BITS, PILANI – DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
I Year First Semester 2010-2011
Course: ES C112 Thermodynamics
Comprehensive Examination [Closed Book]

Max.Marks:80 Date: 28.12-2010
Weightage: 40 % COMMON TO ALL BRANCHES Time: 3 hours

Note: (i) Answer all Questions in a sequence (ii) Assume suitable value if required (iii) Thermodynamics tables are provided (iv) Answer Every Question on a fresh page (v) Answer the questions of part A in BLUE COLOUR , part B in GREEN COLOUR and part C in RED COLOUR .

PART -A

1. A pipe flowing light oil has a manometer attached as shown in Fig. 1. What is the absolute pressure in the pipe flow? (Density of water is 1000kg/m^3 while that of oil is 910 kg/m^3) **(6)**

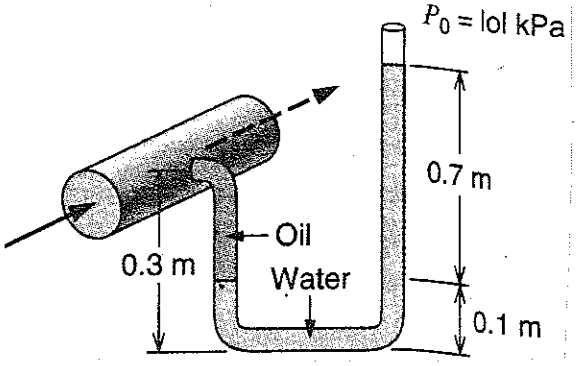

Fig. 1

2. A piston/cylinder arrangement contains air at 250kPa and 300 ° C. The 50-kg piston has a diameter of 0.1 m and initially pushes against the stops (Fig 2). The atmosphere is at 100 kPa and 20°C. The cylinder now cools as heat is transferred to the ambient surroundings. (a)At what temperature does the piston begin to move down? (b)How far has the piston dropped when the temperature reaches ambient? **(10)**

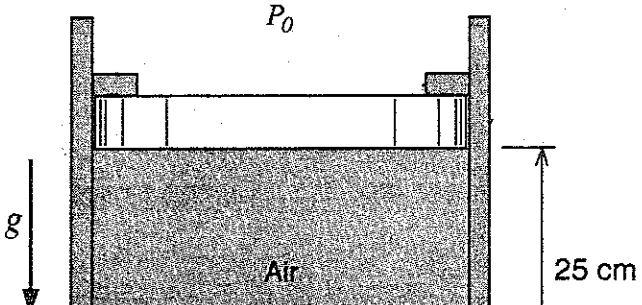

Fig. 2

3. A vertical cylinder has a 61.18 kg piston locked with a pin, trapping 10 L of R-22 at 10°C with 90% quality inside. Atmospheric pressure is 100 kPa, and the cylinder cross-sectional area is 0.006 m^2. The pin is removed, allowing the piston to move and come to rest with a final temperature of 10° C for the R-22. Find the final pressure, final volume, and work done by the R-22. **(10)**

PART –B

4. (i)What is a steady state process? Mention any two assumptions of a steady state process . **(4)**

   (ii) A piston cylinder device contains 5 kg of R-134a at 800 kPa and 70 ° C.The refrigerant is now cooled at constant pressure until it exists as a liquid at 15 °C. Determine the amount of heat loss and show the process in a T-v diagram **(6)**

5. Two tanks A and B are separated by a partition. Initially Tank A contains 2 kg steam at 1MPa and 300 ° C while tank B contains 3 kg saturated liquid – vapour mixture at 150 ° C with a vapour mass of 50%.Partition is removed and the system is allowed to attain equilibrium. If the final pressure is 300 kPa, determine (i) the final temperature (ii) the amount of heat lost from the tanks. **(10)**

6. Helium is to be compressed from 120 kPa and 310 K to 700 kPa and 430 K.A heat loss of 20 kJ/kg occurs during the compression process. Determine the power input required for a mass flow rate of 5400kg/hr. **(6)**

PART –C

7. Calculate the amount of work input a refrigerator needs to make ice cubes out of a tray of 0.25 kg liquid water at 10 ° C. Assume the refrigerator works in a Carnot cycle between –8 ° C and 35 ° C with a motor-compressor of 750 W. How much time does it take if this is the only cooling load using Tables B.1.1 & B.1.5? **(10)**

8. A piston-cylinder has constant pressure of 2000 kPa with water at 20 ° C. It is now heated up to 100 ° C. Find the heat transfer and the entropy change using the steam table B.1.4. Repeat the calculation using constant heat capacity and incompressibility. **(10)**

9. A reversible adiabatic compressor receives 0.05 kg/s saturated vapor R-22 at 200 kPa and has an exit pressure of 800 kPa. Neglect kinetic energies and find the exit temperature and the minimum power needed to drive the unit. **(8)**

BITS, PILANI – DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY
FIRST SEMESTER 2010-11
COURSE : ES C112 Thermodynamics
Test : 2 (Open Book)

Max. Marks: 40 **Date : 11.12.10**
Weightage : 20% **Time : 50 min**

Note: Answer all Question and Assume suitable value if required

---

1a) What is the difference between a nozzle and a diffuser **(3)**

b) Steam at 1.8 MPa and 400^{0}C steadily enters a nozzle whose inlet area is 0.2 m^2.The mass flow rate of steam through the nozzle is 5 kg/s. Steam leaves the nozzle at 1.4 MPa with a velocity of 275 m/s. Heat losses from the nozzle per unit mass of the steam are estimated to be 2.8 kJ/kg .Determine (i) the inlet velocity (ii) the exit temperature of the steam **(10)**

2(a)A steam turbine has an inlet of 2 kg/s water at 1000kPa and 350^0 C with velocity of 15 m/s. The exit is at 100 kPa, x = 1, and very low velocity. Find the specific work **(3)**

(b) A 4-kg/s steady flow of ammonia runs through a device where it goes through a polytropic process. The inlet state is 150 kPa, -20^0 C and the exit state is 400 kPa, 80^{0}C, where all kinetic and potential energies can be neglected. The specific work input has been found to be given as $(n / n-1)\ \Delta(Pv)$.
(i) Find the polytropic component n.
(ii)Find the specific work and the specific heat transfer. **(10)**

3(a) A steam power plant operates between a heat source which is a boiler operating at a pressure of 4 bar and at a temperature of 290 ^{0}C, and a heat sink which is cooling water from river at 15 ^{0}C, What is the maximum attainable efficiency of the plant? **(4)**

(b) Sixty kilograms per hour of water runs through a heat exchanger, entering as Saturated liquid at 200 kPa and leaving as saturated vapor. The heat is supplied by a Carnot heat pump operating from a low-temperature reservoir at 16°C. Find the rate of work into the heat pump. **(10)**

BITS, PILANI – DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY
FIRST SEMESTER 2010-11
COURSE : ESC112 Thermodynamics
Test : I (Closed Book)

Max. Marks: 50 **Date : 24.10.10**
Weightage : 25% **Time : 50 min**

Note: Answer all Question and Assume suitable value if required

---

1a) A 2.5 m tall steel cylinder has a cross sectional area of 1.5 m^2. At the bottom with a height of 0.5 m is liquid water on top of which is a 1 m high layer of gasoline as shown in fig.1. The gasoline surface is exposed to atmospheric air at 101 kPa. What is the pressure in the bottom most layer of water? **(6)**

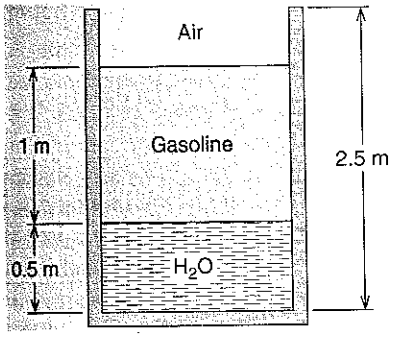

Fig.1

b) The diameters of the pistons shown in the fig .2 are D_1 = 10 cm and D_2 =4 cm..When the pressure in chamber 2 is 2000kPa and the pressure in chamber 3 is 700kPa, what is the pressure in chamber1? . **(10)**

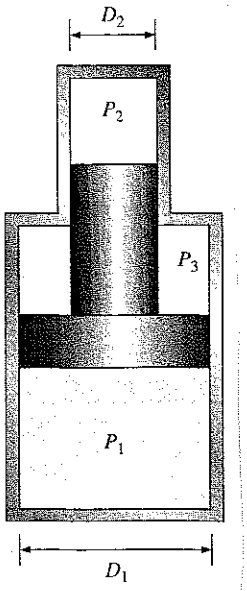

Fig.2

2a) Saturated vapor R-134a at 50^0C changes volume at constant temperature. Find the new pressure, and quality (if saturated) (i)when the volume doubles. (ii) when the volume is reduced to half the original volume. **(8)**

b) A 1-m^3 rigid tank has propane at 100 kPa, 300 K and connected by a valve to another tank of 0.5 m^3 with propane at 250 kPa, 400 K. The valve is opened and the two tanks come to a uniform state at 325 K. what is the final pressure? **(9)**

3a) A work of 2.5 kJ must be delivered on a rod from a pneumatic piston/cylinder where the air pressure is limited to 500 kPa. What should be the diameter of the cylinder to restrict the rod motion to maximum 0.5 m? **(7)**

b) A balloon behaves so the pressure is $P = C_2 V^{1/3}$, $C_2 = 100$ kPa / m. The balloon is blown up with air from a starting volume of 1 m^3 to a volume of 3 m^3. Find the final mass of air assuming it is at 25°C and the work done by the air. **(10)**

BITS, PILANI – DUBAI
FIRST SEMESTER 2010-11
COURSE: ESC112 Thermodynamics
Quiz: 2

Max. Marks: 14 **Date: 9.12.10**
Weightage : 7% **Duration: 20 min**
Name: **ID:** **Sec:**

1) A substance is compressed adiabatically and reversibly, how will entropy change? **(2)**

2) An apple with an average mass of 0.15 kg and average specific heat of 3.65 kJ/ kg .K Find the entropy change when it is cooled from 20 ° C to 5 ° C **(2)**

3) A mass of 1 kg of air contained in a cylinder at 1.5 MPa, 1000 K, expands in a reversible isothermal process to a volume 10 times larger. Calculate the change of entropy of the air **(3)**

4) A liquid is compressed in a reversible adiabatic process. What is the change in T? **(2)**

5) A window receives 200 W of heat transfer at the inside surface of 20^0 C .Find the flux of entropy at the surface. **(2)**

6) 1 kg of air is heated from 300K to 500K while pressure drops from 500 kPa to 400 kPa. Calculate the change in entropy if. Cp=1.004 kJ/kg K and R=0.287 kJ/kg K **(3)**

BITS, PILANI – DUBAI
FIRST SEMESTER 2010-11
COURSE: ESC112 Thermodynamics
Quiz: I

Max. Marks: 16 **Date: 22.11.10**

Weightage : 8% **Duration: 20 min** **A**

Name: **ID:** **Sec:**

---

1) Why dU is given to be $U_2 - U_1$ where as work is represented as ${}_1W_2$? (1)

2) Show that 1 kPa . m^3 =1 k J (1)

3) 0.8 m^3 tank contains N_2 at 600kPa and 300K.Gas is compressed isothermally to a volume of 0.1 m^3.Find the change in internal energy, work and heat transferred during the process.(4)

4) A storage battery is charged with the 20 A current and 25 V voltage. The rate of heat transfer from the battery is 20 W. Find the change in internal energy? (3)

5) A crane lifts a load of 450 kg vertically up with a power input of 1 kW. How fast can the crane lift the load? (2)

6) 5 kg of air is heated from 27 ^{0}C to 77 ^{0}C at constant volume. Find the specific work and heat transfer if average specific heat for constant volume is 0.72 kJ/kg K. What is the % increase in specific work and heat transfer when it is heated from 1027 ^{0}C to 1077 ^{0}C with average specific heat for constant volume is 0.904 kJ/kg K. (5)