BITS, PILANI DUBAI CAMPUS
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
I Year First Semester 2012-2013

Course: BITS F111 Thermodynamics

Comprehensive Examination [Closed Book]

Max.Marks: 80
Weightage: 40 %

Date: 03-01-2013
Time: 3 hours

COMMON TO ALL BRANCHES

*Note: (i) Answer all Questions in a sequence (ii) Assume suitable value if required (iii) Thermodynamics Datebook is permitted (iv) Answer Every Question on a fresh page (v) Answer the questions of **Part A , Part B and Part C separately***

PART A

1. An ideal gas is expanded through a polytropic process from 500 kPa to 200 kPa while its volume is tripled. a) Calculate the polytropic exponent. b) What will be the ratio of final to initial volume for the same pressure conditions, assuming the value of n as 1? **(6 M)**

2. Define the phase of the water at the following states and depict in PV and TV diagrams. i) 2000 kPa, 300 °C. ii) 300 °C, 0.02 m^3/kg. **(6 M)**

3. Calculate the average specific volume and density of concrete mixture in a $2m^3$ container. The mixture is prepared by mixing 500 kg of granite stone, 250 kg of dry sand, 0.5 m^3 of liquid water at 25 °C and the rest is air. The density of air is given as 1.1 kg/m^3. **(6 M)**

4. In a bulldozer arm piston/cylinder, the fluid pressure is 2 kPa and the radius of the cylinder is 50 cm. It moves sand, cement and water from a distance of 5m, 10m and 15m respectively. Calculate the total work done. How much work has to be done if 100 kg of this mixture has to be transferred to a truck at a height of 4 m? **(6 M)**

5. In a piston/cylinder saturated water at 500 kPa undergoes a constant pressure change to 200 °C. If the piston is initially at 10 cm from the bottom of the cylinder, whose radius is 30 cm, calculate the work done and change in volume of the cylinder in the process. **(6 M)**

PART B

1. A piston/cylinder contains air at 600 kPa, 290 K and a volume of 0.01 m^3. A constant-pressure process gives 54 kJ of work out. Find the final temperature of the air and the heat transfer input. **(8M)**

2. The front of a jet engine acts as a diffuser,receiving air at 900 km/hr, -5^{0}C, and 50 kPa,bringing it to 80 m/s relative to the engine before entering the compressor (Fig.1). If the flow area is reduced to 80% of the inlet area, find the temperature and pressure in the compressor inlet. **(8M)**

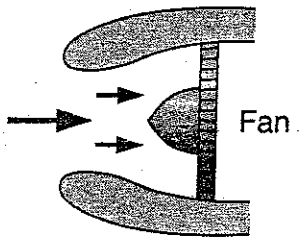

Fig. 1

3. A heat pump heats a house in the winter and then reverses to cool it in the summer. The interior temperature should be 20 °C in the winter and 25 °C in the summer. Heat transfer through the walls and ceilings is estimated to be 2400 kJ per hour per degree temperature difference between the inside and outside. (a) If the outside winter temperature is 0 °C, what is the minimum power required to drive the heat pump? (b) For the same power in part (a), what is the maximum outside summer temperature for which the house can be maintained at 25 °C? **(7M)**

PART C

1. A nozzle in a high pressure liquid water sprayer has an area of 0.5 cm^2 .It receives water at 250 kPa, 20 °C and the exit pressure is 100 kPa. Neglect the inlet kinetic energy and assume a nozzle isentropic efficiency of 85 %.Find (a) the ideal nozzle exit velocity (b) the actual nozzle mass flow rate (c) Represent the real process and the ideal process in a T-s diagram. **(9M)**

2. A heat engine receives heat from a source at 1500 K at a rate of 700 kJ/s and it rejects the waste heat to a medium at 320 K.The measured power output of the heat engine is 320 kW. Determine (a) the reversible power (b) the rate of irreversibility and (c) the II law efficiency of this engine. **(9M)**

3. A constant pressure piston/cylinder contains 0.5 kg of water at 500 kPa and 100°C. Heat is added from a reservoir at 700 °C to the water until it reaches 700 °C. Find the (a) Entropy generated and (b) total irreversibility in the process if the surrounding is at 25 °C. **(9M)**

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FIRST SEMESTER 2012-13

COURSE: BITS F111 Thermodynamics

Test 2 (Open Book)

Max. Marks: 40 **Date: 25.11.12**

Weightage: 20% **Time: 50 min**

Note: Answer all the Questions and Assume suitable value if required.

1. Air enters a compressor operating at steady state at 200 kPa, 300 K. The exit is at 800kPa, 500 K, with negligible kinetic energy change . Heat transfer from the compressor to its surroundings occurs at a rate of 200 kJ/min. Calculate the power input to the compressor. (6 M)

2. Steam enters a turbine operating at steady state with a mass flow rate of 4000 kg/h. The turbine develops a power output of 800 kW. The inlet conditions are 5 MPa, 300°C, and the velocity is 10 m/s. At the exit, the pressure is 30 kPa, the quality is 80% , and the velocity is 60m/s. Calculate the rate of heat transfer between the turbine and surroundings. (8 M)

3. A diffuser is an adiabatic device that decreases the kinetic energy of the fluid by slowing it down. What happens to this lost kinetic energy? (3 M)

4. R-134a enters the capillary tube of a refrigerator as saturated liquid at 35 °C and is throttled to 10 °C. Determine the state of the refrigerant at the exit and the pressure drop during the process. (10 M)

5. Air at 100 kPa, 900 K enters a nozzle and exits at 825 K, 100 kPa. Calculate the inlet velocity if the exit velocity is 550 m/s assuming there is no heat loss. (6 M)

6. Water at 10 °C, 200 kPa is used to cool the air flowing in to a heat exchanger 1000 K to 500 K. If the inlet and outlet pressure of air is same and is equal to 1100 kPa. Calculate the ratio $\dot{m}_{H2O} / \dot{m}_{air}$, if the water leaves as saturated vapor at the inlet pressure. (7 M)

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FIRST SEMESTER 2012-13

COURSE: BITS F111 Thermodynamics

Test I (Closed Book)

Max. Marks: 50 **Date: 11.10.2012**

Weightage : 25% **Time: 50 min**

Note: Answer all the Questions and Assume suitable value if required. Mention appropriate units in your answers. Without units, the answer will not be deemed as correct, even if the numerical value is correct.

1. A 10 m long vertical tube of cross sectional area 300 cm^2 is placed in a water fountain. It is filled with 15°C water, the bottom closed and the top open to the 100 kPa atmosphere.
   a) How much water is in the tube?
   b) What is the pressure at the bottom of the tube? **(6)**
2. The balloon behaves so the pressure is $P = CV^{1/3}$, C = 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 initial pressure, final mass of the air, assuming it is at 25° C, and the work done by the air. Show the process in a P-v diagram. **(10)**
3. 5 kg of saturated liquid – vapour mixture of water is contained in a piston–cylinder device at 125 kPa. Initially 2 kg of water is in the liquid phase while the rest is in vapour state. Heat is transferred to the water and the piston which is resting on a stops start moving when the pressure inside reaches 300 kPa. Heat transfer continues at constant pressure until the total volume increases by 20%. Find **(a)** Initial and final temperature **(b)** Mass of liquid water when the piston first starts moving **(c)** Overall work done and **(d)** Represent the process in a P-v diagram. **(17)**

4. Heating of a liquid-vapor mixture of R 134-a from 10°C to 50°C in closed rigid vessel of 2 m^3 makes the liquid phase to disappear. Calculate **(a)** the initial quality and initial mass of liquid **(b)** the work done during the process and **(d)** plot the process in a T-v diagram. **(10)**

5. 0.5 kg ammonia at 70°C and 0.03787 m^3/kg undergoes an expansion process at constant pressure producing 100 kJ of work. Determine **(a)** Initial pressure **(b)** final temperature and **(c)** final volume of ammonia. **(7)**

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BITS, PILANI – DUBAI CAMPUS
FIRST SEMESTER 2012 – 2013

First Year Sections 1, 2 & 3

Quiz 2 **A**

Course Code: BITS F111	Date: 31. 10 .12	**Name:**----------
Course Title: THERMODYNAMICS	Max Marks: 14	**ID.No:**----------
Duration: 20minutes	Weightage : 7%	**Sec.:** ----------

Instructions: 1. Attempt all questions 2. Assume suitable value if required

[Cp (CO_2) = 0.842 kJ/kg-K, Cv (air) = 0.717 kJ/kg-K]

1. A 1200 kg car is accelerated from 30 to 50 km/h in 5 s. Find the work done in the process. (2)

2. CO_2 is heated from 500 to 1500 K at constant pressure. Find the specific heat transfer during the process. (2)

3. A 1.30 m^3 rigid vessel containing 1.5 kg of air is heated up by 30 °C. Calculate the work done and heat transfer. (2)

4. An ideal gas undergoes an expansion from 100 kPa, 1.5 m^3 to 10 kPa, 5.7 m^3. Calculate the polytropic exponent. (3)

5. Heat is transferred steadily through a 0.2m thick 8m x 4m wall at a rate of 1.6kW.The inner and outer surface temperature of the walls are 15°C and 5°C respectively. Find the average thermal conductivity of the wall. (2)

6. A 3m^2 hot black surface at 80°C is losing heat to the surrounding air at 25°C.The heat transfer coefficient of the black surface is 12 W/m^2K. Calculate the rate of heat loss from the surface. (3)

BITS, PILANI – DUBAI CAMPUS
FIRST SEMESTER 2012 – 2013
First Year Sections 1, 2& 3

Quiz 2 **B**

Course Code: BITS F111	Date: 31. 10 .12	**Name:**----------
Course Title: THERMODYNAMICS	Max Marks: 14	**ID.No:**----------
Duration: 20minutes	Weightage: 7%	**Sec.:** ----------

Instructions: 1. Attempt all questions 2. Assume suitable value if required

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BITS, PILANI – DUBAI CAMPUS
FIRST SEMESTER 2012 – 2013
First Year Sections 1, 2 & 3

Quiz 1 **A**

Course Code: BITS F111	**Date: 26.09.12**	**Name:----------**
Course Title: THERMODYNAMICS	**Max Marks: 16**	**ID.No:----------**
Duration: 20minutes	**Weightage: 8%**	**Sec.: ----------**

Instructions: ***1. Attempt all questions*** ***2.Assume suitable value if required***

1. A 2 m^3 container is filled with 800 kg of granite (density of 2400 kg/m^3) and the rest of the volume is air with density equal to 1.15 kg/m^3. Find the mass of air and the overall (average) specific volume. (3)

2. A manometer shows a pressure difference of 1 m of liquid water. Find ΔP in k Pa. (2)

3. Separate the following T, v, m, V into intensive and extensive properties (2)

4. During a heating process the temperature of an object rises by 20°C.What is the equivalent temperature rise in Kelvin? (1)

5. In a 2m deep swimming pool, what is the pressure difference between the top and bottom? (2)

6. A spherical vessel of 5 m radius keeps a vacuum 0f 0.05 kPa. What is the net force acting on its surface? (2)

7. If a body of 5 kg is at an altitude of 50 m, moving down with its all energy, what will be the velocity? (2)

8. What will be the direction of motion, if 100 N upward force is applied on a body of 9 kg at a height of 10 m in normal gravitational force? (2)