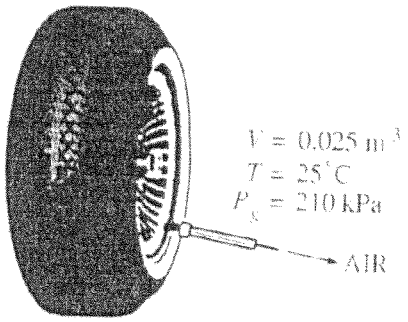
國 立 清 華 大 學 命 題 紙

98 學年度 動力機械 系（所） 甲 組碩士班入學考試

科目 熱流學(一) 科目代碼 1002 共 2 頁第 1 頁 *請在【答案卷卡】內作答

1. (12%) The pressure in an automobile tire depends on the temperature of the air in the tire. When the air temperature is 25°C, the pressure gage reads 210 kPa. If the volume of the tire is 0.025m^3, determine the pressure rise in the tire when the air temperature in the tire rises to 50°C. Also, determine the amount of air that must be bled off to restore pressure to its original value at this temperature. Assume the atmospheric pressure to be 100 kPa. (R = 0.287kPa•m^3/kg•K)



2. (18%) An ideal Otto cycle has a compression ratio of 9.2 and uses air as the working fluid. At the beginning of the compression process, air is at 98 kPa and 27°C. The pressure is doubled during the constant-volume heat-addition process. Using constant specific heats at room temperature, show the cycle on P-v diagram and determine the following:
   (a) the amount of heat transferred to the air,
   (b) the net work output,
   (c) the thermal efficiency, and
   (d) the mean effective pressure (MEP) for the cycle.
   (C_p =1.005 kJ/kg•K, C_v =0.718 kJ/kg•K, and k = 1.4)

3. (20%) A unit mass of ideal gas is reversibly compressed in a cylinder so that the ratio of the heat transferred to the work done, dQ/dW, is constant during the compression. Assuming that the specific heats C_p and C_v of the gas are constant and that the internal energy and the enthalpy of the gas are functions of temperature alone, find a simple temperature explicitly, but which does include the initial pressure and volume P_1, V_1. Comment on the specific cases dQ/dW =0 and dQ/dW =1.

4. (15%) A mass m of water at T_1 is isobarically and adiabatically mixed with an equal mass of water at T_2. Show that the entropy change of the process is

$$2mC_p \ln \frac{(T_1+T_2)/2}{\sqrt{T_1T_2}}$$

Also discuss on the irreversibility of this process according to the above relation.

5. (20%) Consider the incompressible, laminar, two-dimensional flow motion between two large parallel plates with a uniform inlet flow. The distance between the plates is H.
   (a) Draw the cross-sectional profile of x-component velocity $u(y)$ at three representative longitudinal locations.
   (b) Divide the whole flow field into different regions according to the sign (+, 0, -) of their vorticity. Also write and explain the sign of each region.
   (c) Draw the pressure variation in the longitudinal direction x, along with your three longitudinal locations in part (a) marked. Also physically explain for its trend.

6. (15%) Consider the fully-developed region in the flow field in Question 5. First write out the complete two-dimensional incompressible Navier-Stokes equations. Then, derive the simplified momentum equation as well as the boundary conditions ready for analytical solution. There is no need for actual solution, but you need to explain why the simplifications could be made.