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16/ENG041026
Electrical/Electronics Engineering.
ENG 281 Assignment 3.

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

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

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 0.2 ohms in R.

Soln

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

$$\delta P = \frac{\partial P}{\partial E}\delta E + \frac{\partial P}{\partial R}\delta R \quad \text{--} \quad (2)$$

$$\frac{\partial P}{\partial E} = \frac{2E}{R} \quad \text{---} \quad (3)$$

$$\delta E = -5 \text{ volts} = -\frac{5}{200} \times 100\% = -2.5\% \text{ of } E = -\frac{2.5E}{100} \quad (4)$$

$$\frac{\partial P}{\partial R} = -\frac{E^2}{R^2} \quad \text{---} \quad (5)$$

$$\delta R = +0.2 \text{ ohms} = \frac{0.2}{8} \times 100\% = 2.5\% \text{ of } R = +\frac{2.5R}{100} \quad (6)$$

$\therefore$ ~~$\delta P = 2$~~ By substituting eqns. (3), (4), (5) and (6) into Eqn (2).

Equation (2) becomes:

$$\delta P = \frac{2E}{R}\left(-\frac{2.5E}{100}\right) + \left(-\frac{E^2}{R^2}\right)\left(+\frac{2.5R}{100}\right)$$

$$\delta P = \frac{E^2}{R}\left(-\frac{2.5 \times 2}{100} - \frac{2.5}{100}\right)$$

$$\delta P = \frac{E^2}{R}\left(-\frac{5 - 2.5}{100}\right) = \frac{E^2}{R}\left(-\frac{7.5}{100}\right)$$

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

$$\therefore \quad \delta P = -\frac{7.5}{100}P$$

However, $E = 200$ volts
$R = 8$ ohms

$\therefore$ The actual change in P with respect to 5 volts drops in E and an increase of 0.2 ohms in R is:

$$\delta P = -\frac{7.5}{100} P = -\frac{7.5}{100} \times \frac{E^2}{R}$$

$$\delta P = \frac{-7.5}{100} \times \frac{200^2}{8} = -375 \text{ watts}$$

$\therefore$ There was a 375 watts decreased in the power P dissipated by the resistor.

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

$$y = \frac{KWd^4}{t^3} \quad \text{---} \quad ②$$

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 2.5 percent and t is increased by 4 percent.

Soln.

$$y = \frac{Kwd^4}{t^3} \quad \text{---} \quad ②$$

Recall:

$$\delta y = \frac{\partial y}{\partial w}\delta w + \frac{\partial y}{\partial d}\delta d + \frac{\partial y}{\partial t}\delta t \quad \text{---} \quad ③$$

$$\frac{\partial y}{\partial w} = \frac{Kd^4}{t^3}(1) = \frac{Kd^4}{t^3} \quad \text{---} \quad ④$$

$$\delta w = +\frac{3}{100} \times w = +\frac{3w}{100} \quad \text{---} \quad ⑤$$

$$\frac{\partial y}{\partial d} = \frac{4kwd^3}{t^3} \quad \text{----} \quad (6)$$

$$\delta d = +\frac{2.5}{100} \times d = +\frac{2.5d}{100} \quad \text{---} \quad (7)$$

$$\frac{\partial y}{\partial t} = -\frac{3kwd^4}{t^4} \quad \text{-----} \quad (8)$$

$$\delta t = +\frac{4}{100} \times t = +\frac{4t}{100} \quad \text{---} \quad (9)$$

By substituting eqns (4), (5), (6), (7), (8) and (9) into eqn (3).

Equation (3) becomes:

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

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

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

$$\therefore \delta y = y\left(\frac{3+10-12}{100}\right)$$

$$\delta y = +\cancel{\frac{0.5}{100}y} = +\frac{1}{100}$$

Therefore, there was an approximate ~~0.5~~ 1 Percentage Increase in the deflection y where w is increased by 3 percent, d is increased by 2.5 percent and t is increased by 4 percent.