OYEIXALE SEMILORE
16/ENG06/065
MECHANICAL ENGINEERING
ENGINEERING MATHEMATICS

① The power P dissipated in a resistor is given as equation (1)

$$P = \frac{E^2}{R} \quad \text{---} (1)$$

If E = 200 volts and R = 8 ohms. find the change in P resulting from a drop of 5 volts in E and an increase of 2 ohms in R.

Solution

$$P = \frac{E^2}{R}$$

$$\delta P = \frac{\partial P}{\partial E}\delta E + \frac{\partial P}{\partial R}\delta R$$

$$\frac{\partial P}{\partial E} = \frac{R(2E) - E^2(0)}{R^2} = \frac{2E}{R}$$

$$\frac{\partial P}{\partial R} = \frac{R(0) - E^2(1)}{R^2} = \frac{-E^2}{R^2}$$

$$\delta P = \frac{2E(-5)}{R} + \left(\frac{-E^2}{R^2}\right)(+0.2)$$

$$\delta P = \left(\frac{2 \times 200 \times -5}{8}\right) + \left(\frac{-200^2}{8^2}\right)(0.2)$$

$$\delta P = \frac{-2000}{8} - \frac{8000}{64}$$

$$\delta P = -250 - 125$$

$\therefore \delta P = -375W$

$\therefore$ P decreases by 375W

$\therefore$ There was 375W decreases in Power

(2) The deflection y at the centre of a circular plate suspended at the edge and uniformly loaded is given in Equation (2)

$$y = \frac{kwd^4}{t^3}$$

where w = total load, d = diameter of plate
t = thickness and k is a constant

Calculate the approximate percentage change in y, if w is increased by 3 percent, d is increased by 2 per cent and t is increased by 4 percent

solution

$$y = \frac{kwd^4}{t^3}$$

$\cancel{\delta y = \frac{\delta P}{\delta}}$ $\delta y = \frac{\partial y}{\partial w}\delta w + \frac{\partial y}{\partial d}\delta d + \frac{\partial y}{\partial t}\delta t$

$$\frac{\partial y}{\partial w} = \frac{kd^4(1)}{t^3} = \frac{kd^4}{t^3}$$

$$\frac{\partial y}{\partial d} = \frac{4kwd^3}{t^3}$$

$$\frac{\partial y}{\partial t} = -\frac{3kwd^4}{t^4}$$

$$\delta w = \pm\left(\frac{3}{100} \times w\right) = \pm\left(\frac{3w}{100}\right)$$

$$\delta d = \pm\left(\frac{2.5}{100} \times d\right) = \pm\left(\frac{2.5d}{100}\right)$$

$$\delta t = \pm\left(\frac{4}{100} \times t\right) = \pm\left(\frac{4t}{100}\right)$$

$$\therefore \cancel{\delta y = 4kwd^3}$$

$$\delta y = \frac{kd^4}{t^3}\left(\pm\frac{3w}{100}\right) + \frac{4kwd^3}{t^3}\left(\pm\frac{2.5d}{100}\right) - \frac{3kwd^4}{t^4}\left(\pm\frac{4t}{100}\right)$$

$$\delta y = \frac{kwd^4}{t^3}\left(\frac{+3}{100}\right) + \frac{kwd^4}{t^3}\left(\frac{10}{100}\right) - \frac{kwd^4}{t^3}\left(\frac{12}{100}\right)$$

$$\delta y = \frac{kwd^4}{t^3}\left[\frac{3}{100} + \frac{10}{100} - \frac{12}{100}\right]$$

$$\delta y = \frac{kwd^4}{t^3}\left[\frac{+1}{100}\right]$$

$$\delta y = y\,[+1\%].$$

$\therefore$ The approximate change in $y$ if $w$ is increased by 3 percent, $d$ is increased by 2 percent and $t$ is increased by 4 percent is [+1%]

$$\frac{\partial y}{\partial t} = \frac{-3kwd^4}{t^4}$$

$$\delta w = \pm\left(\frac{3}{100} \times w\right) = \pm\left(\frac{3w}{100}\right)$$

$$\delta d = \pm\left(\frac{2.5}{100} \times d\right) = \pm\left(\frac{2.5d}{100}\right)$$

$$\delta t = \pm\left(\frac{4}{100} \times t\right) = \pm\left(\frac{4t}{100}\right)$$

$\therefore$ $\cancel{\delta y = 4kwd^3}$

$$\delta y = \frac{kd^4}{t^3}\left(+\frac{3w}{100}\right) + \frac{4kwd^3}{t^3}\left(+\frac{2.5d}{100}\right) - \frac{3kwd^4}{t^4}\left(+\frac{4t}{100}\right)$$

$$\delta y = \frac{kwd^4}{t^3}\left(+\frac{3}{100}\right) + \frac{kwd^4}{t^3}\left(\frac{10}{100}\right) - \frac{kwd^4}{t^3}\left(\frac{12}{100}\right)$$

$$\delta y = \frac{kwd^4}{t^3}\left[\frac{3}{100} + \frac{10}{100} - \frac{12}{100}\right]$$

$$\delta y = \frac{kwd^4}{t^3}\left[\frac{+1}{100}\right]$$

$$\delta y = y\,[+1\%]$$

$\therefore$ The approximate change in y if w is increased by 3 percent, d is increased by 2 percent and t is increased by 4 percent is [+1%]