Faculty of Engineering
Department of Mechanical Engineering
Fall 2015
MEN310 - Heat Transfer

Instructors: Dr. Charbel Habchi

Exam #1 - 10%
75 minutes (November 5, 2015 – 19:30-20:45)

Student Name: ______________________________ **Student ID:** ________________ **Section:** ____

There are **3 questions** in the booklet each has several parts, please answer all parts of these questions to the best of your ability.

Marking Scheme

Questions	Weight	Mark
Question 1	**30 points**	
Question 2	**30 points**	
Question 3	**40 points**	
Total	**100 points**	

1. **Open book examination. Only original books are allowed.**
2. **Do not take the staple out. The exam booklet must remain intact.**
3. **Cheating penalty will be an "F" grade on the exam.**
4. **Mobile phones/devices are to be turned off and stowed away.**
5. **If something is not understood write your assumptions and solve the problem without asking questions.**

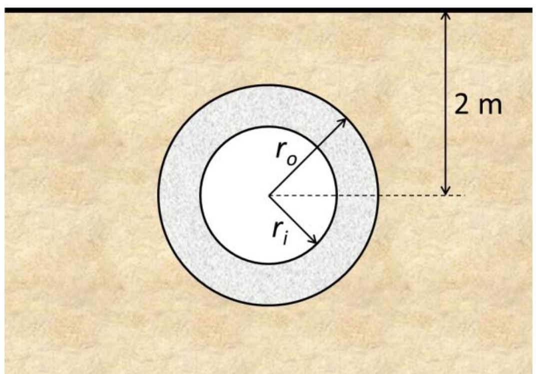
Good luck

QUESTION 1: Steady-State Conduction

A horizontal copper pipe carrying steam at $T_\infty = 200^oC$ with a heat transfer coefficient $h = 10^4\ W/m^2.K$ is buried in earth at a depth of 2 m. The earth is assumed a semi-infinite medium with a thermal conductivity of 1 W/m.K and its surface temperature is 10^{o}C. The pipe, having a thickness of 1 cm, has a length of 10 m and an inner radius of 50 cm. Assume isothermal pipe. The copper thermal conductivity is $k = 350\ W/m^2.k$.

a) **Sketch the thermal resistance network showing the key features.**

b) **Calculate the rate of heat loss from the steam in MW.**

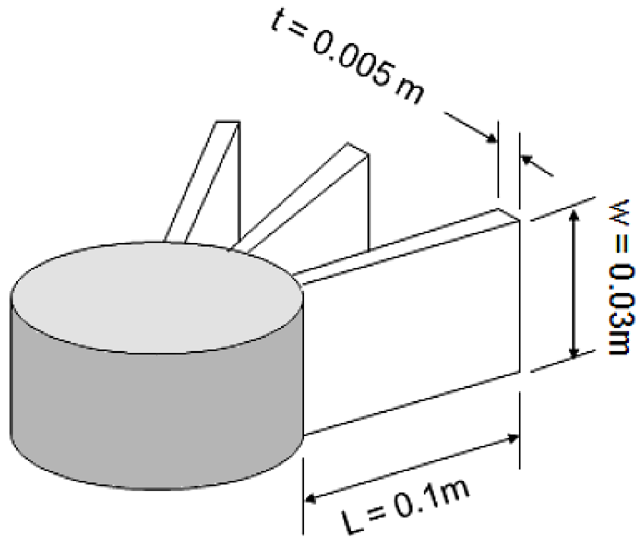


QUESTION 2: Fins Calculation

The figure below shows part of a set of radial aluminum fins (k = 200 W/m.K) that are to be fitted to a small air compressor. The device dissipates 2 kW by convection to the surrounding air which is at 20^oC. Each fin is 100 mm long, 30 mm high and 5 mm thick. The tip of each fin may be assumed to be adiabatic and a heat transfer coefficient of h = 10 W/m^2.K acts over the remaining surfaces.

a) **Calculate the heat loss through the fins if the base temperature is 150^oC.**

b) **Estimate the number of fins required to ensure the base temperature does not exceed 150^oC.**



QUESTION 3: Energy Balance and Numerical Methods in Heat Conduction

A right isosceles triangular wedge of width 1 m (into the paper) is partially submerged in water as shown in the figure below. The bottom surface BCFE and the two sides ABC and DEF of the wedge are assumed adiabatic. The conductivity of the wedge is 100 W/m.K. The upper part of the wedge exchanges heat by convection with ambient air at $T_{\infty,a} = 10^oC$ with $h_a = 10\ W/m^2.K$. The lower part exchanges heat by convection with water at $T_{\infty,w} = 5^oC$ with $h_w = 100\ W/m^2.K$. The wedge is subject to a volumetric heat generation at $\dot{q} = 100\ W/m^3$.

Assume steady-state conduction. There is no interaction between air and water.

a) Calculate the temperature of the wedge surface assuming uniform temperature distribution.

b) Assuming non-uniform temperature distribution, calculate the temperature on nodes 1, 2 and 3.

c) Comment the difference in results between part a) and b).