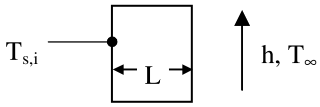
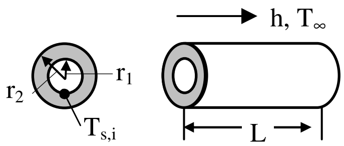
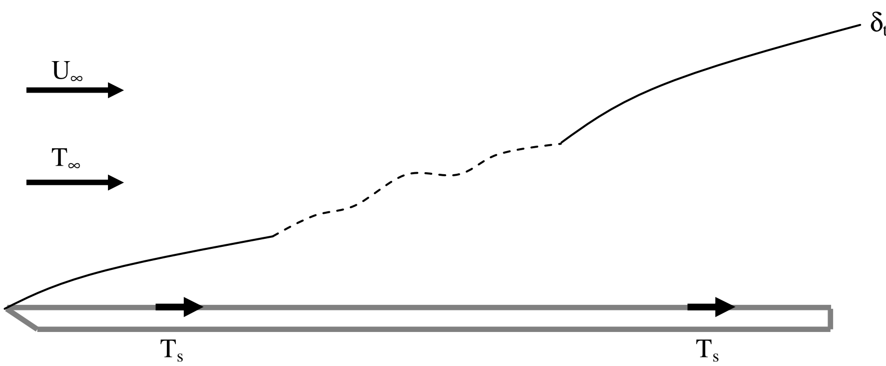
ME 327 Midterm Exam

October 28, 2005 (Time: 2 hours)

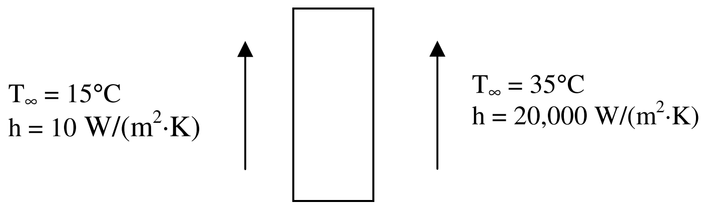
This is an **open book** exam (text, notes, assignments, etc. are allowed).
Answer **all questions (5 in part I and 3 in part II)**.
State all **assumptions** and justify, where possible. **Reference** all data used.

Part I Short Answer (Answer on the exam paper)

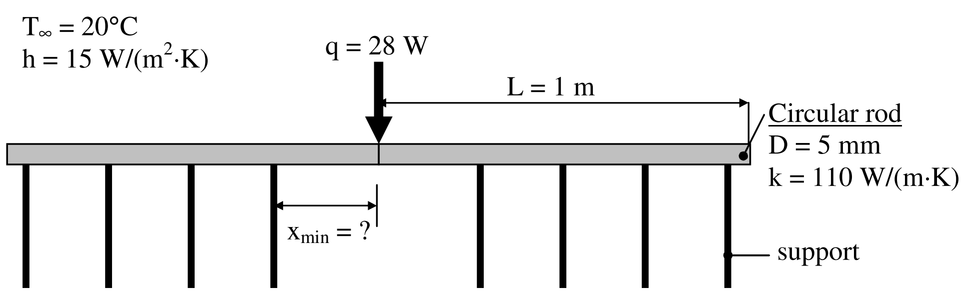
	Marks
1. For the plane wall shown below with fixed values of surface area (A), ambient temperature (T_∞), interior surface temperature ($T_{s,i}$) and convective heat transfer coefficient (h), list 2 ways that the heat transfer through the wall can be reduced? 	(2)
2. For a thin hollow cylinder, shown below, with fixed value of r_1, L, k, h, T_∞ and $T_{s,i}$, but a variable r_2, how can the heat transfer through the cylinder be reduced? 	(2)
3. What is the appropriate governing equation for 2-D, transient heat transfer with internal heat generation in Cartesian coordinates? If the equation is solved with constant surface temperature boundary conditions, list 4 variables or properties that the temperature in the medium depend on [T = f (? , ? , ? , ?)].	(2)
4. Sketch the temperature profiles in both the laminar and turbulent regions (locations labeled T_s) of the thermal boundary layer for the flat plate shown below. 	(2)
5. Sketch the velocity and temperature profiles at the same position in the laminar boundary layer for flow over a flat plate when the fluid is: **(a)** mercury (a liquid metal) and **(b)** engine oil.	(2)
TOTAL	**10**

Part II Calculations (Answer in the booklet) Marks

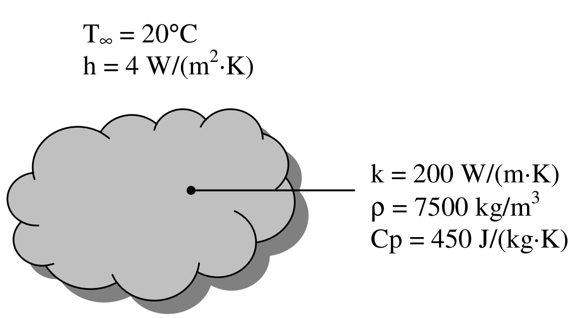
1. A piece of paraffin wax that is 2.4 cm thick and has a surface area of 0.5 m^2 separates two air streams as shown below. Determine **(a)** the rate of heat transfer between the air streams and **(b)** the uncertainty in the heat transfer rate if the uncertainty in the thickness is ±10%. (10)



2. A heat rate of 28 W is added to weld two identical rods ($k = 110$ W/(m·K)) that are supported on both sides of the weld as shown below. The rods are 5 mm in diameter and 1 m long. The convective heat transfer coefficient between the rod and the ambient air is 15 W/(m^2·K) and the ambient air temperature is 20°C. It is necessary to support the rod near the welding tip, but the temperature of the position where the rod is supported must not exceed 200°C. Assuming steady state conditions (i.e., the welding process takes a long time), determine the minimum distance between the welding tip and the support closest to the weld. Assume negligible conduction heat transfer into the supports. (10)



3. A body with a volume of 0.1 m^3 and a surface area of 0.5 m^2 is cooled in ambient air with a temperature of 20°C and a convective heat transfer coefficient of 4 W/(m^2·K). If the initial temperature of the body is 450°C, determine **(a)** how long does it take to cool the surface of the body to a temperature of 350°C and **(b)** how much energy has been transferred from the body at this time? (10)



TOTAL **30**