Concordia
UNIVERSITY

FACULTY OF ENGINEERING AND COMPUTER SCIENCE
DEPARTMENT OF BUILDING, CIVIL AND ENVIRONMENTAL ENGINEERING

COURSE		NUMBER	SECTION
Thermodynamics I		**ENGR 251**	**CV**
EXAMINATION	DATE	TIME & PLACE Room:	# OF PAGES
Final	**August 22, 2006**	**19:00 – 22:00**	**3**
PROFESSOR		LAB INSTRUCTOR	
Radu Zmeureanu			
MATERIALS ALLOWED: NO CALCULATORS ALLOWED: YES (only non-programmable)		This is a closed-book written examination	

SPECIAL INSTRUCTIONS:
Answer all questions.
Return the question book, tables and answer book.
Only non-programmable calculators are allowed.

Name: _____ I.D.: _____
Surname, given names

Question # 1

(a) A condenser (heat exchanger) brings 1 kg/s water flow at 10 kPa from 300°C to saturated liquid at 10 kPa. The cooling is done by lake water at 20°C that returns to the lake as saturated liquid at 30°C. Consider an insulated condenser. Find the flow rate of cooling water from the lake. **(15 marks)**

(b) An inventor claims that a new engine has the efficiency of 75% while operating between 1700°C and 20°C. Is the inventor right in his claim? Explain. **(5 marks)**

Question # 2 (20 marks)

(a) One kilogram of nitrogen at 1 MPa and 200°C is expanded in an insulated reversible turbine to 200 kPa. Consider a polytropic process with k=1.4, M=28 kg/kmol and $R_{universal}$ =8.314 kJ/(kmol K). Calculate the work produced, the heat transfer and the entropy change. Draw the P-v and T-s diagrams.

(b) One kilogram of nitrogen at 1 MPa and 200°C is expanded in a cylinder-piston device at constant temperature to 200 kPa. Calculate the work produced, the heat transferred and the entropy change. Draw the P-v and T-s diagrams.

Question # 3 (30 marks)

A heat pumps operates on the vapor compression refrigeration cycle. The following information are given:

Working fluid	Refrigerant R-134a
Condenser pressure	0.8 MPa
Temperature of refrigerant leaving the condenser	30°C
Evaporator pressure	0.22 MPa
Quality of refrigerant leaving the evaporator	1.0
Isentropic efficiency of compressor	0.7
Heating capacity	30 kW

(a) Draw the schematic diagram of the heat pump. Indicate the name of each component and the heat flows and work.
(b) Draw the *T-s* diagrams for this cycle
(c) Determine and tabulate the pressure, temperature and enthalpy at each key point of the cycle.
(d) Determine and tabulate the heat flow or work for each process.
(e) Calculate the Coefficient of Performance of this cycle, and compare with the CARNOT efficiency corresponding to this cycle?

Question # 4 (30 marks)

The operation of an engine is modeled by the Otto cycle. The following information are given:

Pressure at the start of compression	101 kPa
Temperature at the start of compression	20°C
Maximum temperature	1200°C
Compression ratio	8 to 1

Use the following data for air:

R = 0.287 kJ/kg.K;
c_v = 0.7165 kJ/kg.K;
c_p = 1.008 kJ/kg.K
k = 1.4.

(a) Draw the P-v and T-s diagrams for the cycle
(b) Determine and tabulate the pressure, temperature and specific volume at each key point.
(c) Determine and tabulate the heat transfer and work for each process
(d) Determine the net work output of the engine
(e) Determine the thermal efficiency and the corresponding CARNOT efficiency