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Quiz 5

MECH3011 Fluid Mechanics

Summer 2021

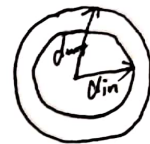
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- Closed book/closed notes
- Show all steps to obtain full credit
- Calculator allowed

Air flows in between two concentric circular tubes need to be kept as laminar. The inner tube's diameter is 30 cm, the outer tube's diameter is 40 cm, and the hydraulic diameter is 10 cm. Assume transitional Reynolds based on the hydraulic diameter is 2500. $N.s/m^2$. Calculate the maximum permissible volume flow rate (before it transitions). $\rho_{air} = 1.23 \text{ kg/m}^3$, $\mu_{air} = 1.8 \times 10^{-5} \text{ N.s/m}^2$

$$A = \frac{1}{4} \pi (d_{out}^2 - d_{in}^2) = \frac{1}{4} \pi [(40 \times 10^{-2})^2 - (30 \times 10^{-2})^2]$$

$$= 5.4978 \times 10^{-2} \text{ m}^2$$



$$Re = \frac{\rho V_{max} D_{hydraulic}}{\mu_{air}} = \frac{1.23 \times V_{max} \times (10 \times 10^{-2})}{1.8 \times 10^{-5}} = 2500 \text{ N.s/m}^2$$

$$\Rightarrow V_{max} = \frac{2500 \times 1.8 \times 10^{-5}}{1.23 \times (10 \times 10^{-2})} \text{ m/s} = 3.6585 \times 10^{-1} \text{ m/s}$$

$$Q_{max} = A \cdot V_{max} = 5.4978 \times 10^{-2} \text{ m}^2 \times 3.6585 \times 10^{-1} \text{ m/s}$$

$$= 2.0114 \times 10^{-2} \text{ m}^3/\text{s}$$