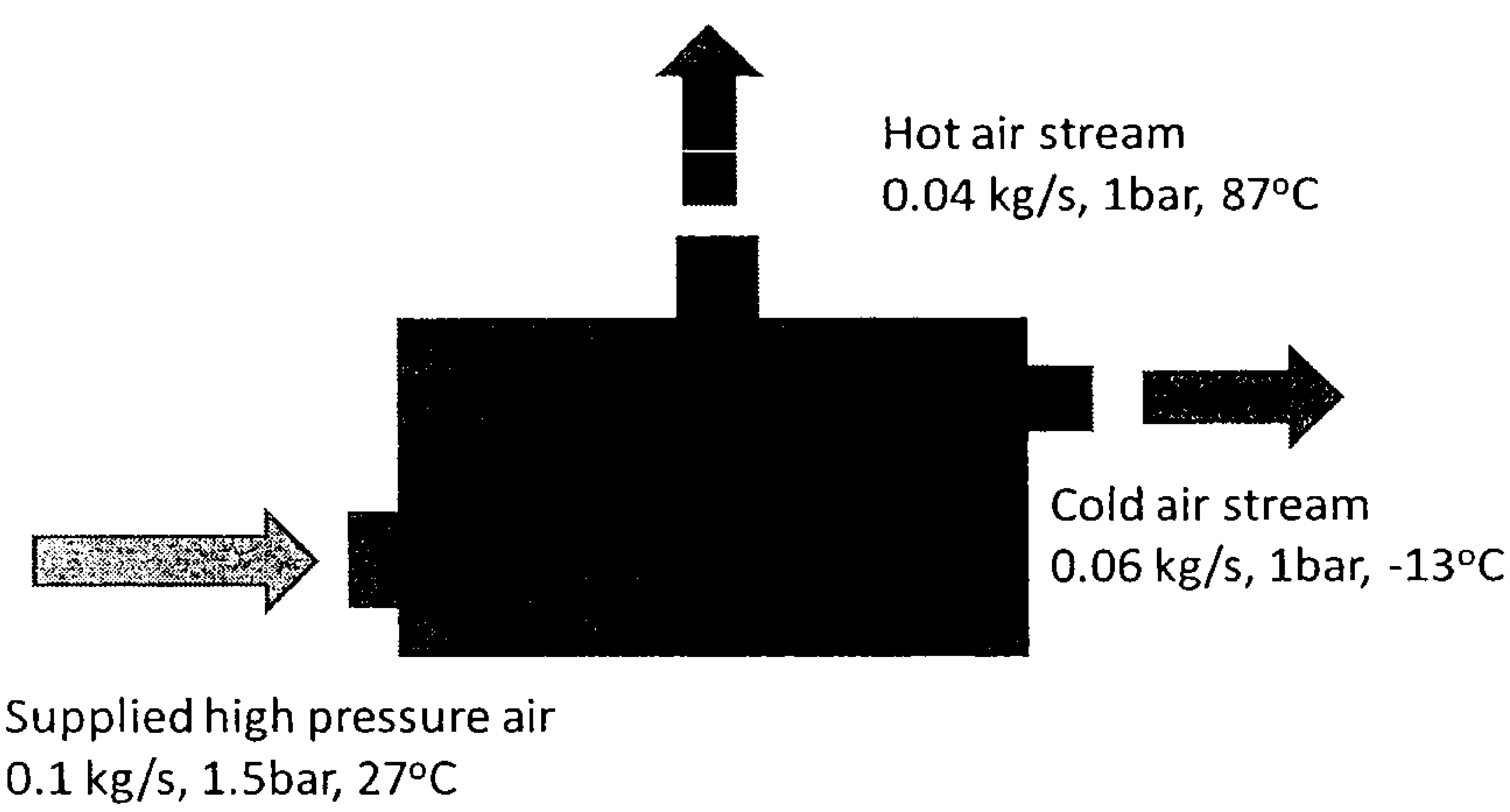
國立清華大學 100 學年度碩士班入學考試試題

系所班組別：動力機械工程學系甲組(熱流組)

考試科目（代碼）：熱流學(一)(1002)

 *請在【答案卷、卡】作答

1. A case has been filed to the Intellectual property office in Taiwan for patent application. The inventor claims that he has a device which can generate separated hot and cold air streams from only high pressure air supplied, i.e., no work or heat transfer needed. With a 0.1kg/s and 1.5 bar air pressure supplied at 27°C, the device can generate a 0.04kg/s hot air steam at the pressure of 1 bar and temperature of 87°C and a 0.06kg/s cold air stream at pressure of 1 bar and temperature of -13°C. (a) Use the conservation of energy and entropy production to examine this invention. **(10%)** (b) Determine if the device is possible and explain the reason. **(5%)** Neglect the change in the kinetic and potential energies. (k=1.4,R=0.287kJ/(kg.K), Cp=1.003 kJ/(kg.K), Cv=0.717 kJ/(kg.K))



2. 0.03kg of air undergoes a thermodynamic cycle inside an air engine (piston-cylinder arrangement) consisting of three processes: Process 1-2: constant pressure expansion, Process 2-3: adiabatic expansion, and Process 3-1: isothermal compression. The engine is operated at the pressure between 100kPa and 600kPa with maximum volume of 0.02m^3. (a) Sketch the cycle on a p-V diagram. **(5%)** (b) Derive the equations for calculating the work at each process **(5%)** (c) Calculate the work output from the cycle. **(5%)** (k=1.4, R=0.287kJ/(kg.K), Cp=1.003 kJ/(kg.K), Cv=0.717 kJ/(kg.K))

3. Consider a 20-m-diameter hot-air balloon that, together with its cage, has a mass of 80 kg when empty. This balloon is hanging still in the air at a location where the atmospheric pressure and temperature are 90 kPa and 15°C, respectively, while carrying three 65-kg people. Determine the average temperature of the air in the balloon. What would your response be if the atmospheric air temperature were 30°C? (R= 0.287kPa.m^3/kg.K) **(15%)**

4. An air-standard cycle with constant coefficients is executed in a closed system and is composed of the following four processes:
   1-2 v = *constant:* heat addition from 100 kPa and 27°C to 300 kPa
   2-3 P = *constant:* heat addition to 1027°C
   3-4 Isentropic expansion to 100 kPa
   4-1 P = *constant:* heat rejection to initial state
   (a) Show the cycle on P-v and T-s diagrams.
   (b) Calculate the net work output per unit mass.
   (c) Determine the thermal efficiency.
   (C_p =1.003 kJ/kg.K, C_v =0.717 kJ/kg.K, k =1.4) **(20%)**

5. What are a Rankine cycle and a reversed Rankine cycle (corresponding to vapor-compression refrigeration cycle)? Please show their T-s diagrams and the corresponding hardware loops. **(8%)** What are a Brayton cycle and a reversed Brayton cycle? Please show their T-s diagrams and the corresponding hardware loops. **(8%)** Please define the COP of both reversed cycles and explain why the COP of a reversed Rankine refrigeration cycle is always greater than the one of a reversed Brayton refrigeration cycle? **(4%)**

6. (a) What is the mathematical definition of the viscosity of a fluid element? **(2%)**
   (b) What are the definitions of Newtonian fluids and non-Newtonian fluids? **(2%)**
   (c) How to measure the viscosity of compressible gases? **(3%)**
   (d) Please explain the trend between the viscosity versus temperature and viscosity versus pressure for fluids and gases. Why? **(4%)**
   (e) What is the mathematical definition of compressibility of a fluid element? **(2%)**
   (f) What is the continuity equation of an incompressible flow? **(2%)**