所別：機械工程學系碩士班 丙組 科目：熱力學(含熱傳)

1. (15 %) A 0.5-m^3 rigid tank containing argon at 300 K and 600 kPa is connected by a valve to another 1.0-m^3 rigid tank that contains argon at 350 K and 100 kPa. Now the valve is opened and the system is allowed to reach thermal equilibrium with the surroundings at 290 K. Determine the final pressure in the tank.

2. (15 %) Consider a large classroom on a hot summer day with 100 students, each dissipating 60 W of sensible heat. All the lights, with 5.0 kW of rated power, are kept on. The heat gain through walls and roof is negligible. Chilled air is available at 288 K, and the return air is not to exceed 298 K. Determine the required flow rate of air, in kg/s, that needs to be supplied to the room to keep the average temperature of the room constant. (c_p = 1.005 kJ/kg-K)

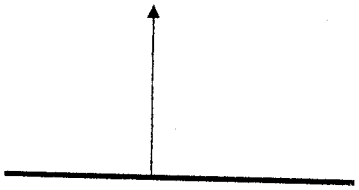
3. Answer the following questions.
   (a) What are the spark-ignition and compression-ignition engines? (5 %)
   (b) Compare the thermal efficiency and compression ratio of the air-standard Otto and Diesel cycles. (7 %)
   (c) Discuss the ways that can be used to improve the thermal efficiency of a gas turbine. (6 %)

4. Octane is burned with 50 % excess air. Determine the air-fuel ratio. (10 %)

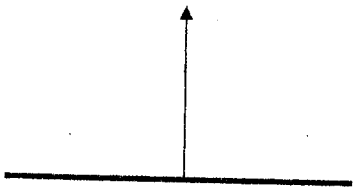
5. Please compare the definition and physical significance of the Biot number and Nusselt number. (6 %)

6. Consider a plane wall of thickness L, which is to set as shield of a burner. The inner surface (x = 0) receives radiation that is partially absorbed within the shield and has the effect of an internally distributed heat source. In particular, heat is generated per unit volume within the shield according in $\dot{q}(x) = q_o'' a e^{-ax}$, where q_o'' is the incident radiation flux and a is the absorption coefficient of the shield material.
   (a) If the inner (x = 0) and outer (x = L) surfaces of the shield are maintained at temperature of T_1 and T_2, respectively. Find the form of the temperature distribution in the shield. (5%)
   (b) Derive an expression that could be used to determine the x location in the shield at which the temperature is a maximum. (5%)

7. Plot and explain the directional (θ) distribution of a diffuse emitter and a real surface emitter. (6%)



diffuse emitter



real surface emitter

參考用

8. Please plot the axial variation of tube wall temperature (T_s) and fluid mean temperature (T_m) from the entrance of the tube to fully developed condition at (a) constant wall temperature and (b) constant heat flux conditions. (10 %)

9. While applying the Dittus-Boelter equation, $Nu_D = 0.023\, Re_D^{0.8}\, Pr^n$, n = 0.3 for cooling and 0.4 for heating. Please make a brief explanation for this condition. (10%)