22. Two steel wires having same length are suspended from a ceiling under the same load. If the ratio of their energy stored per unit volume is $1:4$, the ratio of their diameters is: **[9 Jan 2020 II]**

(a) $\sqrt{2}:1$ (b) $1:2$

(c) $2:1$ (d) $1:\sqrt{2}$

22. (a) If force F acts along the length L of the wire of cross-section A, then energy stored in unit volume of wire is given by

$$\text{Energy density} = \frac{1}{2} \text{ stress} \times \text{strain}$$

$$= \frac{1}{2} \times \frac{F}{A} \times \frac{F}{AY} \quad \left(\because \text{ stress} = \frac{F}{A} \text{ and strain} = \frac{X}{AY} \right)$$

$$= \frac{1}{2} \frac{F^2}{A^2 Y} = \frac{1}{2} \frac{F^2 \times 16}{(\pi d^2)^2 Y} = \frac{1}{2} \frac{F^2 \times 16}{\pi d^4 Y}$$

If u_1 and u_2 are the densities of two wires, then

$$\frac{u_1}{u_2} = \left(\frac{d_2}{d_1} \right)^4 \Rightarrow \frac{d_1}{d_2} = (4)^{1/4} \Rightarrow \frac{d_1}{d_2} = \sqrt{2} : 1$$