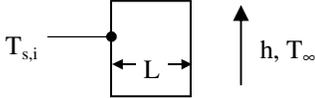
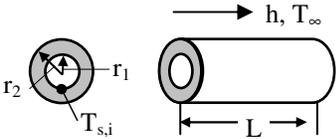
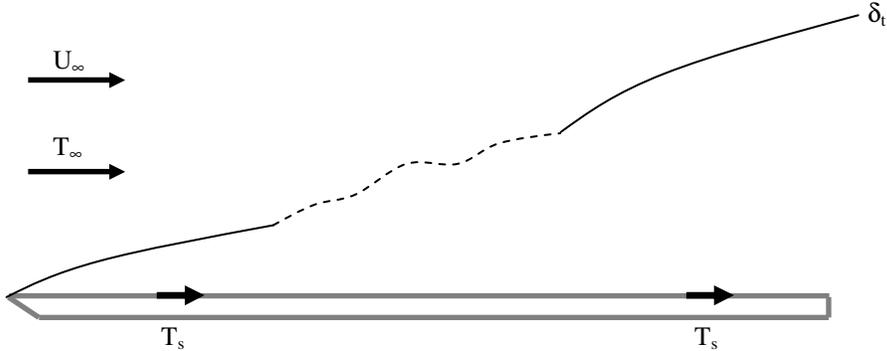


ME 327 Midterm Exam
October 28, 2005 (Time: 2 hours)

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.

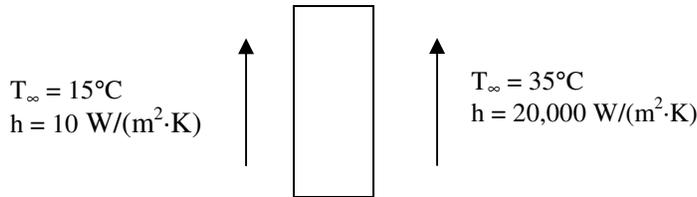
Part I Short Answer (Answer on the exam paper)

Marks

<p>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?</p> 	(2)
<p>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?</p> 	(2)
<p>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 [$T = f(?, ?, ?, ?)$].</p>	(2)
<p>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.</p> 	(2)
<p>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:</p> <p>(a) mercury (a liquid metal) and</p> <p>(b) engine oil.</p>	(2)
TOTAL	
10	

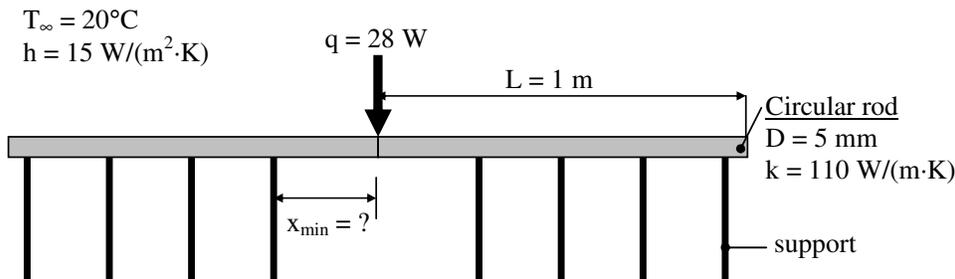
1. A piece of paraffin wax that is 2.4 cm thick and has a surface area of 0.5 m² separates two air streams as shown below. Determine (a) the rate of heat transfer between the air streams and (b) the uncertainty in the heat transfer rate if the uncertainty in the thickness is ±10%.

(10)



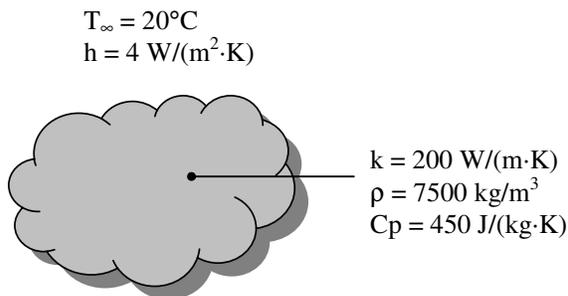
2. A heat rate of 28 W is added to weld two identical rods ($k = 110 \text{ W}/(\text{m}\cdot\text{K})$) that are supported on both sides of the weld as shown below. The rods are 5 mm in diameter and 1 m long. The convective heat transfer coefficient between the rod and the ambient air is $15 \text{ W}/(\text{m}^2\cdot\text{K})$ 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 m³ and a surface area of 0.5 m² is cooled in ambient air with a temperature of 20°C and a convective heat transfer coefficient of $4 \text{ W}/(\text{m}^2\cdot\text{K})$. 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