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Mechanical Engineering

The power P dissipated in a resistor is given 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 increase of 0.2 ohm in R

Solution.

$P = E^2/R$ E = 200 Volts R = 8 ohms

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

$\partial E = -5$ volts $\partial R = 0.2$ ohms

$$\frac{\partial P}{\partial E} = \frac{2E}{R} \qquad \frac{\partial P}{\partial R} = E^2 R^{-1} = -E^2 R^{-2} = \frac{-E^2}{R^2}$$

$$\partial p = \frac{2E}{R} \times -5 + \left(\frac{-E^2}{R^2} \times 0.2\right)$$

$$\partial p = \frac{2(200)}{8} \times -5 - \frac{(200)^2}{(8)^2} \times 0.2$$

$$\partial p = -250 - 125$$

$$\partial p = -375 \text{ watts}$$

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 in y if W is increased by 3 percent, d is increased by 2½ percent and t is increased by 4 percent

Solution

$$\delta y = \frac{\partial y}{\partial W}\cdot \delta W + \frac{\partial y}{\partial d}\cdot \delta d + \frac{\partial y}{\partial t}\cdot \delta t$$

$$\delta W = \frac{3}{100} \text{ of } W = \frac{3W}{100}$$

$$\delta d = \frac{2.5}{100} \times d = \frac{2.5d}{100}$$

$$\delta t = \frac{4}{100} \times t = \frac{4t}{100}$$

$$y = KWd^4t^{-3}$$

$$\frac{dy}{dW} = Kd^4t^{-3} = \frac{Kd^4}{t^3}$$

$$\frac{dy}{dd} = 4Kwd^3t^{-3} = \frac{4Kd^3}{t^3} = \frac{4WKd^3}{t^3}$$

$$\frac{dy}{dt} = -3kwd^4t^{-4} = \frac{-3kwd^4}{t^4}$$

$$dy = \frac{kd^4}{t^3} \times \frac{3w}{100} + \frac{4kwd^3}{t^3} \times \frac{2.5d}{100} - \frac{3kwd^4}{t^4} \times \frac{t}{100}$$

$$dy = \frac{wkd^4}{t^3}\left(\frac{3}{100}\right) + \frac{kwd^4}{t^3}\left(\frac{2.5\times4}{100}\right) - \frac{kwd^4}{t^3}\left(\frac{3\times4}{100}\right)$$

$$dy = \frac{wkd^4}{t^3}\left(\frac{3}{100} + \frac{10}{100} - \frac{12}{100}\right)$$

$$dy = y\left(\frac{1}{100}\right) = 1\% \text{ of } y$$