BITS, PILANI – DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
1st Year First Semester -2009-2010
Course: ES C112 Thermodynamics
Comprehensive Examination [Closed Book]

Max.Marks:80 **Date: 23.12-2009**
Weightage: 40 % **COMMON TO ALL BRANCHES** **Time: 3 hours**

Note: (i) Answer all Question in a sequence (ii) Assume suitable value if required (iii) Thermodynamics tables are permitted (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

Part -A

1 .A tank contains 2 kg of nitrogen at 100 K with a quality of 50%. Through a volume flow meter and valve, 0.5 kg is now removed while the temperature remains constant. Find the final state inside the tank and the volume of nitrogen removed if the Valve/meter is located at (a) The top of the tank (b) The bottom of the tank (8 Marks)

2. A balloon behaves such that the pressure inside is proportional to the diameter squared. It contains 2 kg of ammonia at 0°C and 50% quality. The balloon and ammonia are now heated so that a final pressure of 600 kPa is reached. Considering the ammonia as a control mass, find the amount of work done in the process. (12 Marks)

3. List the similarities between heat and work (6 Marks)

Part-B

4. A closed tank, V = 10 L, containing 5 kg of water initially at 25°C, is heated to 175°C by a heat pump that is receiving heat from the surroundings at 25°C. Assume that this process is reversible and find the heat transferred to the water and the change in entropy. (12Marks)

5. A rigid container has 0.75 kg of water at 400°C, 1200 kPa.The water is now cooled to final pressure of 400 kPa.Find the final temperature, the work and heat transfer in the process. (10Marks)

6. Discuss the important facts about entropy (5Marks)

Part – C

7. Air entering a diffuser at 100 kPa, 300 K, with a velocity of 200 m/s. The inlet cross-sectional area of the diffuser is 100 mm^2. At the exit, the area is 860 mm^2 and the exit velocity is 20 m/s. Determine the exit pressure and temperature of the air.
Assume C_p value for air as 1.004 kJ / kg - K (10 Marks)

8. Steam enters a turbine at 3 MPa, 450°C, expands in a reversible adiabatic process and exhausts at 10 kPa. Changes in kinetic and potential energies between the inlet and the exit of the turbine are small. The power output of the turbine is 800 kW. What is the mass flow rate of steam through the turbine? (10 Marks)

9 a)Write steady state steady flow energy equation for nozzle and turbine (4Marks)

b) Write isentropic efficiency expression for compressor. (3Marks)

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FIRST SEMESTER 2009-10
COURSE: ES C112 Thermodynamics
Test : II (Open Book)

Max.Marks:40 **Date :22.11.09**
Weightage: 20% **Time : 50 min**

Note: (i) Answer all Question
(ii) Assume suitable value if required
(iii) Thermodynamics tables are permitted
(iv)Show stepwise calculation indicating the units wherever it is required

1(a) A Cylinder /Piston arrangement contains 5kg of water at 100°C with x = 20% and a piston of mass 75 kg resting on some stops as shown in the fig 1 .The outside pressure is 100 kPa and the cylinder area is 24.5 cm^2 .Heat is now added until the water reaches a saturated vapour state. Find the initial volume, final pressure, work and heat transfer for the process, also show the process in a P-v diagram.(10)

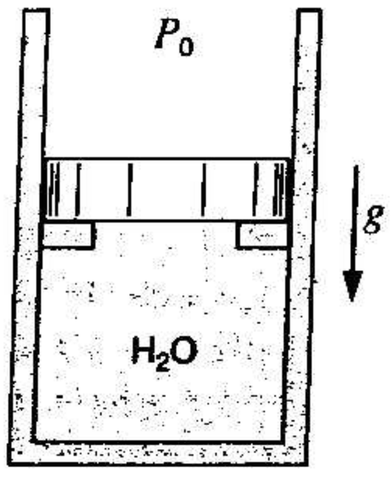

Fig.1

(b)A 100L rigid tank contains N_2 at 900 K and 3MPa is now cooled to 100 K .Find the work and heat transfer during the process.(3)

2(a.) When the steam with quality ,x is flowing through the nozzle exit ,find the density of steam for the following conditions at the exit of nozzle, Enthalpy =2500 kJ/kg: pressure = 0.275 MPa.. (5 marks)

(b) A two fluid heat exchanger has 2 kg/s liquid ammonia at 20°C, 1003 kPa entering state 3 and exiting at state 4. It is heated by a flow of 1 kg/s nitrogen at 1500 K, state 1 , leaving at 600 K, state 2 as shown in Fig 2. Find the total rate of heat transfer inside the heat exchanger and also find temperature and specific volume at state 4 of the ammonia. (10marks)

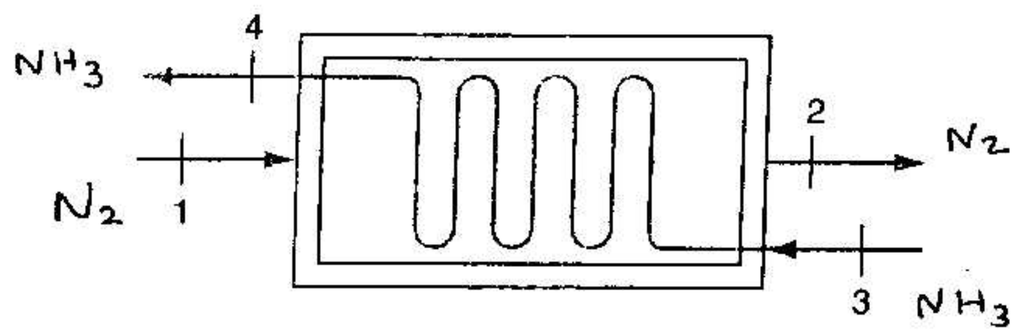

Fig.2

3.(a)Ice cubes in a glass of water will eventually melt and all the water will approach room temperature. Is this a reversible process? Justify.(2)

(b)It is proposed that solar energy be used to warm a large collector plate. This energy would, in turn, be transferred as heat to a fluid within a heat engine, and the engine would reject energy as heat to the atmosphere. Experiments indicate that about 1880kJ/m^{2}h of energy can be collected when the plate is operating at 90 °C. Estimate the minimum collector area that would be required for a plant producing 1 kW of useful shaft power. The atmospheric temperature may be assumed to be 20 °C. (10)

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FIRST SEMESTER 2009-10
COURSE: ES C112 Thermodynamics
Test : I (Closed Book)

Max.Marks:50 **Date :04.10.09**
Weightage: 25% **Time : 50 min**

Note: (i) Answer all Question
(ii) Assume suitable value if required
(iii) Thermodynamics tables are permitted
(iv)Show stepwise calculation indicating the units wherever it is required

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1(*a*) A 5 m^3 container is filled with 900 kg of granite (density of 2400 kg/ m^3)and the rest of the volume is air (density of 1.15 kg/ m^3).Find the mass of air and the overall average specific volume (6)

(b) Two cylinders are connected by piston as shown in the Fig1. Cylinder A is used as a hydraulic lift and pumped up to 500 kPa.The piston mass is 25 kg and there is standard gravity. What is the gas pressure in cylinder B? (10)

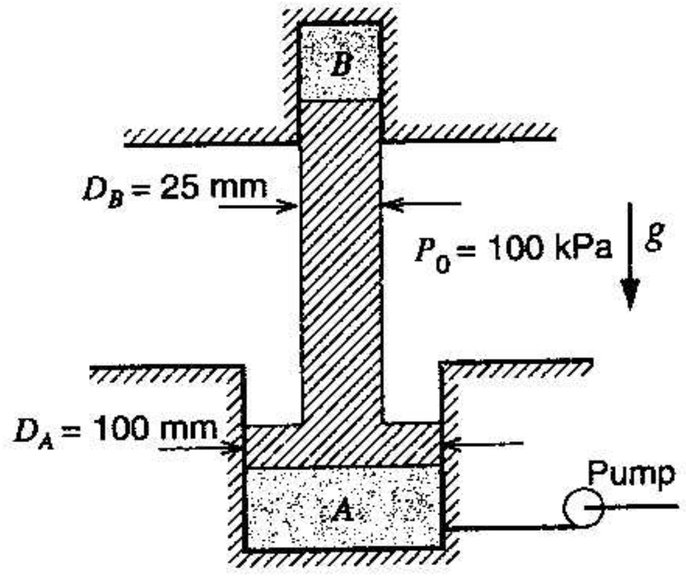

Fig 1.

2(a) A 20 m^3 tank contains nitrogen at 25 ° C and 800 kPa Some nitrogen is allowed to escape until the pressure in the tank drops to 600 kPa. If the temperature at this point is 20 ° C , determine the amount of nitrogen that has escaped. (9)

(b) A cooking pan whose inner diameter is 20 cm is filled with water and covered with a 4 kg lid .If the local atmospheric pressure is 101k Pa, determine the temperature at which the water will start boiling when it is heated. (8)

3 (a) What do you understand by path function and point function. What are exact and inexact differentials? (5)

(b) 10 kg of water in a piston cylinder arrangement exists as saturated liquid/vapor at 100 kPa, with a quality of 50%. It is now heated so the volume triples. The mass of the piston is such that a cylinder pressure of 200 kPa will float it.

a) Find the final temperature and volume.

b) Find the work done for above process.

c) Plot the process in P-v diagram (12)

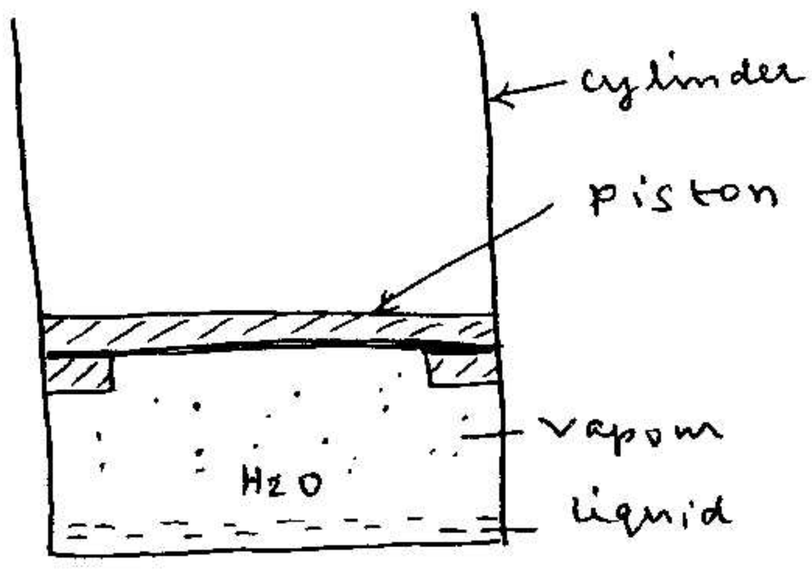

Fig 3.

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A

Quiz 2

Course Code: ES C112 **First YEAR Sections 1,3,5** Date: 07.12.09

Course Title: THERMODYNAMICS Max Marks: 14

Duration:20minutes Weightage: 7%

Name: ..... **ID No:** ..... **Sec** .....

1. 1 kg of liquid water is heated from 30°C to 80°C.calculate the entropy change
a)from average specific heat and
b)from steam table. (4 marks)

2. a)A substance is compressed adiabatically so P and T go up,. Does that change s? (2marks)

b)1kg of air at 250 kPa and 27°C expands in an isentropic process to 100 kPa and -42°C Calculate the work done during the process (4marks)

3.Prove that entropy is the property of the system. (4 marks)

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FIRST SEMESTER 2009 – 2010

A

Quiz 1

Course Code: ES C112 **First YEAR Sections 1,3,5** Date:

22.10.09

Course Title: THERMODYNAMICS Max Marks: 16

Duration:25minutes Weightage: 8%

Name: ..... **ID No:** ..... **Sec** .....

Instructions: 1. Attempt all questions
2.Assume suitable value if required
3.Thermodynemic Table is allowed

1. A 1200 kg car accelerates from zero to 100 km/h over a distance of 400 m. The road at the end of the 400 m is at 10 m higher elevation. What is the total increase in the car kinetic and potential energy? (2 Marks)

2. Derive C_p-C_v = R (1Marks)

3.A gas with mass m, in a constant pressure process the volume is changed from V_1 to V_2 and the initial and final specific internal energy value are u_1 and u_2. Prove that the amount of heat transfer during the process is $H_2 - H_1$. (2 Marks)

4. Helium gas expands from 125 kPa ,350 K and 0.25 m^3 to 100 kPa in a polytrophic process with n=1.667 .Find the final temperature (2Marks)

5. A piston cylinder assembly in a car contains 0.2 L of air at 90 kPa and 20 °C .the air is expands in a polytrophic process with n=1.25 to a final volume which is six times larger. If the final pressure is 9.5kPa, find the work done during expansion (2Marks)

6.Give the P-v diagram for a poly tropic process (2Marks)

7.A liquid of mass 4 kg has its temperature increased from 15 °C to 100 °C . Heat transfer into the liquid to the value 714 kJ is required to accomplish the increase in temperature. Determine the specific heat capacity of the liquid. (2M)

8. Water at 1.0 bar has a quality of 90 % . Determine its specific enthalpy (2 M)

9. In a heat pump cycle , the Q_{out} = 100 kJ/s and Q_{in} = 50 kJ/s. Calculate the work input into the cycle. (1 M)