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Mechatronics
Engineering mathematics

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

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

If $E = 200V$ and $R = 8\Omega$. Find the change in P resulting from a drop of 5 volts in E and an increase of 0.2 ohm in R.

soln

$$dP = \frac{\partial P}{\partial E} dE + \frac{\partial P}{\partial R} dR$$

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

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

$dE = -5V$, $dR = 0.2\Omega$, $E = 200V$, $R = 8\Omega$

$$\therefore dP = \frac{2(200)(-5)}{8} + \frac{(200^2)(0.2)}{(8)^2}$$

$$= -250 + 125$$

$$= -125\,W$$

Therefore, There was a 125w drop in the power supply.

2 The deflection y at the centre of a circular plate suspended at the edge and uniformly loaded is given as

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

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

Calculate the approximate percentage change in y if w is increased by 3 percent, d is increased by 2½ per cent and t is increased by 4 per cent.

Soln

$$dy = \frac{\partial y}{\partial w} dw + \frac{\partial y}{\partial d} dd + \frac{\partial y}{\partial t} dt$$

$$\frac{\partial y}{\partial w} = \frac{kd^4}{t^3} \qquad dw = \frac{3}{100} \times w = 0.03w$$

$$\frac{\partial y}{\partial d} = \frac{kw4d^3}{t^3} \qquad dd = \frac{2.5}{100} \times d = 0.025d$$

$$\frac{\partial y}{\partial t} = \frac{-3kwd^4}{t^4} \qquad dt = \frac{4}{100} \times t = 0.04t$$

$$\therefore dy = \left(\frac{kd^4}{t^3} \times 0.03w\right) + \left(\frac{kw4d^3}{t^3} \times 0.025d\right) + \left(\frac{-3kwd^4}{t^4} \times 0.04t\right)$$

$$dy = \frac{0.03\,kwd^4}{t^3} + \frac{0.1\,kwd^4}{t^3} - \frac{0.12\,kwd^4}{t^3}$$

$$= \frac{kwd^4}{t^3}\left(0.03 + 0.1 - 0.12\right)$$

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

$$\therefore \quad y(0.01$$

$$dy = y(1/100)$$

Therefore, y increases by 0.01 percent.