國立成功大學

114學年度碩士班招生考試試題

編　號：115

系　所：生物醫學工程學系

科　目：熱力學

日　期：0210

節　次：第 1 節

注　意：1.可使用計算機
2.請於答案卷(卡)作答，於試題上作答，不予計分。

1. Please describe the followings
   (1) The difference between Carnot efficiency and isentropic efficiency. (6%)
   (2) 1st law, 2nd law and 3rd law of thermodynamics using ONLY mathematical statement, no points will be given if the mathematical statement is not shown. (6%)
   (3) Based on Clausius inequality, please derive the entropy change of an irreversible process from two fixed states (ΔS_{irr}), considering ideal gas in a closed system. (8%)

2. Air at 300 kPa and 700 K enters an adiabatic nozzle with negligible initial velocity and exits at a pressure of 100 kPa. The isentropic efficiency of the nozzle is 90%. Determine the following:
   (1) The maximum possible exit velocity. (4%)
   (2) The exit temperature. (4%)
   (3) The actual exit velocity of the air. (7%)
   Assume air has constant specific heats with Cp=1.1 kJ/kg•K, and k=1.35.

3. Explain the First and Second Laws of Thermodynamics using the concepts of heat engines, heat pumps, and refrigerators. Additionally, derive and express the thermal efficiency and the coefficient of performance (COP) for heat engines, heat pumps, refrigerators, the Carnot cycle, and the reversed Carnot cycle. (15%)

4. A piston-cylinder device initially holds air at a pressure of 200 kPa and a temperature of 350 K, with an initial volume of 1 m^3. The air undergoes compression following a process where PV^n remains constant, reaching a final pressure of 400 kPa. The surrounding temperature is 27 °C. Determine whether this process is reversible, irreversible, or impossible. (15%)

5. Heat transfer takes place between two thermal reservoirs at temperatures of 500 K and 1500 K. By considering the two reservoirs and the heat transfer region as one closed system, calculate the following:
   (1) The rate of entropy generation (in kJ/(K·min)) for the system. (10%)
   (2) The rate of entropy change (in kJ/(K·min)) for the entire system, given that the heat transfer rate between the reservoirs is 800 kJ/min. (10%)

6. A cylinder fitted with a piston has an initial volume of 0.8 m^3 and contains nitrogen at 300 kPa 27°C. The piston is moved, compressing the nitrogen until the pressure is 1 MPa and the temperature is 200°C. During this compression process heat is transferred from the nitrogen, and the work done on the nitrogen is 80 kJ. Determine the amount of heat transfer. (15%)