

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. A piston-cylinder assembly fitted with an electrical resistor of negligible mass hold 1.6 kg of air initially at 0.3 MPa, 25°C. Over a period of 8 minutes, electricity is provided to the resistor at a rate of 0.4 kW. During this period, a heat transfer of 15 kJ occurs from the air to its surroundings until the volume is doubled. Assume the surroundings are at 1 atm. Determine (a) the final temperature of the air, (b) the final pressure of the air, (c) the work done by the system.  $c_p = 1.005 \text{ kJ/kg} \cdot \text{K}$   
(25%)

2. Air at 600kPa, 950 K enter a turbine operating at steady state and exits at 150 kPa, 650 K. Heat transfer from the turbine occurs at an average outer surface temperature of 35°C at the rate of 45 kJ per kg of air. For air with  $c_p = 1.4 \text{ kJ/kg} \cdot \text{K}$ , determine  
(a) the rate power is developed in kJ per kg of air.  
(b) the rate of entropy production within the turbine.  
(c) the rate of entropy production if the turbine is well insulated.  
(25%)

3. A heat pump is to be used to heat a house during the winter. The house is to be maintained at 27 °C at all times. The house is estimated to be losing heat at a rate of 40 kW when the outside temperature is at -3 °C. Determine

(1) The minimum power required to drive the heat pump unit, in kW. (10%)

(2) The heat rate of 40 kW could be supplied from an electric heater or a furnace. Make a comparison in exergy destruction among heat pump, electric heater and furnace. (15%)

4. Answer the following questions:

(1) In a system which undergoes a *reversible* process, the work done is 5 kJ and the heat *rejected* is 7 kJ. The change in entropy is (a) Positive (b) Negative (c) Zero (d) Can't tell? Please explain why. (9%)

(2) In a system which undergoes an *irreversible* process, the work done is 5 kJ and the heat *rejected* is 7 kJ. The change in entropy is (a) Positive (b) Negative (c) Zero (d) Can't tell? Please explain why. (8%)

(3) In a system which undergoes an *irreversible* process, the work done is 5 kJ and the heat *added* is 7 kJ. The change in entropy is (a) Positive (b) Negative (c) Zero (d) Can't tell? Please explain why. (8%)