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CIVIL ENGINEERING
ENG 251

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

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

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 0.2 ohm in R.

Soln

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

$E = 200\,V$, $R = 8\,\Omega$, $\delta P = ?$, $E_{drop} = 5V$, $R_{increase} = 0.2\,\Omega$

$$\frac{\partial P}{\partial E} = \frac{2E}{R} \qquad \frac{\partial P}{\partial R} = -E^2R^{-2} = -\frac{E^2}{R^2}$$

$\delta E = -5V$ $\qquad \delta R = +0.2V$

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

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

$$\delta P = -250 + (-125)$$

$$\delta P = -375 \text{ Watts}$$

∴ P decreases by 375 Watts

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

$$y = \frac{k w d^4}{t^3}$$

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 2½ percent and t is increased by 4 percent.

Soln

$$y = \frac{k w d^4}{t^3}$$

$w = +3\%$ $\quad d = 2\frac{1}{2}\% \simeq 5/2\%$

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

$$\frac{\partial y}{\partial w} = \frac{k d^4}{t^3}, \quad \frac{\partial y}{\partial d} = \frac{4 k w d^3}{t^3}, \quad \frac{\partial y}{\partial t} = -\frac{3 k w d^4}{t^4}$$

$$\delta w = \frac{3}{100} \text{ of } w \qquad \delta d = \frac{5/2}{100} \text{ of } d \qquad \delta t = \frac{4}{100} \text{ of } t$$

$$\delta y = \left(\frac{k d^4}{t^3}\right)\left(\frac{3t}{100}\right) + \left(\frac{4 k w d^3}{t^3}\right)\left(\frac{5/2\, d}{100}\right) + \left(\frac{-3 w d^4}{t^4}\right)\left(\frac{4t}{100}\right)$$

$$\delta y = \frac{3 w k d^4}{100 t^3} = \frac{20 k w d^4}{200 t^3} - \frac{12 k w d^4}{100 t^5}$$

$$\delta y = \frac{k k l d^4}{t^3}\left[\frac{3}{100} + \frac{20}{200} - \frac{12}{100}\right]$$

$$\frac{k w l d^4}{t^3}\left[\frac{6+20-24}{200}\right]$$

$$\frac{1 c w l d^4}{t^3}\left[\frac{2}{200}\right]$$

Recall $y = \frac{k w l d^4}{t^3}$

$$= y\left[\frac{1}{100}\right]$$

$$\delta y = y\left[\frac{1}{100}\right]$$

Therefore y increases by 1 percent.