

5.a. Given :-

$$f_n = 5 \text{ Hz} ; d = 2 \text{ mm} = 0.002 \text{ m} ;$$

$$I = 0.0098 \text{ kg-m}^2$$

$$G = 0.85 \times 10^{11} \text{ N/m}^2.$$

$$l = ?$$

Natural frequency of Pendulum $\omega_n = \sqrt{\frac{K_t}{I}}$

$$f_n = \frac{1}{2\pi} \cdot \omega_n.$$

$$\omega_n = 2\pi \cdot f_n = 2\pi(5) = 10\pi \text{ rad/s} //$$

$$\omega_n = 10\pi \text{ rad/sec} //$$

W.K.T $\frac{T}{J} = \frac{G\theta}{l} \Rightarrow K_t = \frac{T}{\theta} = \frac{GJ}{l}$

$$J = \frac{\pi d^4}{32}$$
$$= \frac{\pi (0.002)^4}{32}$$

$$J = 1.57 \times 10^{-12} \text{ m}^4$$

$$\omega_n^2 = \frac{K_t}{I}$$

$$(10\pi)^2 = \frac{GJ}{I \cdot l}$$

$$986.96 = \frac{0.85 \times 10^{11} \times 1.57 \times 10^{-12}}{0.0098 \times l}$$

$$l = 0.0138 \text{ m}$$