BITS, PILANI – DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI

1st Year First Semester 2007-2008

Course: ES UC112 Thermodynamics

Comprehensive Examination [Closed Book]

Max.Marks:80 COMMON TO ALL BRANCHES **Date: 05 / 01/2008**
Weightage: 40 % **Time : 3 hours**

Note: (i) Answer all Question in a sequence
(ii) Assume suitable value if required
(iii) Approved tables are permitted
(iv) Answer Every Question on a fresh page
(v) There are two parts of the Question papers: Part A and Part B.
Answer the questions of part A in the BLUE COLOUR main answer book and those of part B in the RED COLOUR main answer book

PART: A

1. A 250 liters tank consists N_2 gas at 0.6 MPa and 150 K. Calculate the mass of N_2. Use the following methods to determine the specific volume a) Nitrogen table and b) Ideal gas equation of state. [10 Marks]

2. Air goes through a polytropic process from 125 kPa and 325 K to 300 kPa and 500 K. Find polytropic exponent n and specific work in the process. [5 Marks]

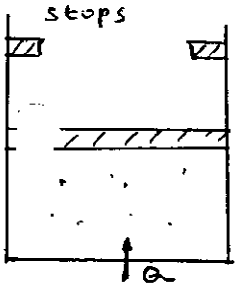

Figure.1

3. 5 kg of water at 15 ^{0} C contained in a vertical cylinder by a frictionless piston of a mass such that the pressure of water is 700 kPa as shown in Figure 1. Heat is transferred slowly to the water causing the piston to rise until it reaches the stops, at which point the volume inside the cylinder is 0.5 m^3; more heat is transferred to the water until it exists as saturated vapor. Find the pressure in the cylinder, work done and heat transfer during the process. [15 Marks]

4. Air at 10° C and 80 kPa enters the diffuser of a jet engine steadily with a velocity of 200 m/s. The inlet area of diffuser is 0.4 m^2. The air leaves the diffuser with a velocity that is very small compared with the inlet velocity. Calculate a) the mass flow rate of air and b) temperature of the air leaving the diffuser. [10Marks]

PART: B

1. Consider the process shown in Figure, tank A is insulated, has a volume of 0.6 m^3 and is initially with filled with steam at 1.4 MPa, 300 ° C. Tank B is uninsulated, has a volume of 0.3 m^3 and is initially filled with steam at 0.2 MPa, 200 ° C. A valve interconnecting the two tanks is then opened and steam flows from A to B until the temperature in A is 250 ° C, at which time the valve is closed. During this time, heat is transferred from B to the surroundings at 25° C such that the temperature in B remains at 200 ° C. It may be assumed that the steam remaining in A has undergone a reversible adiabatic process. Determine a) the final pressure in each of the tanks b) the final mass in tank B and c) the net entropy change for the process. [15 Marks]

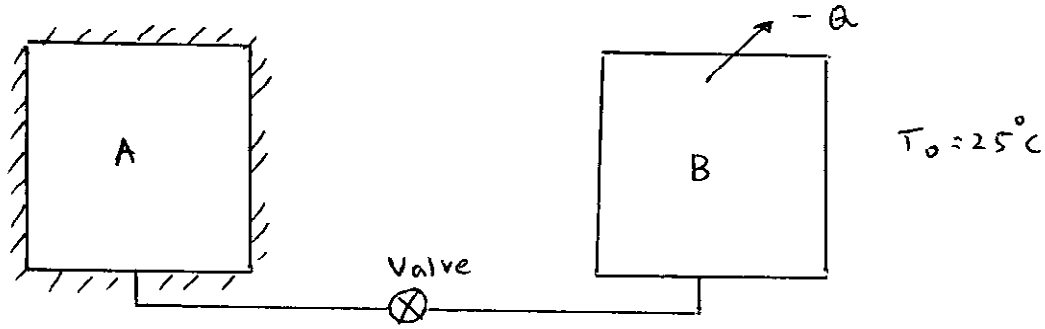

Figure.2

2. Steam enters an adiabatic turbine steadily at 3 MPa and 400 ° C and leaves at 50 kPa and 100 ° C. If the power out of the turbine is 2 MW, determine a) the isentropic efficiency of the turbine and b) the mass flow rate the steam flowing through the turbine. [10 Marks]

3. Two reversible heat engine A and B are arranged in series A rejects heat directly to B. Engine A received 200 kJ at temperature of 421 ° C from a hot source, while engine B is in communication with a cold sink at a temperature of 4.4° C. If the work output of A is twice that of B, find (a) The intermediate temperature and efficiency of each engine (b) Heat rejection to the cold sink. [10 Marks]
4. Write short notes on the following:
   (i) Zeroth law of thermodynamics (ii) Mixtures of Ideal Gases [5 Marks]

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First Semester 2007-2008
Course: ES UC112 Thermodynamics
TEST : 11 [Open Book]

Max.Marks :40
Weightage : 20 %

Date: 16 / 12/2007
Time : 50 min

[COMMON TO ALL BRANCHES]

Note: (i) Answer all Question
(ii) Assume suitable value if required
(iii) Approved tables are permitted
(iv) Approved Text book and reference books are allowed

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1. A spherical aluminium vessel has an inside diameter of 0.5 m and 10 mm thick wall. The vessel contains water at 25 ^{0} C with quality of 1 %. The vessel is then heated until the water inside is saturated vapor. Considering the vessel and water together as a system, calculate the heat transfer during this process. Use a density of 2700 kg / m^3 and specific heat of 0.9 kJ / kg K for aluminium. **[10 Marks]**

2. In an air compressor, air flows steadily at the rate of 13.5 kg / min. The air enters the compressor at 4 m / s with a pressure of 1.2 bar and a specific volume of 0.45 m^3/ kg. It leaves the compressor at 6.85 m/s with pressure of 7.5 bar and a specific volume of 0.125 m^3/ kg. The internal energy of the air leaving the compressor is 156 kJ / s greater than that of air entering. The cooling water which flows through the compressor jackets absorbs heat from the air at the rate of 8100 kJ/ min. Find
   (a) Power required to drive the compressor
   (b) Ratio of the inlet and outlet pipe diameter **[10 Marks]**

3. Two heat engines operating on carnot cycle are arranged in series. The first engine '**A**' receives heat at 927 ^{0} C and rejects heat at a constant temperature T_2. The second engine '**B**' receives the heat rejected by the first engine , and in turn

rejects heat to a reservoir at 27 ^{0} C. Calculate the temperature T_2 in degree Celsius for the situation where

(a) The work out put of the two engine are equal

(b) The efficiency of the two engine are equal **[15 Marks]**

4. 1 m^3 of air at 4 MPa, 300 ^{0} C expands in a reversible isothermal process in a cylinder to 0.1 MPa. Calculate heat transfer during the process and change of entropy of air. **[5 Marks]**

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BITS,Pilani - Dubai campus - Academic City

First Semester 2007 - 2008
Course: ES UC 112 Thermodynamics
TEST: 1[Closed book]

Max.Marks :75
Weightage: 25 %

[Common to All branches]

Date:11.11.07
Time: 50 min

Note: *(i) Answer all Questions*
(ii) Assume suitable value if required
(iii) Approved tables are permitted

[1] Two cylinders are connected by a piston as shown in Fig.1. 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 the cylinder B? [20]

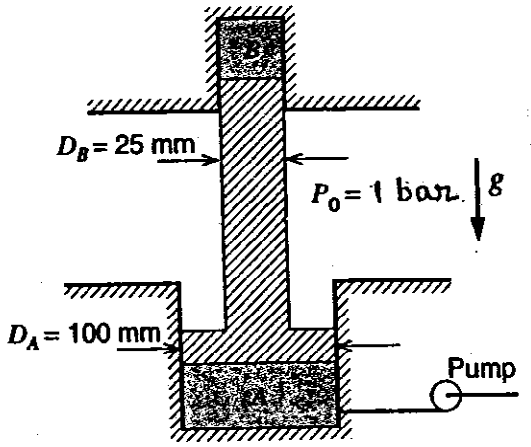


FIG. 1

[2] Two tanks are connected as shown in Fig.2, both containing water. Tank A is at 200 kPa, specific volume (v) = 0.5 m^3 / kg. V_A = 1 m^3 and Tank B contains 3.5 kg at 0.5 MPa and 400 ^{0}C. The valve is now opened and the two come to a uniform state. Find the final specific volume. [15]

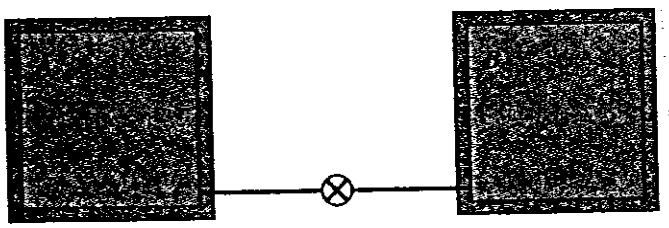
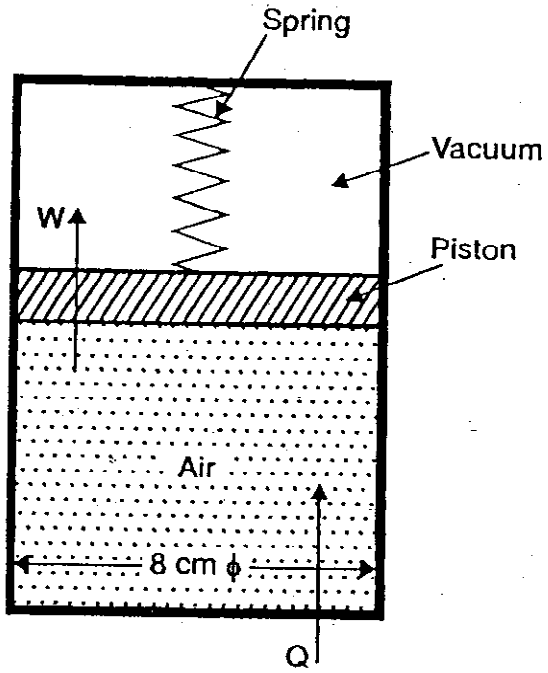


FIG. 2

[3] The Figure shows a cylinder of 8 cm inside diameter having a piston loaded with a spring (stiffness = 150 N/cm of compression). The initial pressure, volume and temperature of air in the cylinder are $3x10^5$ N/m^2, 0.000045 m^2 and 20 ^{0}C respectively. Determine the work done if the heat is added to the system so that piston moves up 3.5 cm. [20]



[4] The gas space above the water in a closed tank contains nitrogen at 25^{0}C, 100 kPa. The tank has a total volume of 4 m^3 and contains 500 kg of water at 25^{0}C. An additional 500 kg of water is now slowly forced into the tank. Assuming that the temperature remains constant. Calculate the final pressure of the nitrogen and the work done on the nitrogen during the process. [20]