ชื่อ.....รหัส.....

มหาวิทยาลัยสงขลานครินทร์
คณะวิศวกรรมศาสตร์

การสอบปลายภาค ประจำภาคการศึกษาที่ 1 ประจำปีการศึกษา 2550

วันที่ : 31 กรกฎาคม 2550 เวลา : 9:00 – 12:00

วิชา : Heat Transfer (230-313) ห้องสอบ : A401

- อนุญาตให้นำหนังสือและเอกสารอื่นๆ เข้าห้องสอบได้
- อนุญาตให้นำเครื่องคิดเลขทุกรุ่นเข้าห้องสอบได้
- ข้อสอบมีทั้งหมด 9 ข้อ (13 หน้า) ให้ทำทุกข้อ
- กระดาษไม่พอให้ทำต่อด้านหลัง
- ใช้ดินสอทำข้อสอบได้

ทุจริตในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

หน้าที่	ข้อที่	คะแนนเต็ม	คะแนนที่ได้	หน้าที่	ข้อที่	คะแนนเต็ม	คะแนนที่ได้
2	1	15		8	6	10	
3	2	5		9	7	20	
4	3	5		11	8	10	
5	4	10		12	9	25	
6	5	15					
คะแนนรวม						115	

อ. ผกามาศ เจษฎ์พัฒนานนท์

20 กรกฎาคม 2550

1. A student living in a 4-m × 6-m × 6-m dormitory room turns his 150-W fan on before he leaves his room on a summer day hoping that the room will be cooler when he comes back in the evening. Assuming all the doors and windows are tightly closed and disregarding any heat transfer through the walls and the windows, determine the temperature in the room when he comes back 10 hours later. Use specific heat values at the average temperature and assume the room to be at 100 kPa and 15°C in the morning when he leaves. (15 points)

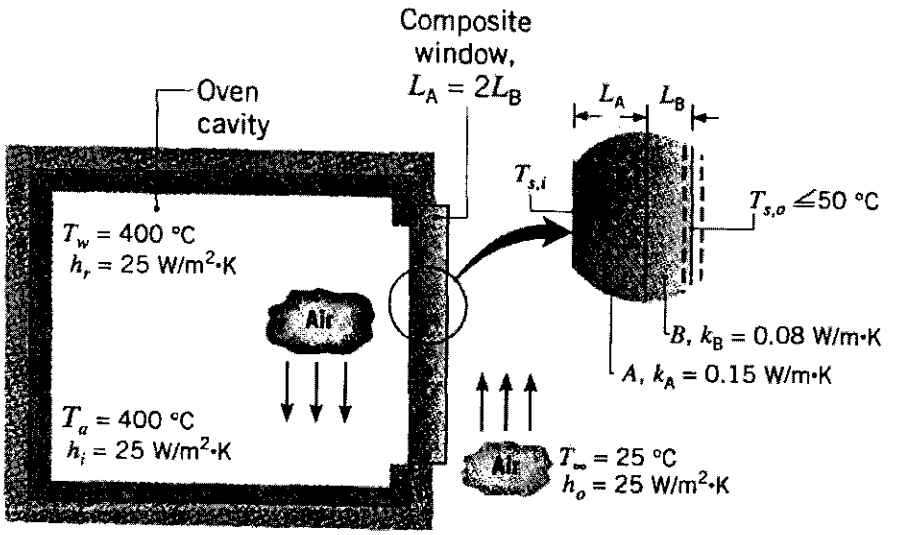
2. A flask filled with hot coffee is in a room whose air and walls are at a fixed temperature. Identify all heat transfer mechanisms that contribute to cooling of the coffee. Comment the methods to improve design of flask to reduce heat transfer processes. (5 points)

3. An uninsulated steam pipe is in a room in which the air and wall are at 25°C. The outside diameter of the pipe is 70 mm, and its surface temperature and emissivity are 200°C and 0.8, respectively. If the coefficient associated with free convection heat transfer from the surface to the air is 15 $W/m^2.K$, what is the rate of heat loss from the surface per unit length of pipe? (5 points)

4. Six identical power transistors with aluminum casing are attached on one side of a 1.2-cm-thick 20-cm × 30-cm copper plate (k = 386 W/m.°C) by screws that exert an average pressure of 10 MPa. The base area of each transistor is 9 cm^2, and each transistor is placed at the center of a 10-cm × 10-cm section of the plate. The interface roughness is estimated to be about 1.4 μm. All transistors are covered by a thick Plexiglas layer, which is a poor conductor of heat, and thus all the heat generated at the junction of the transistor must be dissipated to the ambient at 23°C through the back surface of the copper plate. The combined convection/radiation heat transfer coefficient at the back surface can be taken to be 30 $W/m^2.°C$. If the case temperature of the transistor is not to exceed 75°C, determine the maximum power each transistor can dissipate safely. If we eliminate the thermal contact resistance at the interface completely, how much we can lower the operating temperature of the transistor?

(10 points)

5. A leading manufacturer of household appliances is proposing a self-cleaning oven design that involves use of a composite window separating the oven cavity from the room air. The composite is to consist of two high-temperature plastics (A and B) of thicknesses $L_A = 2L_B$ and thermal conductivities $k_A = 0.15$ W/m.K and $k_B = 0.08$ W/m.K. During the self-cleaning process, the oven wall and air temperature, T_w and T_a are 400 °C, while the room air temperature T_∞ is 25 °C. The inside convection and radiation heat transfer coefficients h_i and h_r, as well as the outside convection coefficient h_o, are each approximately 25 W/m^2.K. What is the minimum window thickness, $L = L_A + L_B$, needed to ensure a temperature that is 50 °C or less at the outer surface of the window? This temperature must not be exceeded for safety reasons. (15 points)

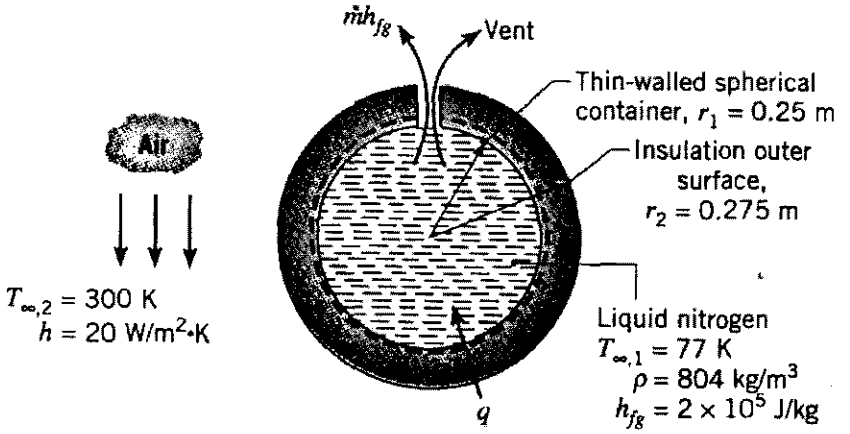


6. A spherical, thin-walled metallic container is used to store liquid nitrogen at 77 K. The container has a diameter of 0.5 m and is covered with an evacuated, reflective insulation composed of silica powder. The insulation is 25 mm thick, and its outer surface is exposed to ambient air at 300 K. The convection coefficient is known to be 20 $W/m^2.K$. The talent heat of vaporization and the density of liquid nitrogen are 2×10^5 J/kg and 804 kg/m^3, respectively.

6.1 What is the rate of heat transfer to the liquid nitrogen?

6.2 What is the rate of liquid boil-off? (Answer in liters/day)

Note Value of k is in Table A-6



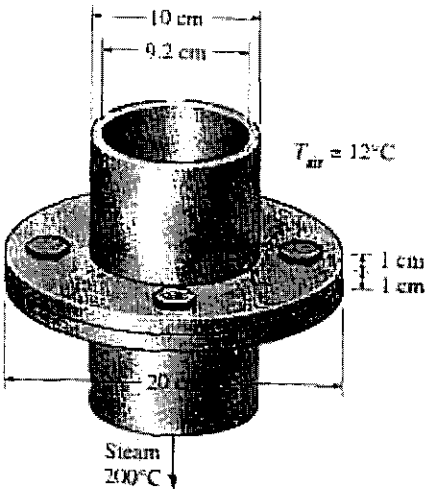
(10 points)

7. Two 3-m-long and 0.4-cm-thick cast iron (k = 52 W/m.°C) steam pipes of outer diameter 10 cm are connected to each other through two 1-cm thick flanges of outer diameter 20 cm. The steam flows inside the pipe at an average temperature of 200°C with a heat transfer coefficient of 180 W/m^2.°C. The outer surface of the pipe is exposed to an ambient at 12 °C, with a heat transfer coefficient of 25 W/m^2.°C.

7.1 Disregarding the flanges, determine the average outer surface temperature of the pipe.

7.2 Using this temperature for the base of the flange and treating the flanges as the fins, determine the fin efficiency and the rate of heat transfer from the flanges.

7.3 What length of pipe is the flange section equivalent to for heat transfer purpose?



(20 points)

8. During a picnic on a hot summer day, all the cold drinks disappeared quickly, and the only available drinks were those at the ambient temperature of 30°C. In an effort to cool a 350 mL drink in a can, which is 13 cm high and has a diameter of 6.5 cm, a person grabs the can and starts shaking it in the iced water of the chest at 0°C. The temperature of the drink can be assumed to be uniform at all times, and the heat transfer coefficient between the iced water and the aluminum can is 170 $W/m^2.°C$. Using the properties of water for the drink, estimate how long it will take for the canned drink to cool to 4°C. (10 points)

9. Oil flow in a journal bearing can be treated as parallel flow between two large isothermal plates with one plate moving at a constant velocity of 12 m/s and the other stationary. Consider such a flow with a uniform spacing of 0.7 mm between the plates. The temperature of the upper and lower plates are 40°C and 15°C, respectively. By simplifying and solving the continuity, momentum and energy equations, determine (a) the velocity and temperature distributions in the oil, (b) the maximum temperature and where it occurs, and (c) the heat flux from the oil to each plate. (25 points)