Cover Type B

University of Technology, Sydney

TO BE RETURNED AT THE END OF THE EXAMINATION.
THIS PAPER MUST NOT BE REMOVED FROM THE EXAM CENTRE.

SURNAME: ______________________

FIRST NAME: ______________________

STUDENT NUMBER: ______________________

COURSE: ______________________

AUTUMN SEMESTER 2011

SUBJECT NAME : Thermodynamics

SUBJECT NO. : 48651

DAY/DATE : Wednesday 29 June 2011

TIME ALLOWED : __3__ Hours plus __10__ Min. reading time

START/END TIME : 9:30/12:40

NOTES/INSTRUCTIONS TO CANDIDATES:

All questions are to be attempted.

All questions are of equal value.

This is a RESTRICTED Open Book examination.

Calculators, text book and one A4 sheet of notes without worked examples may be used.

Rough work can be done on the three blank pages at the end of each answer booklet.

Thermodynamics (48651) final examination
Faculty of Engineering, UTS

Total mark: 50
Autumn 2011

Question 1

As shown in Fig. Q1, a heat engine receives heat from a source at 1200 K at a rate of 500 kJ/s and rejects the waste heat to a low temperature body at 300 K. The power output of the heat engine is 180 kW.

Determine

1) the rate of the heat wasted (or rejected) by the heat engine;
2) the thermal efficiency of this heat engine; and
3) the thermal efficiency if this engine operates on a Carnot cycle;
4) Is the given engine power cycle possible or not? Why?

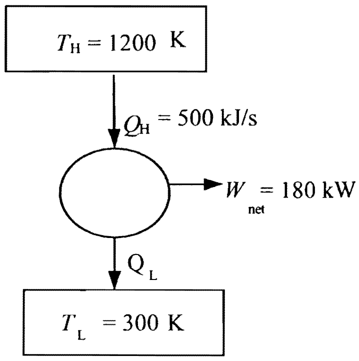

Fig. Q1

Question 2

As shown in Fig. Q2, a nozzle receives air at 1100 K, 150 kPa with negligible kinetic energy. The exit pressure is 102.4 kPa and the process is reversible and adiabatic.

Find the exit velocity

1) using constant specific heat c_p = 1.005 kJ/kg-K, R = 0.287 kJ/kg-K; and
2) using Table A7.1 in the textbook.

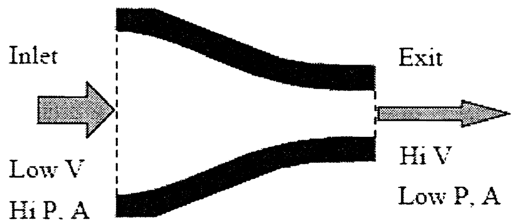

Fig. Q2

Question 3

As shown in Fig. Q3, an initially evacuated canister of 0.002 m^3 is connected through a valve to an R-134a supply line. The supplied R-134a is saturated liquid at 0 °C. The valve is opened, and the canister is filled with the supplied R134a until the pressure in the canister is equal to that in the supply line. As this filling is done very quickly, the process can be assumed to be adiabatic.

1) Show two independent properties and calculate the quality at the final state;
2) Find the final mass of R-134a in the canister (Hint: if it is very close to saturated liquid, the final state may be approximated by saturated liquid); and
3) Determine the net change of entropy.

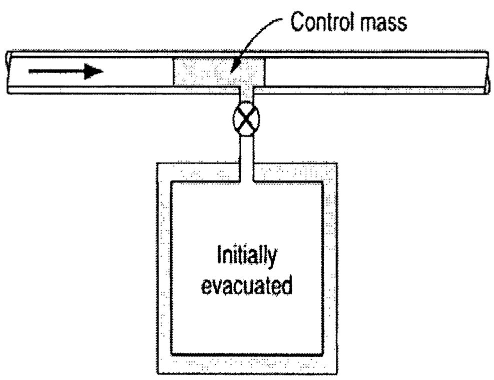

Fig. Q3

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Question 4

As shown in Fig. Q4, a gas turbine plant operates on the Brayton cycle between the pressure limits of 100 kPa and 800 kPa. Air enters the compressor at 30 °C at a mass flow rate of 200 kg/s. The maximum cycle temperature is 1400 K. Assuming constant properties for air with c_p = 1.005 kJ/kg-K, R = 0.287 kJ/kg-K and k = 1.4.

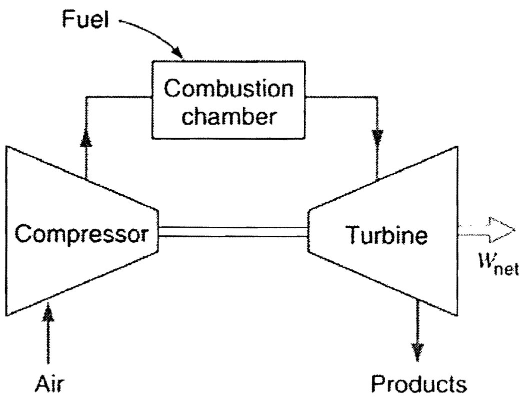

Fig. Q4

1) Show the power cycle on a *T-s* diagram.
2) Calculate the thermal efficiency of this power cycle; and
3) If the temperature at the exit of the turbine is 600 °C, calculate the isentropic efficiency of the turbine by assuming adiabatic expansion.

Question 5

A steam power plant operating on a Rankine cycle has a condenser temperature of 45 °C, a maximum pressure of 5.0 MPa, and boiler exit temperature of 900 °C.

1) Determine the thermal efficiency of the cycle.

2) If an open feedwater heater is added to the Rankine cycle with an extraction pressure of 1.0 MPa, as shown in Fig. Q5.2, find the fraction of extraction steam flow and recalculate the thermal efficiency. The pump work may be ignored.

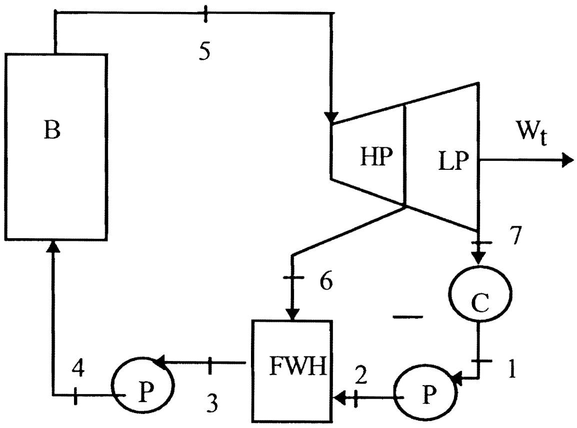

Fig. Q 5.2

Given the enthalpy of the steam extracted from the turbine for the feedwater heater, h_6 = 3640.6 kJ/kg.

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