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

Instructors: Dr. Charbel Habchi - Dr. Samer Maaraoui

Exam #1 - 10%
70 minutes (March 31, 2016 – 19:00-20:10)

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	**25 points**	
Question 2	**25 points**	
Question 3	**50 points**	
Total	**100 points**	

1. **Open book/notes 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.**

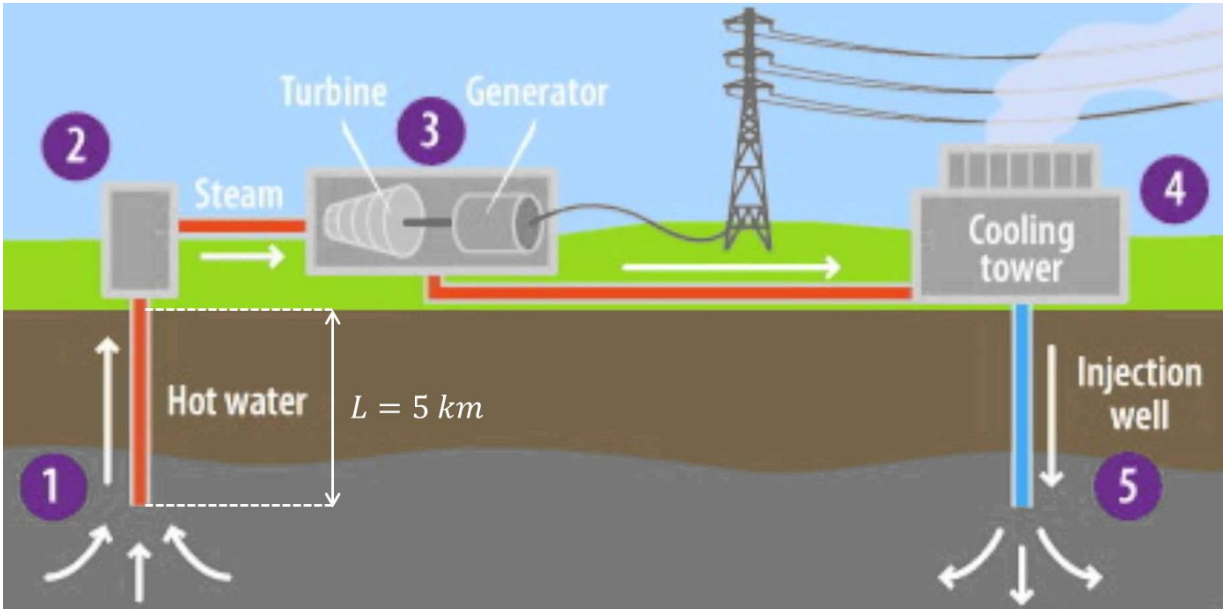
Good luck

QUESTION 1: Geothermal Pipes

In geothermal applications, vertical pipes are used to carry steam to a power plant as shown in the figure below. The pipe wall has a thermal conductivity of 0.4 W/m.K and an outer diameter of 20 cm. The pipe length from the inlet to the earth surface is 5 km. It is assumed that the pipe has a uniform inner wall temperature equal to 150°C. The earth has a thermal conductivity of 1 W/m.K and its surface temperature is 20°C. The geothermal pipe loses heat to the earth at a rate of 370 kW.

a) **Sketch the thermal resistance network labeling all resistances and nodes.**

b) **Calculate the inner diameter of the hot geothermal pipe.**

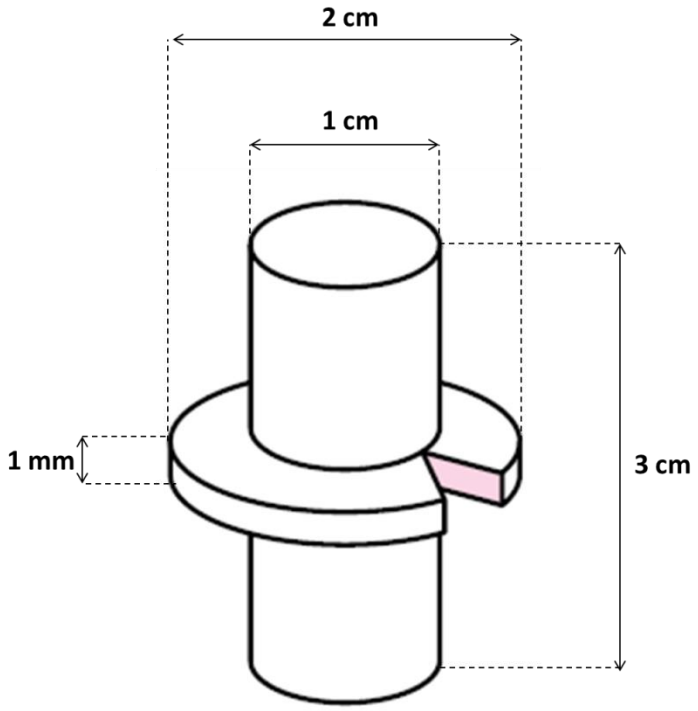


QUESTION 2: Fins Calculation

Heat is generated in a metallic rod of diameter 1 cm and length of 3 cm at rate of 0.2 MW/m^3. The rod thermal conductivity is 1 W/m.K and the temperature at its centerline is 71.25°C. The bottom and top surfaces of the rod are assumed adiabatic. A circumferential fin of rectangular profile is attached to the rod and it has a thermal conductivity of 100 W/m.K. The fin has a thickness of 1 mm and an outer diameter of 2 cm. The tip of the fin may be assumed adiabatic and a heat transfer coefficient of h = 10 $W/m^2.K$ acts over the remaining surfaces. The rod and fin are surrounded by air at 20°C.

a) **Sketch the temperature distribution in the metallic rod and the fin.**

b) **Calculate the rate of heat loss through the fin.**



QUESTION 3: Numerical Methods in Heat Conduction

The metallic object (with $k = 1\ \mathrm{W/m.K}$) shown in the figure below is subjected to convective cooling with ambient air at $T_\infty = 20°\mathrm{C}$ with $h = 100\ \mathrm{W/m^2.K}$. Only one side is adiabatic as shown in the figure. The depth into the plane of the paper is equal to 1 m. A uniform heat generation takes place in the triangular part of the object at the upper right corner at rate of $\dot{q} = 0.1\ \mathrm{MW/m^3}$.

Assume steady-state conduction with $\Delta x = \Delta y = 1$ cm.

a) Write the nodal equations for nodes 1, 2 and 3 using numerical data from the figure.

b) Solve the temperature in nodes 1, 2 and 3 using Gauss-Seidel iterations method.

c) Assume now that the object has a uniform unknown temperature T_s. Calculate this temperature and comment the difference in the results with respect to those obtained in part b).