EXAMINATION NUMBER_____

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI – DUBAI CAMPUS
FIRST SEMESTER 2003 – 2004
ESC U C112 THERMODYNAMICS
COMPREHENSIVE EXAMINATION (CLOSED BOOK)
DURATION: 180 MINUTES MAXIMUM MARKS: 40 WEIGHTAGE: 40%

NOTES:

1. Standard Thermodynamics tables are allowed.
2. Highlight all your answers by enclosing in boxes.
3. Assume any missing data suitably and mention the same at appropriate place in your answer.
4. All the parts of a particular question should be answered together. Sub Questions answered at different locations in the answer sheet are liable to be ignored for evaluation.

PART A

Q1. Compute the missing properties in the following table and then fill the blanks in the table. **Write the answers legibly and neatly with bold letters. Restrict your answers up to 3rd decimal place. Attach this answered sheet to your main answer book before you submit.** Note that you will have to just write the answers. You may use the last page of your main answer book for any calculations/rough work to answer this question. **[16*0.5 = 8M]**

Pure Substance	Pressure kPa	Temperature ^{o}C	Specific Volume m^3/kg	Enthalpy kJ/kg	Entropy kJ/kg K	Quality if saturated Or Degree of Super heat if super heated.
Water		– 26	1455			
R12	1000				0.756	
R22		– 14.61		244.29		
Methane		100			4.5538	

PART B

Q2. A piston cylinder arrangement contains 1kg of water as shown in FigQ2. The piston is spring-loaded and initially rests on some stops. A pressure of 300kPa will just float the piston and at a volume of 1.5m^3, a pressure of 500 kPa will balance the piston.

The initial state of the water is 100kPa and occupies a total volume of 0.5m^3. Heat is now added until a pressure of 400 kPa is reached. Plot the P – V diagram. Find the initial temperature and final volume. Find the work and heat transfer on the process. **[8M]**

Q3. R 134a is to be cooled by water in a heat exchanger. FigureQ3 shows the schematic of such an arrangement. R134a enters the heat exchanger a mass flow rate of 6kg/minute at 1Mpa and 70°C and leaves at 35°C. The cooling water enters at 300kPa and 15°C and leaves at 25°C. Simplify the FLOT equation applicable for heat exchangers and hence determine the mass flow rate of cooling water required. Also find the heat transfer rate from the refrigerant to water. **[8M]**

Q4. Refer FigQ4. Two streams of water one at 0.6Mpa, saturated vapour and the other at 0.6Mpa, 600° C mix adiabatically in a SSSF process to produce a single flow out at 0.6Mpa, 400° C. Find the total entropy generation for the process. **[8M]**

Q5.

(A) Write short notes on assumptions of SSSF and USUF processes.
(B) Derive the two Gibbs equations Tds = du + Pdv and Tds = dh - vdP.
(C) Write short notes on the concept of relative pressure and relative specific volume.
(D) Write short notes on availability and irreversibility. **[8M]**

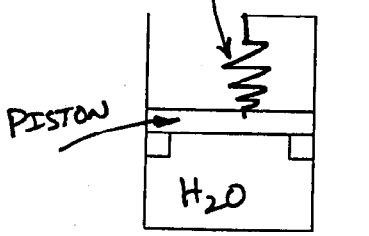
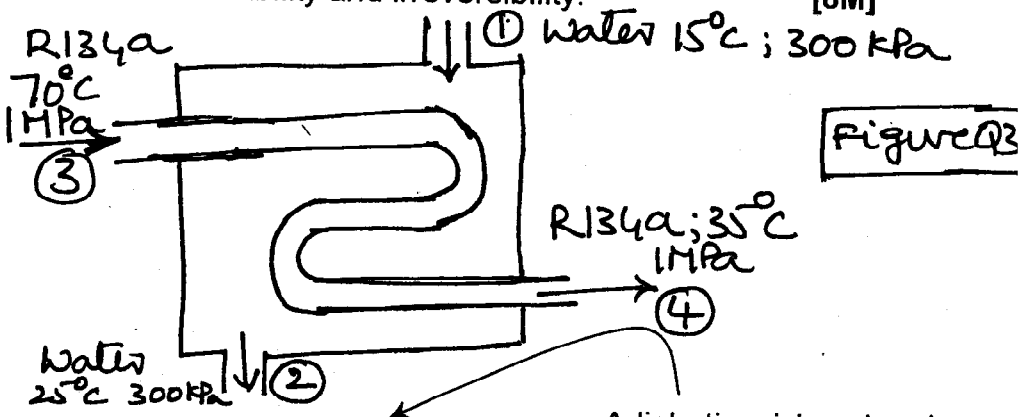


Figure Q2.



FigureQ3

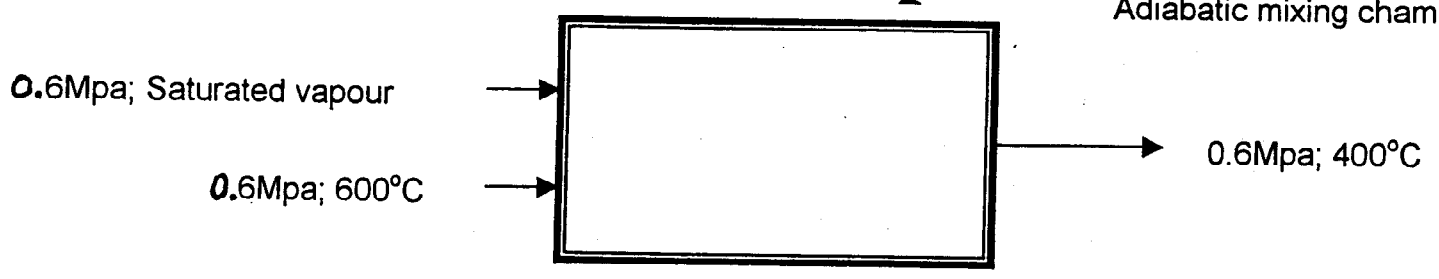


Figure Q4.

BITS, PILANI – DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
FIRST SEMESTER 2003 – 2004
ESC U C112 THERMODYNAMICS TEST 2 (OPEN BOOK) Date: 14 /12/ 03
DURATION: 50 MINUTES MAXIMUM MARKS: 20 WEIGHTAGE: 20%

NOTES:

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Q1. Refer Fig Q1, which shows a piston cylinder arrangement connected to a pipeline. The pipeline carries air at 500kPa, 600K. Piston weight is such that it exerts a constant pressure of 300kPa, before the piston reaches stops. Initially, the cylinder contains air at 17°C. The volume of the air at this condition is $0.25m^3$. Now the valve connecting the cylinder and pipe line is opened allowing the air to go in to the cylinder and push the piston up till the piston touches the stops at which the volume of the air is $1m^3$. The charging process is continued till air conditions in the cylinder become Pressure = 400kPa, Temperature = 350K. To analyze the problem air can be considered as an Ideal gas with R = 0.287kJ/kgK; C_v = 0.7165kJ/kgK; C_p = 1.0035kJ/kgK.

(a) Among SSSF and USUF models, which model can effectively be used to analyze this problem? Give the reasons.
(b) Simplify the conservation of mass equation and get the expression that relates m_i, m_1 and m_2 where m_i, m_1 and m_2 are the mass entered, initial mass and final mass respectively. Using the Ideal gas equation find the numerical values of these three masses.
(c) Estimate the work done due to the movement of the piston.
(d) Simplify FLOT equation and using this equation find Q_{cv}. **8M**

Q2. A heat pump is used maintain interior space of a room at 20°C. Out side temperature is 0°C. Heat loss through the walls; roof; bottom of the room is 48000kJ/hour. Find the minimum power required to drive the heat pump in kilowatts. Support the equations you used and the answers you got, with necessary logical explanation. **6M**

Q3. Explain how clasius inequality can be used to introduce the concepts of entropy. Also explain the importance of T- S diagram and H-S diagrams in thermodynamic studies. **6M**

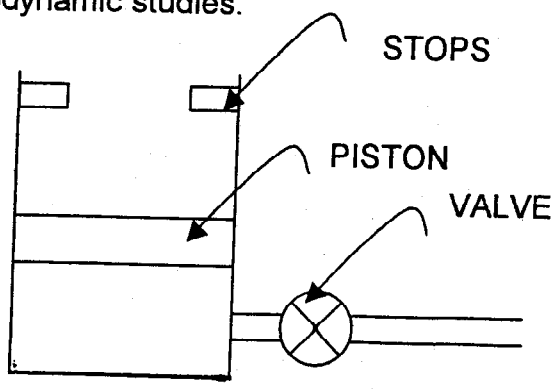

Fig Q1

BITS, PILANI – DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
FIRST SEMESTER 2003 – 2004
ESC U C112 THERMODYNAMICS TEST 2 (OPEN BOOK) Date: 14 /12/ 03
DURATION: 50 MINUTES MAXIMUM MARKS: 20 WEIGHTAGE: 20%

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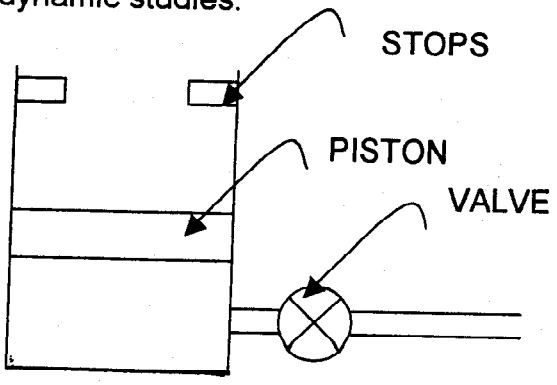

Fig Q1

BITS, PILANI – DUBAI CAMPUS
KNOWLEDGE VILLAGE, DUBAI
FIRST SEMESTER 2003 – 2004
ESC U C112 THERMODYNAMICS TEST 1 (CLOSED BOOK) Date: 09 /11/ 03
DURATION: 50 MINUTES MAXIMUM MARKS: 20 WEIGHTAGE: 20%

NOTES:

1. Standard Thermodynamics tables are allowed.
2. Highlight all your answers by enclosing in boxes.
3. Assume any missing data suitably and mention the same at appropriate place in your answer.
4. All the parts of a particular question should be answered together.

Q1. An insulated cylinder is divided in to two parts of $1m^3$ each by an initially locked thin piston as shown in FigureQ1. Side A has air at 200kPa, 300K and side B has air at 1Mpa, 1000K. The piston is now unlocked so that it is free to move and it conducts heat so that the air comes to a uniform temperature $T_A = T_B$. By properly selecting the system, show that, $u_2 = (m_A u_{A1} + m_B u_{B1})/m_2$. Calculate the mass in both A and B. Using Ideal gas tables of air find the final temperature and pressure. **6M**

Q2. Two steady flows of air enter a control volume shown in FigureQ2. Flow "1" with state 1 is flowing at 0.025kg/s at 350kPa, 150^0C. Flow "2" with state 2 enters at 350kPa, 15°C. Both the flows flow at very low velocities. A single flow "3" with state 3 exits at 100kPa and temperature of - 40°C through a 25mm diameter pipe. The control volume rejects 1.2kW of heat to surroundings and produces 4.5kW of power. Neglecting changes in kinetic energy and potential energy, determine mass flow rate of air at the inlet state 2.Take R and C_p for air as 0.287kJ/kg K and 1.0035 kJ/kg K respectively. **5M**

Q3. A spherical elastic balloon initially containing 5kg of ammonia as saturated vapor at 20°C is connected by a valve to a $3m^3$ evacuated tank. The balloon is made such that the pressure inside is proportional to diameter. The valve is now opened allowing ammonia to flow in to the tank until the pressure in the balloon has dropped to 600kPa at which point the valve is closed. The final temperature in both the balloon and the tank is 20°C. Determine the final pressure in the tank and work done by ammonia in the process. Use the suffix "t" for the properties of ammonia in tank and the suffix "b" for the properties of ammonia in balloon.

6M

[P T O]

Q4. Reproduce the following table in your answer book. Perform the necessary calculations and fill the blanks in the table. **3M**

Pure substance: Water	Pressure: 800 kPa Enthalpy: 3162 KJ/kg	Phase: _____ Temperature (°C) _____ Quality: _____
Pure substance: R134 – a	Temperature: 8°C Pressure: 600kPa	Phase: _____ Internal Energy (KJ/kg)_____ Quality: _____

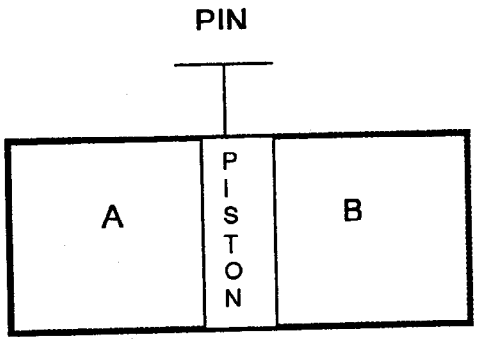

Figure Q1

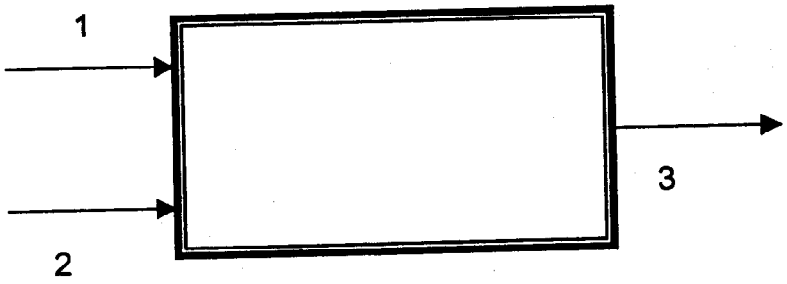

Figure Q2

Name: _____ ID NO: _____ Section: _____

A

BITS, Pilani – Dubai Campus, Knowledge village, Dubai
First Semester 2003-2004

Course : ESC U C112 Thermodynamics Quiz No :1 (Closed book)
Duration: 30 Min **Maximum Marks: 10M**

1. Select the most appropriate option among the given options and completely cross against that option in the answer sheet. Example: option (a) of Question no 21 is represented as

a	b	c	d

2. Incompletely crossed answer blocks; answers marked with modes other than above-mentioned shall be considered as wrong answers.

1. The mass dependent properties are known as
   (a) Intensive properties
   (b) Extensive properties
   (c) Either extensive or intensive properties
   (d) None of the above
2. A system is said to be in thermodynamic equilibrium, when the system is in
   (a) Mechanical equilibrium only
   (b) Mechanical and thermal equilibrium
   (c) Mechanical, thermal, chemical and phase equilibrium
   (d) Thermal equilibrium only
3. A pure substance, which is in saturated liquid state, is heated at constant specific volume. If the final state is well below the critical point, the possible phase is
   (a) Compressed liquid
   (b) Saturated vapor
   (c) Super heated vapor
   (d) Saturated liquid.
4. During a phase change process of a pure substance, the temperature and pressure are
   (a) Dependent properties
   (b) Independent properties
   (c) Extensive properties
   (d) None of the above.
5. In superheated vapour condition of any pure substance, the temperature and pressure are
   (a) Dependent properties
   (b) Independent properties
   (c) Extensive properties
   (d) None of the above.
6. Quality of a saturated liquid vapour mixture is
   (a) Intensive property
   (b) Extensive property
   (c) Can be extensive or intensive property
   (d) None of the above.
7. Property enthalpy of an ideal gas is a function of
   (a) Pressure only
   (b) Pressure and temperature
   (c) Pressure and volume
   (d) Temperature only
8. Isochoric process implies that _____ is constant in the process
   (a) Temperature
   (b) Pressure
   (c) Specific volume
   (d) All of the above

A

9. The general expression of First Law of thermodynamics equation for SSSF process does not include
   (a) Time rate of change of total energy term (b) Time rate of heat transfer
   © Time rate of work transfer (d) Mass flow rate terms
10. In the absence of compressed liquid data, a general approximation is to treat compressed liquid as
   (a) Saturated vapour
   (b) Saturated liquid at the given temperature
   (c) Saturated liquid at the given pressure
   (d) None of the above.
11. In a certain process the net change in entropy works out to be a positive quantity. Then the process is
   (a) Reversible
   (b) Irreversible
   (c) Both reversible and irreversible
   (d) None of the above
12. The claimed efficiency of a heat engine cycle is 95% while the Carnot efficiency is 95.5%. Then
   (a) The claimed cycle is possible
   (b) The claimed cycle is impossible
   (c) Carnot cycle can never have efficiency equal to 95.5%
   (d) None of the above.
13. As irreversibilities increase, work required for refrigeration process
   (a) Decreases
   (b) Increases
   (c) Either increases or decreases
   (d) None of the above.
14. A certain control mass undergoes a constant volume process while receiving a heat of 1000kJ. The work interacted is
   (a) 1000kJ
   (b) 0
   (c) 10kJ
   (d) None of the above.
15. In Throttling process _____ is constant
   (a) Entropy
   (b) Pressure
   (c) Enthalpy
   (d) None of the above.
16. A Carnot heat pump works between 30 °C and 100 °C. COP of the heat pump is
   (a) 0.3 (b) 30/70 (c) 303/70 (d) 303/343
17. Entropy is _____ function
   (a) Path (b) Point (c) Either path or point (depending on different things)
   (d) None of the above
18. When a carnot heat engine cycle is reversed the resultant cycle is
   (a) Carnot refrigeration cycle
   (b) Carnot refrigeration/heat pump cycle
   (c) Carnot heat engine cycle
   (d) Carnot heat pump cycle
19. State whether the following statement is true or false. Mark **true as 'a' and false as 'b'** "When the system is moving from one state to another state, Work interacted is different for different processes between the states".
20. State whether the following statement is true or false. Mark **true as 'a' and false as 'b'** **"A balloon containing an Ideal gas is being deflated. The deflation process can better be analyzed by USUF model"**

Name: _____ ID NO: _____ Section: _____

B

BITS, Pilani – Dubai Campus, Knowledge village, Dubai
First Semester 2003-2004

Course : ESC U C112 Thermodynamics Quiz No :1 (Closed book)
Duration: 30 Min **Maximum Marks: 10M**

1. Select the most appropriate option among the given options and completely cross against that option in the answer sheet.
   Example: option (a) of Question no 21 is represented as

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B

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