BITS, PILANI – DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
1st Year Second Semester -2008
Course: ES UC112 Thermodynamics
Comprehensive Examination [Closed Book]

Max.Marks:80 **COMMON TO ALL BRANCHES** **Date: 29 / 05/2008**
Weightage: 40 % **Time : 3 hours**

Note: (i) Answer all Question in a sequence
(ii) Assume suitable value if required
(iii) Thermodynamics tables are permitted
[Page: From 653 to722& From 726 to778]
(iv) Answer Every Question on a fresh page
(v) Answer all the questions in the **BLUE COLOUR** *main answer sheet only*

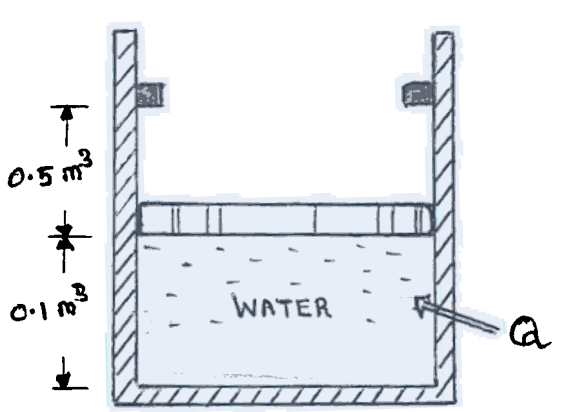
One kg of air at a pressure of **8 bar** and a temperature of **100 ^{0} C** undergoes a reversible polytropic process following the law **$pv^{1.2}$ = C**. If the final pressure is **1.8 bar**, determine

a) The final specific volume and Final temperature

b) The work done and heat transfer

[**Assume:** Characteristic gas constant **R =0.287 kJ/kg K** and Ratio of specific heats **γ = 1.4**]. **[10 Marks]**

2. A piston/cylinder contains **50 kg** of water at **200 kPa** with a volume of **0.1 m^3** as shown in Fig 1. Stops in the cylinder are placed to restrict the enclosed volume to a maximum of **0.5 m^3**. The water is now heated until the piston reaches the stops. Find the necessary work and heat transfer. **[12 Marks]**



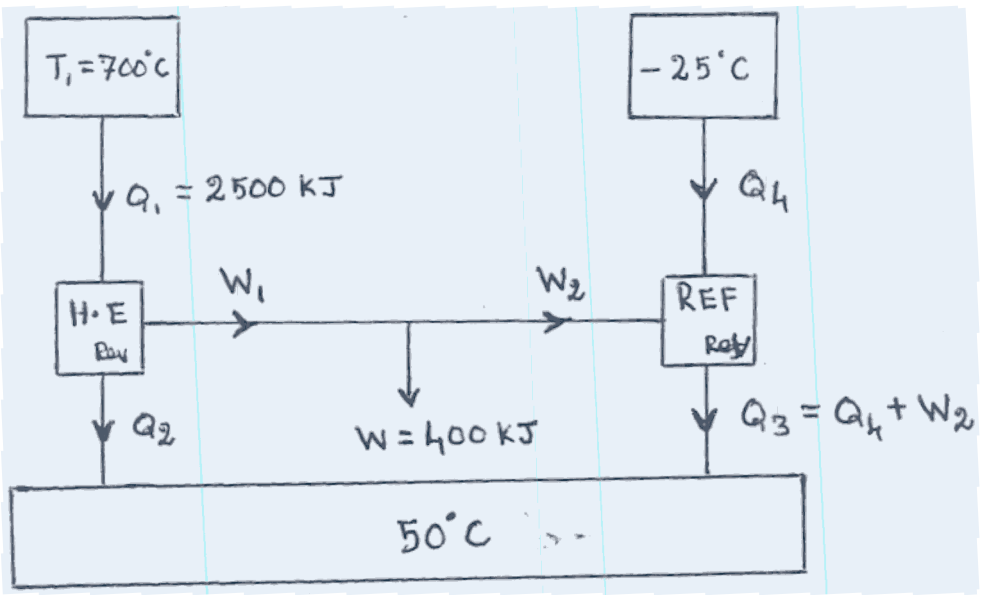


FIG. 3

6. Air enters an adiabatic nozzle operating at steady state as shown in Fig. 4. At the inlet, the pressure is **180 kPa** and the temperature is **65 ^{0} C**. At the outlet, the pressure is **100 kPa** and velocity is **300 m / s**. The mass flow rate of air is **0.15 kg /s** and the isentropic exit temperature of the nozzle is **285.75 K**. **Assume** the change in the Inlet velocity of the nozzle is negligible when compared with Exit velocity, Potential energy is zero and Nozzle is completely insulated. Take the enthalpy of air as $\mathbf{h = c_p t}$, where $\mathbf{c_p}$ is equal to **1.005 kJ /kg.k,** Gas constant **R = 0.287 k J/kg.k.** **[12 Marks]**

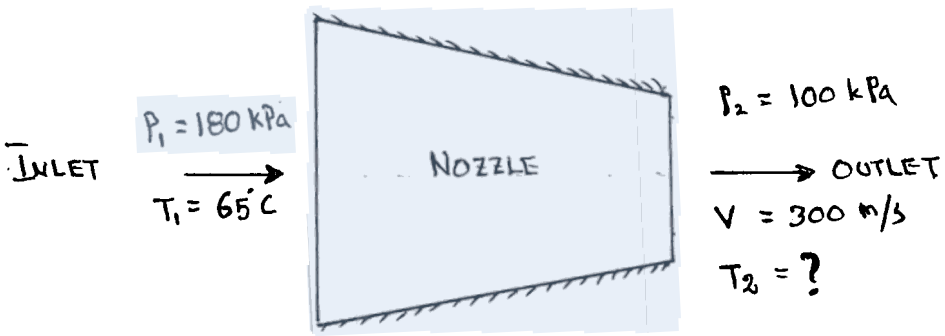


FIG. 4

7. Write short notes on the following:

(i) Available Energy (ii) Psychrometric Properties **[8 Marks]**

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I st Year II nd Semester 2007-2008
Course: ES UC112 Thermodynamics
Test : II [Open Book]

Max.Marks :20 **Date: 27 / 04/2008**
Weightage : 20 % **Time : 50 min**

Note: (i) Answer all Question.
(ii) Assume suitable value if required.
(iii) Thermodynamics tables are permitted.
(iv) Strictly prohibited to use of solution manual related to a Thermodynamics subject.
(v) *Photocopy of the text books and class notes are strictly not permitted.*

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1. Air at a temperature of 15 ^{0} C passes through a heat exchanger at a velocity of 30 m/s where its temperature is raised to 800 ^{0} C as shown in Fig.1. It then enters a turbine with the same velocity of 30 m/s and expands until the temperature falls to 650 ^{0} C. On leaving the turbine, the air is taken at a velocity of 60 m/s to a nozzle where it expands until the temperature has fallen to 500 ^{0} C. If the air flow rate is 2 kg/s, calculate (a) the rate of heat transfer to the air in the heat exchanger, (b) the power output from the turbine assuming no heat loss, and (c) the velocity at exit from the nozzle, assuming no heat loss. Take the enthalpy of air as $h = c_p t$, Assume specific heat for air $c_p = 1.005$ kJ/kg.k] **[8 Marks]**

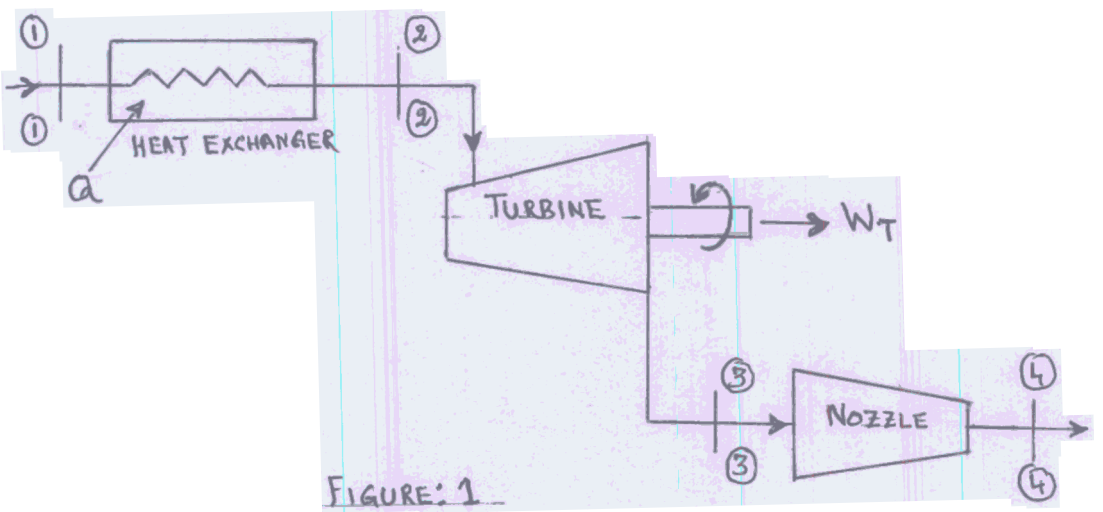

FIGURE: 1

2. Consider the piston/cylinder arrangement shown in Fig. 2. A frictionless piston is free to move between two sets of stops. When the piston rests on the lower stops, the enclosed volume is 400 L When the piston reaches the upper stops, the

volume is 600 L. The cylinder initially contains water at 100 kPa, 20% quality. It is heated until the water eventually exists as saturated vapor. The mass of the piston requires 300 kPa pressure to move it against the outside ambient pressure. Determine the final pressure in the cylinder, the heat transfer and the work for the overall process. **[7 Marks]**

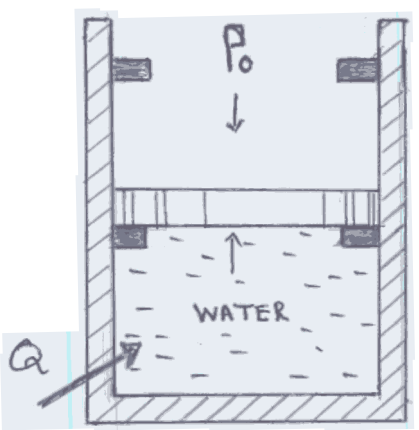

FIGURE: 2.

3. A refrigerator needs to make a tray of 0.25 kg of liquid water at 10 $^{\circ}$ C is converted into ice cubes at 0° C. Assume the refrigerator works in a Carnot cycle between –8° C and 35° C. Calculate the amount of work input for the refrigerator. **[5 Marks]**

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I st Year II nd Semester 2007-2008
Course: ES UC112 Thermodynamics
Test : 1 [Closed Book]

Max.Marks :25 **Date: 09 / 03/2008**
Weightage : 25 % **Time : 50 min**

[COMMON TO ALL BRANCHES]

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

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1. Water is contained in a cylinder fitted with a frictionless piston, as shown in Fig.1. The mass of water is 1 kg and the area of the piston is 0.5 m^2. At the initial state the water is at 110 ^{0} C, with a quality of 90 %, and the spring just touches the piston, but exerts no force on it. Now heat is transferred to the water, and the piston begins to rise. During this process, the resisting force of the spring is proportional to the distance moved, with a force of 10 N /mm. Calculate the pressure in the cylinder when the temperature reaches 200 ^{0} C. **[10 Marks]**

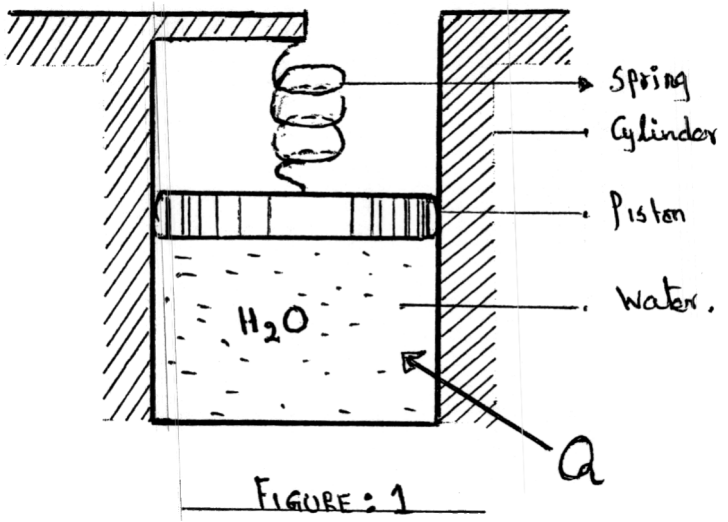

FIGURE : 1

2. The cylinder shown in Fig.2 contains 1 kg of saturated water at 30 ^{0} C. The piston has a cross sectional area of 0.065 m^2, a mass of 40 kg, and is resting on the stops as shown. The volume at this point is 0.1 m^3, Atmospheric pressure out side is

94 kPa, and the local gravitational acceleration is 9.75 m/ s^2. Heat is now transferred to the system until the cylinder contains saturated vapor. [Assume specific heat for water c_p = 4.195 kJ/kg.k]

(a) What is the temperature of the water when the piston first rises from the stops?

(b) Calculate the heat transfer to the system during the process.

(c) Calculate the work done by the water during the overall process. **[9 Marks]**

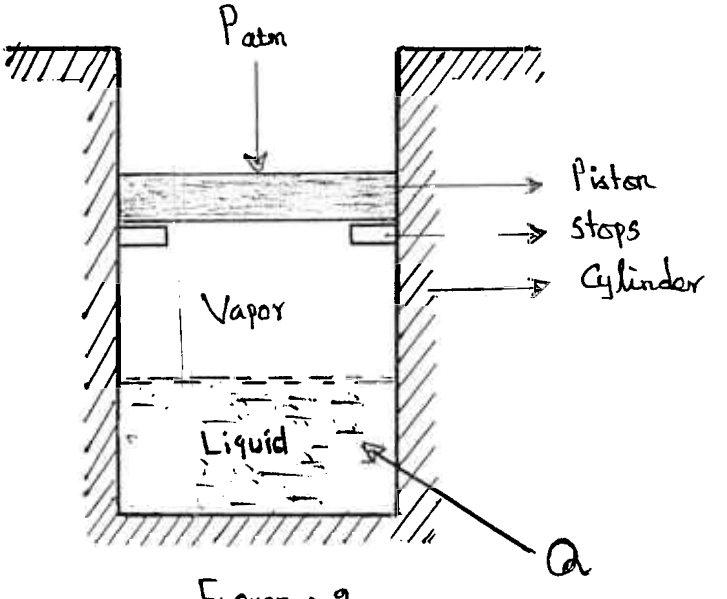

FIGURE : 2

3 To a closed system 150 kJ of work is supplied. If the initial volume is 0.6 m^3 and pressure of the system changes as p = 8 – 4V, where p is in bar and V is in m^3 determine the final volume and pressure of the system. **[6 Marks]**

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