Prince of Songkla University
Faculty of Engineering

Midterm Examination **Semester 2/2550**

25 December 2007 **Time 13:30-16:30**

216-231 Engineering Thermodynamics I **Room: Robot**

Directions

- Books and note are not allowed.
- All types of calculator and dictionary are permitted.
- Attempt all 5 questions.

Juntakan Taweekun
Instructor

Problem	Marks	
1	15	
2	20	
3	15	
4	20	
5	15	
Total	85	

Name _____

ID _____

Name-Surname ..... ID .....

Question 1 (15 points)

A spherical balloon with a diameter of 6 m is filled with helium at 20 °C and 200 kPa. Determine the mass of the helium in the balloon.

Name-Surname ..... ID .....

Question 2 (20 points)

Consider a person standing in a room at 20 °C. For a heat transfer purposes, a standing man can be modeled as a 30-cm diameter, 170-cm long vertical cylinder with both the top and bottom surfaces insulated and with the side surface at an average temperature of 34 °C. The convection heat transfer coefficient is 15 $W/m^2.°C$, Stefan Boltzmann constant (σ) = 5.67×10^{-8} $W/m^2.K^4$ and emissivity of human skin is 0.95.

2.1 Determine the rate of heat loss from this man by convection in the room.
2.2 Determine the total rate of heat transfer from this person.

Name-Surname ..... ID .....

Question 3 (15 points)

An aluminum pan which thermal conductivity is 237 W/m.°C has a flat bottom whose diameter is 20 cm and thickness 0.4 cm. Heat is transferred steadily to boiling water in the pan through its bottom at a rate of 500 W. If the inner surface of the bottom of the pan is 105 °C, determine the temperature of the outer surface of the bottom of the pan.

Name-Surname ..... ID ....

Question 4 (20 points)

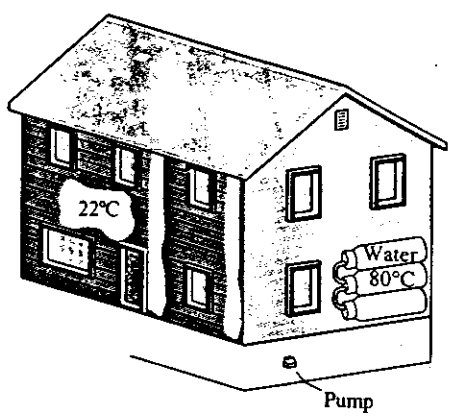
A passive solar house that is losing heat to the outdoors at an average rate of 50,000 kJ/hr is maintained at 22°C at all times during a winter night for 10 hrs. The house is to be heated by 50 glass containers, each containing 20 Litres of water that is heated to 80 °C during the day by absorbing solar energy. A thermostat controlled 15-kW back-up electric resistance heater turns on whenever necessary to keep the house at 22 °C.

where $C_{p,water} = 4.18$ kJ/kg.°C

$\rho_{water} = 1{,}000$ kg/m^3

4.1 How long did the electric heater run that night if the house was integrated with solar heating?

4.2 How long would the electric heater run that night if the house incorporated no solar heating?



Name-Surname ..... ID .....

Question 5 (15 points)

A heat engine is operating on a Carnot cycle and has a thermal efficiency of 55 pe cent. The waste heat from this engine is rejected to a nearby lake at 16 °C at a rate of 844 k /min. Determine

5.1 The power output of the engine (W_{out}) in unit of kW.

5.2 The temperature of the source.

Ideal-gas specific heats of various common gases

Gas	Formula	Gas constant, R kJ/kg · K	C_p kJ/kg · K	C_v kJ/kg · K	k
Air	—	0.2870	1.005	0.718	1.400
Argon	Ar	0.2081	0.5203	0.3122	1.667
Butane	C_4H_{10}	0.1433	1.7164	1.5734	1.091
Carbon dioxide	CO_2	0.1889	0.846	0.657	1.289
Carbon monoxide	CO	0.2968	1.040	0.744	1.400
Ethane	C_2H_6	0.2765	1.7662	1.4897	1.186
Ethylene	C_2H_4	0.2964	1.5482	1.2518	1.237
Helium	He	2.0769	5.1926	3.1156	1.667
Hydrogen	H_2	4.1240	14.307	10.183	1.405
Methane	CH_4	0.5182	2.2537	1.7354	1.299
Neon	Ne	0.4119	1.0299	0.6179	1.667
Nitrogen	N_2	0.2968	1.039	0.743	1.400
Octane	C_8H_{18}	0.0729	1.7113	1.6385	1.044
Oxygen	O_2	0.2598	0.918	0.658	1.395
Propane	C_3H_8	0.1885	1.6794	1.4909	1.126
Steam	H_2O	0.4615	1.8723	1.4108	1.327

Note: The unit kJ/kg · K is equivalent to kJ/kg · °C.

Source: Gordon J. Van Wylen and Richard E. Sonntag, *Fundamentals of Classical Thermodynamics*, English/SI Version, 3rd ed. (New York: John Wiley & Sons, 1986), p. 687, Table A.8SI.