ME 227.3 Thermodynamics I
Department of Mechanical Engineering
University of Saskatchewan
Final Examination
2:00pm December 17, 2005

Name: _____

Student Number: _____

Signature: _____

Please read these instructions carefully.

- Time: 3 hours
- Total marks: 100
- Calculators allowed.
- Closed book exam.
- Formula sheet supplied.
- This exam contains SIX questions.
- No Walkmans, Discmans, IPODs or similar devices allowed.
- No PDAs or laptops allowed.
- No cell phones allowed.
- Please place photo ID on the corner of the table during the exam.

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(10) 1. Define the following terms.

(a) Unrestrained expansion

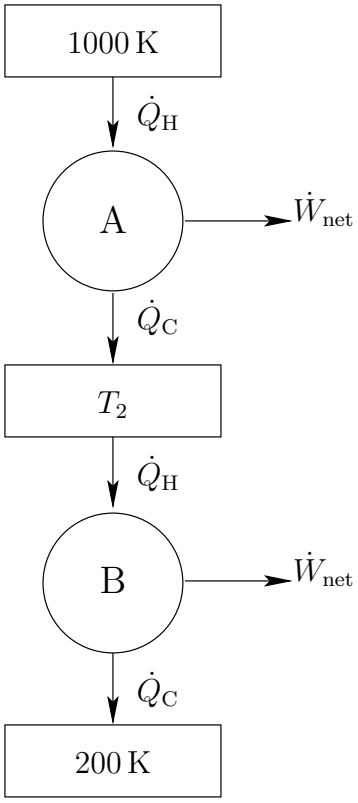
(b) Total energy

(c) Heat engine

(d) Flow work

(e) Closed system

(10) 2. Two Carnot heat engines (A and B) receive heat at the same rate and produce the same power. Determine T_2.



(20) 3. A piston-cylinder device contains 0.6 kg of air and undergoes a cycle consisting of the following three reversible processes starting from 100 kPa and 300 K.

(a) constant temperature process

(b) constant pressure process

(c) adiabatic process

The net work done during the cycle is 20 kJ and the air may be treated as an ideal gas with $R = 0.287\,\text{kJ/(kg} \cdot \text{K)}$ and constant $k = 1.4$. Sketch the cycle on a P-v diagram and determine the maximum pressure.

(20) 4. A boiler receives saturated liquid water at 0.25 kg/s and 40 bar and converts it to a saturated vapour which then passes through a nozzle with an isentropic efficiency of 95%. The nozzle exit pressure is 1 bar. Determine the heat transfer rate to the boiler, the nozzle exit velocity, and the rate of entropy production for the entire system.

(20) 5. A vapour-compression refrigeration system uses R134a as its working fluid and operates between 0.6 bar and 6 bar. The coefficient of performance is 3.03 and the isentropic efficiency of the compressor is 90%. If the compressor inlet temperature is -20^oC and the compressor requires 5.5 kW of power, what is the temperature on each side of the throttling valve and the mass flow rate of the refrigerant?

(20) 6. An ideal Rankine cycle operates with a single reheater at 500 kPa. The steam generator pressure is 60 bar and the condenser pressure is 10 kPa. The exit of the condenser is a saturated liquid and the inlet to the reheater is a saturated vapour. Heat is added in the reheater at a rate of 20 MW and the mass flow rate delivered by the steam generator is 50 kg/s. Calculate the cycle efficiency.