

Name: _____.

Mini-Exam IV

CM 3110

4 December 2007

Note:

You may need your text.

Significant figures count.

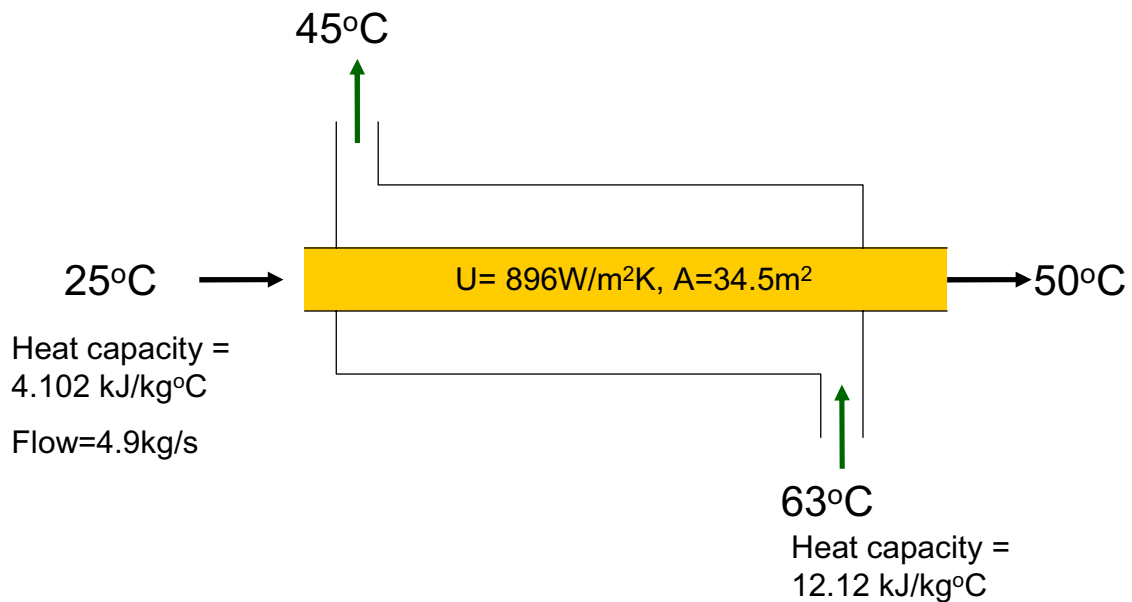
Please box your final answers.

Please be neat.

1. (50 points) Water flows steadily over a flat plate that is 2.00 m long and 1.00 m wide. The average velocity of the water is 0.021 m/s. The bulk temperature of the water is 45°C. The surface temperature of the plate is 30.6°C. What is the heat flux from the water to the plate at steady state? The properties of water are: heat capacity = 4.102 kJ/kg °C; density = 994.7 kg/m³; thermal conductivity = 0.6283 W/mK; the plate is made of steel with the following properties: thermal conductivity = 55.0 W/mK, density = 7800 kg/m³, heat capacity = 420J/kg °C. Please give your answer in units of W/m².

2. (50 points) For the double-pipe heat exchanger shown below and for the conditions given in the figure, the total rate of heat transfer is 502 kW. In a new experiment, the fluid on the outside of the heat exchanger is replaced with a new fluid, Fluid1351, with heat capacity 13.51 kJ/kg °C; the new operating conditions are such that the flow rate and temperatures of the inner fluid are unchanged. If the inlet temperature of Fluid1351 is kept the same at 63°C, answer the following question:

Question: Is the flow rate of the Fluid1351 the same as the flow rate of the original fluid? Is the outlet temperature for the Fluid1351 the same as when the original fluid was used? Please explain clearly your reasoning, showing equations as appropriate.



3. (Bonus! 10 points) A large reactor in the shape of a cube is submerged in stagnant fluid as shown below. The fluid layer is one meter wide. The steady-state temperature profile in the fluid is measured and is plotted below. What is the heat flux from the reactor in the x -direction? Please give your answer in W/m^2 . The fluid may be assumed to be completely stationary and the physical properties of the fluid are as follows: thermal conductivity = 5.012 W/mK , density = 1.082 g/cm^3 , heat capacity = $4.201 \text{ J/kg } ^\circ\text{C}$.

Fluid surrounds the large, cube-shaped reactor, forming a stagnant bath through which heat travels

