



Lebanese American University  
School of Engineering and Architecture  
Department of Mechanical Engineering

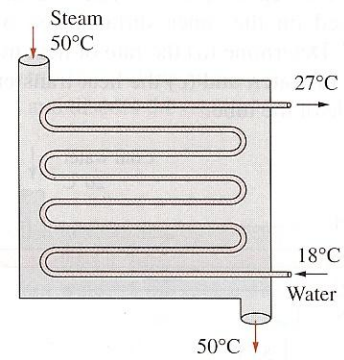
**MEE 512 Thermofluids**  
**Midterm I, Duration 2 hrs**  
Dec. 2, 2009

**Name:**

**ID:**

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1) (25 pts.) Steam in the condenser of a steam power plant is to be condensed at a temperature of  $50^{\circ}\text{C}$  ( $h_{fg}=2383 \text{ kJ/Kg}$ ) with cooling water ( $C_p=4180\text{J/kg}\cdot^{\circ}\text{C}$ ) from a nearby lake, which enters the tubes of the condenser at  $18^{\circ}\text{C}$  and leaves at  $27^{\circ}\text{C}$ . The surface area of the tubes is  $42\text{m}^2$ , and the overall heat transfer coefficient is  $2400\text{W/m}^2\cdot^{\circ}\text{C}$ . Determine the mass flow rate of the cooling water needed and the rate of condensation of the steam in the condenser.



2) (25 pts.) A shell-and-tube heat exchanger with 2-shell passes and 12-tube passes is used to heat water ( $C_p=4180\text{J/kg}\cdot^\circ\text{C}$ ) in the tubes from  $20^\circ\text{C}$  to  $70^\circ\text{C}$  at a rate of  $4.5\text{kg/s}$ . Heat is supplied by hot oil ( $C_p=2300\text{J/kg}\cdot^\circ\text{C}$ ) that enters the shell side at  $170^\circ\text{C}$  at a rate of  $10\text{kg/s}$ . For a tube-side overall heat transfer coefficient of  $350\text{W/m}^2\cdot^\circ\text{C}$ , determine the heat transfer surface area on the tube side.

3) (25 pts.) A fluid flows in smooth pipe with a Reynolds number of 6000. By what percent would the head loss be reduced if the flow could be maintained as laminar flow rather than the expected turbulent flow?

4) (25 pts.) Water flows downward thru a vertical 10-mm-diameter galvanized iron pipe with an average velocity of 5.0 m/s and exits as a free jet. There is a small hole in the pipe 4 m above the outlet. Will water leak out of the pipe thru this hole, or will air enter into the pipe thru the hole? Repeat the problem if the average velocity is 5.0 m/s.

