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CHEMICAL ENGINEERING.

ENGINEERING MATHEMATICS.

(1) 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 an increase of 0.2 ohm in R.

(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 2½ percent and t is increased by 4 percent.

Soln.

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

$R = 8$ Ohms $E = 200$ volts.

$\delta R = 0.2$ Ohm, $\delta E = 5$ volts.

$$P = E^2 R^{-1}$$

$$\frac{dP}{dR} = -E^2 R^{-2}$$

$$dP = \frac{dP}{dE} dE + \frac{\delta P}{\delta R} \delta R$$

$$\delta P = 2ER^{-1} \times 5 + -E^2 R^{-2} \times 0.2.$$

$$= 2 \times 200 \times \frac{1}{8} \times 5 + (-200)^2 \times \frac{1}{8^2} \times 0.2.$$

$$= \frac{400 \times 5}{8} + \frac{40,000 \times 0.2}{8^2}$$

$= \frac{2000}{8} + \frac{8000}{8^2}$

$= 250 + 125$

$= 375$ watts.

Change in P = 375 watts.

(2) $y = \frac{kwd^4}{t^3}$ $\quad k$ = Constant.

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

$dy = \frac{dy}{dw}dw + \frac{dy}{dd}dd + \frac{dy}{dt}dt.$

$dw = +3\% = \frac{+3w}{100}$

$dd = +2\frac{1}{2}\% = \frac{+5}{2} - 100 = \frac{+5}{2} \times \frac{1}{100} = \frac{5d}{200}$

$dt = +4\% = \frac{4t}{100}.$

$\frac{dy}{dw} = kd^4t^{-3}$ $\quad \frac{dy}{dd} = 4kwd^3t^{-3}$ $\quad \frac{dy}{dt} = -3kwd^4t^{-4}.$

$dy = \left(kd^4t^{-3} \times \frac{3w}{100}\right) + \left(4kwd^3t^{-3} \times \frac{5d}{200}\right) + \left(-3kwd^4t^{-4} \times \frac{4t}{100}\right).$

$= \frac{3wkd^4t^{-3}}{100} + \frac{20kwd^4t^{-3}}{200} - \frac{12kwd^4t^{-3}}{100}$

$= wkd^4t^{-3}\left[\frac{3}{100} + \frac{20}{200} - \frac{12}{100}\right]$

$= wkd^4t^{-3}\left[\frac{6+20-24}{200}\right]$

$= wkd^4t^{-3}\left[\frac{2}{200}\right]$

$= wkd^4t^{-3}\left[\frac{1}{100}\right].$

$= y\left[\frac{1}{100}\right]$ $\quad \therefore$ the change in percentage of y is 1%