Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Science and Technology
200 Level 2nd Semester Examination – Dec / Jan. 2017/2018
SCT242-2 Engineering Thermodynamics

Uva Wellassa University

Instructions to candidates:
Duration: Two (02) hours
Number of questions: Four (04)
Answer all questions
Some useful equations are shown in page 4
Mark allocation: 100

1.)

a. Define the extensive and intensive properties. ***(2.5 marks)***

b. What is a polytropic process? ***(2.5 marks)***

c. Determine the work done by the air which enters an evacuated vessel from the atmosphere when the valve is opened. The atmospheric pressure is 1.013 bar and 1.5 m^3 of air at atmospheric condition enters to the vessel.

(10 marks)

d. A piston and a cylinder machine containing a fluid system has a stirring device as shown in in figure 1. The piston is frictionless, and it held down against the fluid due to atmospheric pressure of 101.3 kPa. The stirring device is turned 9500 revolutions with an average torque against the fluid of 1.25 N.m. Meanwhile the piston of 0.65m diameter moves out 0.6m. Find the net work transfer for the system.

(10 marks)

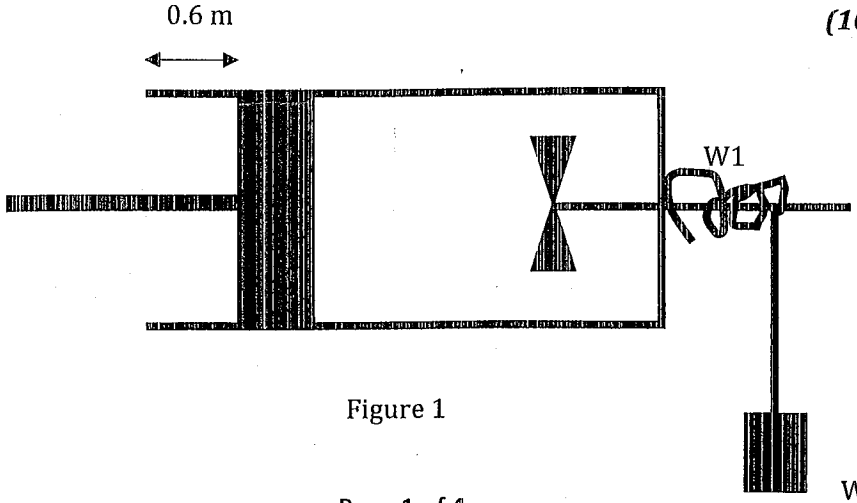

Figure 1

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2.)

a. State the first law of thermodynamics. ***(5 marks)***

b. Air is contained in a vertical piston cylinder assembly by a piston of mass 50 kg and having a free area of $0.01m^2$. The mass of the air is 5g and initially the air occupies a volume of 5l. The atmosphere exerts a pressure of 100kPa on the top of the piston. The volume of the air slowly decreases $0.002m^2$ as the specific internal energy of the air decreases by 260 kJ/kg. Neglecting friction between the piston and cylinder wall determine the heat transfer to the air in kJ.

(10 marks)

c. A 0.2 m thick plane wall is constructed of concrete. At a steady state, the energy transfer rate by conduction through a $1m^2$ area of the wall is 0.15kW. If the temperature distribution is linear through the wall what is the temperature difference across the wall? (k=1.75W/m.K)

(10 marks)

3.)

a. State the Clausius statement. ***(2.5 marks)***

b. State the Kelvin-Plank statement. ***(2.5 marks)***

c. A refrigeration cycle operating as shown in figure 2, has heat transfer Q_{out} = 2530kJ and net-work of W_{cycle} = 844kJ. Determine the coefficient of performance of the system.

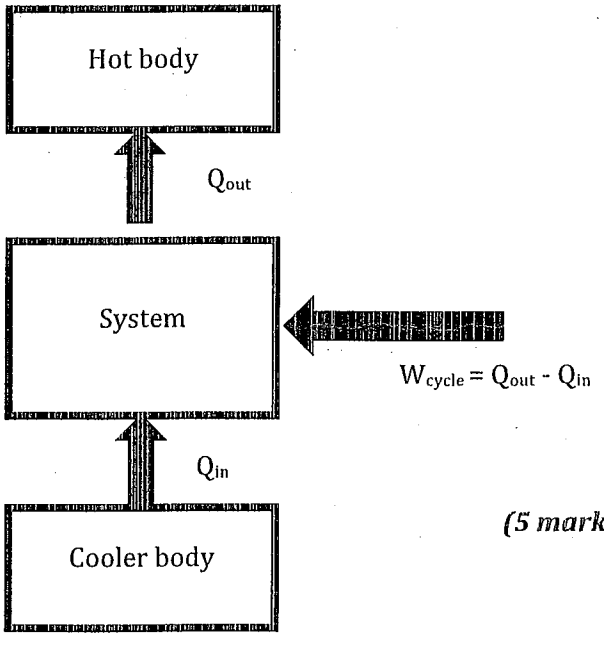

Figure 2

(5 marks)

d. The refrigerator shown in figure 3 operates at a steady state with a coefficient of performance (CoP) of 4.5 and power input of 0.8kW. Energy is rejected from the refrigerator to the surroundings at 20°C by heat transfer from metal coils whose average surface temperature is 28°C. Determine,

i. The rate of energy rejected in kW. ***(5 marks)***

ii. The lowest theoretical temperature inside the refrigerator in K.

(5 marks)

iii. The maximum theoretical power in kW, that could be developed by a power cycle operates between the coil and the surrounding. Would you recommend making use of this opportunity for developing power?

(5 marks)

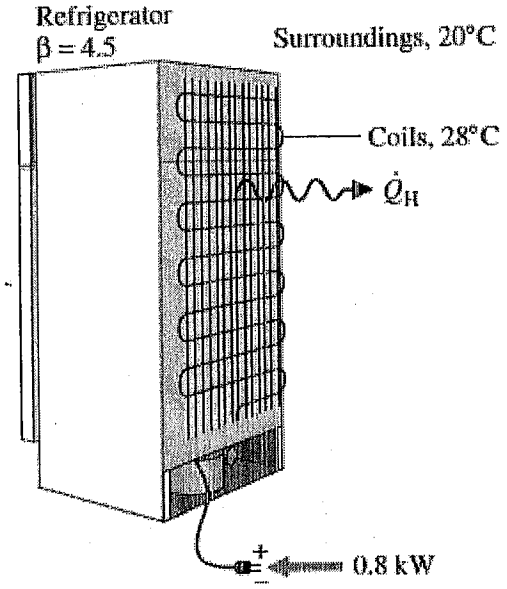

Figure 3

4.)

a. State the methods of increasing the thermal efficiency of a Rankine cycle.

(10 marks)

b. A Rankine cycle operates between pressures of 80 bar and 0.1 bar. The maximum cycle temperature is 600°C. If the steam turbine and condensate pump efficiencies are 0.9 and 0.8 respectively, calculate the

specific work and thermal efficiency. Relevant steam table extract is given below.

p(bar)	t(°C)	Specific volume (m^3/kg)		Specific enthalpy (kJ/kg)			Specific entropy ($kJ/kg\ K$)		
		v_f	v_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
0.1	45.84	0.0010103	14.68	191.9	2392.3	2584.2	0.6488	7.5006	8.1494
80	295.1	0.001385	0.0235	1317	1440.5	2757.5	3.2073	2.5351	5.7424

80 bar, 600°C	v	$0.486\ m^3/kg$
Superheat	h	$3642\ kJ/kg$
table	s	$7.0206\ kJ/kgK$

(15 marks)

Useful Equations

1.) $CoP = \frac{\text{useful heat supplied or removed by the considered system.}}{\text{the work required by the considered system}}$