國立成功大學

112學年度碩士班招生考試試題

編　號：66

系　所：機械工程學系

科　目：熱力學

日　期：0206

節　次：第 2 節

備　註：可使用計算機

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1. What different mechanisms can cause the entropy of a control volume to change? (10%)

2. A cylinder/piston consists of an ideal gas with mass m and constant specific heats, C_p and C_v. Its specific heat ratio is k and gas constant is R. If kinetic and potential energy changes are negligible, show that for a reversible adiabatic process (15%)

   (a) $$C_p = \frac{kR}{k-1}$$

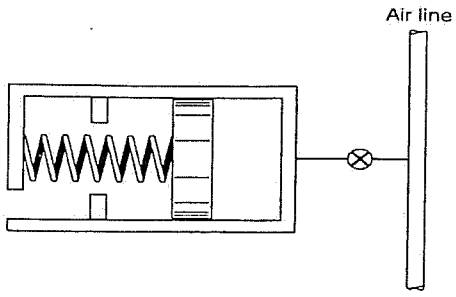
   (b) $$W = \frac{mR(T_2 - T_1)}{1-k}$$

3. A frictionless piston/cylinder is loaded with a linear spring, spring constant 100 kN/m, and the piston cross-sectional area is 0.1 m^2. The cylinder initial volume of 20 L contains air at 200 kPa. The ambient temperature is 10 °C. The cylinder has a set of stops that prevents its volume from exceeding 50 L. A valve connects to a line flowing air at 800 kPa, 50 °C, as shown in the following figure. The valve is now opened, allowing air to flow in until the cylinder pressure reaches 800 kPa, at which point the temperature inside the cylinder is 80 °C. The valve is then closed and the process ends. Assume air is an ideal gas, with constant specific heat, C_p = 1.004 kJ/kg-K, C_v = 0.717 kJ/kg-K, and R = 0.287 kJ/kg-K. (25%)

   (a) What is the pressure while the piston first hit the stops (P_{stop})?

   (b) Taking the inside of the cylinder as a control volume, calculate the work and heat transfer during the process.

   (c) Verify that this process can take place in accordance with the principle of the increase of entropy.



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4. (15%) Derive expressions for (a) (5%) internal energy change, Δu, (b) (5%) enthalpy change, Δh, and (c) (5%) entropy change, Δs, for a gas whose equation of state is $P(v-a)=RT$ for an isothermal process. P, v, R, T are pressure, specific volume, gas constant, and temperature, respectively, while a is a constant.

5. (35%) A turbojet aircraft is flying with a velocity of 280 m/s at an attitude of 9150 m, where the ambient conditions are 32 kPa and -32 °C. The compressor pressure ratio is 12 and the temperature at the turbine inlet is 1100 K. Air enters the compressor at a rate of 50 kg/s, and the jet fuel has a heating value of 42,700 kJ/kg. Efficiencies of the compressor and turbine are 80% and 85%, respectively. Assuming ideal operation for all other components and constant specific heats of for air at room temperature (c_p = 1.005 kJ/kgK, and k = 1.4). (a) (7%) Plot the cycle on a T-s chart, and determine (b) (8%) the velocity of the exhaust gases, (c) (8%) the propulsive power developed, and (d) (7%) the rate of fuel consumption. (e) (5%) Evaluate the thermal efficiency of the cycle