Submission Deadline: _____

ADDIS ABABA UNIVERSITY

AAiT

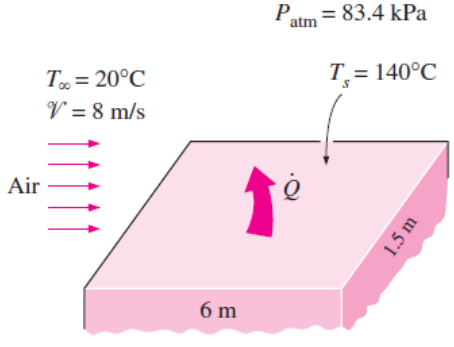
School of Mechanical and Industrial Engineering

Heat Transfer (MEng 3171): Assignment II — Instructor: Dawit M.

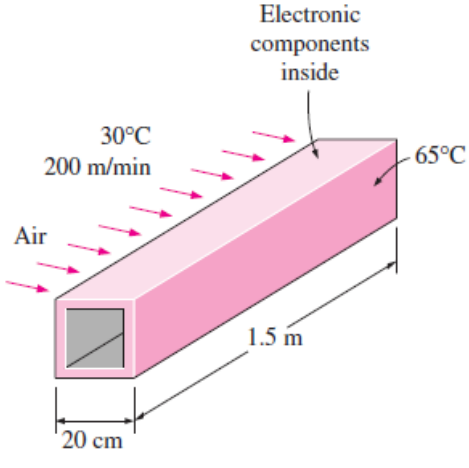
1. How does turbulent flow differ from laminar flow? For which flow is the heat transfer coefficient higher?

2. What is the physical significance of the Reynolds number? How is it defined for external flow over a plate of length L?

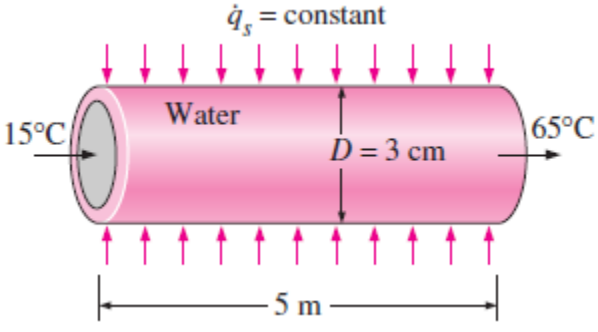
3. The local atmospheric pressure in Denver, Colorado (elevation 1610 m), is 83.4 kPa. Air at this pressure and 20°C flows with a velocity of 8 m/s over a 1.5 m x 6 m flat plate whose temperature is 140°C. Determine the rate of heat transfer from the plate if the air flows parallel to the (*a*) 6-m-long side and (*b*) the 1.5-m side.



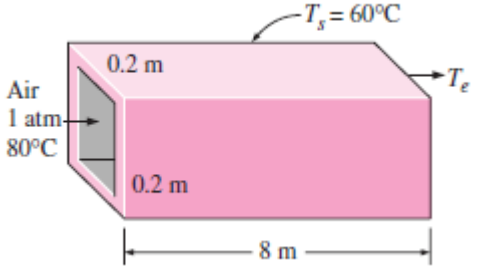
4. The components of an electronic system are located in a 1.5m-long horizontal duct whose cross section is 20 cm X 20 cm. The components in the duct are not allowed to come into direct contact with cooling air, and thus are cooled by air at 30°C flowing over the duct with a velocity of 200 m/min. If the surface temperature of the duct is not to exceed 65°C, determine the total power rating of the electronic devices that can be mounted into the duct.



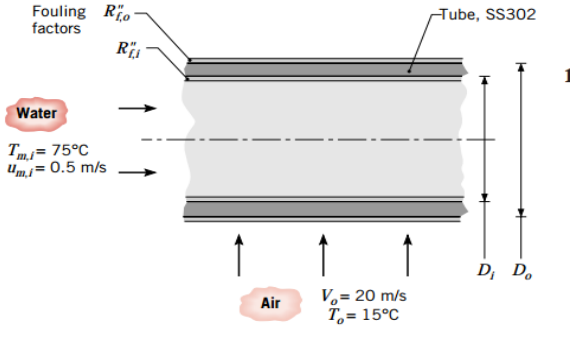
5. Water is to be heated from 15°C to 65°C as it flows through a 3-cm-internal-diameter 5-m-long tube. The tube is equipped with an electric resistance heater that provides uniform heating throughout the surface of the tube. The outer surface of the heater is well insulated, so that in steady operation all the heat generated in the heater is transferred to the water in the tube. If the system is to provide hot water at a rate of 10 L/min, determine the power rating of the resistance heater. Also, estimate the inner surface temperature of the pipe at the exit.



6. Hot air at atmospheric pressure and 80°C enters an 8–m-long uninsulated square duct of cross section 0.2 m × 0.2 m that passes through the attic of a house at a rate of 0.15 m3/s. The duct is observed to be nearly isothermal at 60°C. Determine the exit temperature of the air and the rate of heat loss from the duct to the attic space.



7. A type-302 stainless steel tube of inner and outer diameters Di = 22 mm and Do = 27 mm, respectively, is used in a cross-flow heat exchanger. The fouling factors, R_f, for the inner and outer surfaces are estimated to be 0.0004 and 0.0002 m^2 K/W, respectively.



Determine the overall heat transfer coefficient based on the outside area of the tube, U_o. Compare the thermal resistances due to convection, tube wall conduction, and fouling.

8. Steam in the condenser of a power plant is to be condensed at a temperature of 30°C with cooling water from a nearby lake, which enters the tubes of the condenser at 14°C and leaves at 22°C. The surface area of the tubes is 45 m^2, and the overall heat transfer coefficient is 2100 $W/m^2 \cdot$ °C. Determine the mass flow rate of the cooling water needed and the rate of condensation of the steam in the condenser.