

$$20 = 40 e^{-20k}$$

$$e^{-20k} = \frac{20}{40} \Rightarrow e^{20k} = 2$$

$$20k = \log 2$$



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