BITS, PILANI – DUBAI CAMPUS
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
I Year Second Semester 2010-2011
Course: ES C112 Thermodynamics
Comprehensive Examination [Closed Book]

Max.Marks:80 Date: 2-6-2011

Weightage: 40 % COMMON TO ALL BRANCHES Time: 3 hours

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 in Blue, Part B in Green and Part C in Brown***

PART A

1. The hydraulic piston-cylinder system has a cylinder diameter of 0.2 m with a piston and rod mass of 50 kg. The rod has a diameter of 0.02 m with an outside atmospheric pressure of 100 kPa. The inside hydraulic fluid pressure is 300 kPa. How large a force can the rod push in the upward direction? **(8M)**
2. A 1-m^3 rigid tank with air at 1 MPa and 400 K is connected to an air line. The valve is opened and air flows into the tank until the pressure reaches 5 MPa, at which point the valve is closed and the temperature inside is 450 K. (a) What is the mass of air in the tank before and after the process? (b) The tank eventually cools to room temperature, 300 K. What is the pressure inside the tank then?**(7M)**
3. A frictionless piston–cylinder device containing 2 kg of nitrogen at 100 kPa and 300K, is compressed slowly according to the relation $PV^{1.4}$ = constant until it reaches a final pressure of 400kPa. Calculate the final volume, final temperature and work done during this process. **(12M)**

PART B

1. Saturated water at 130°C and 45 % quality is heated in a rigid vessel to 140°C. Calculate the new quality and internal energy. **(6M)**
2. Air, in a jet engine enters a nozzle with velocity 50 m/s. The inlet condition is 1200 K, 300 kPa. It exits at 800 K, 120 kPa. Assuming no heat loss in the process calculate the exit velocity. **(6M)**

3. Methane at 4000 kPa, 300 K is throttled through a valve to 1000 kPa. Calculate the exit temperature by assuming there is no change in kinetic energy. **(4M)**
4. 200 g of water at 400°C, 20 MPa in a piston/cylinder is cooled through a constant pressure process. Calculate the change in internal energy and the total heat transfer in the process if the final quality is 0.01 %. **(10M)**

PART C

1. A cyclic machine receives 400kJ from a 1000K energy reservoir. It rejects 200kJ to a 400K energy reservoir and the cycle produces 200 kJ of work as output. Is this cycle a reversible, irreversible or impossible? Justify. **(5M)**
2. A piston-cylinder setup with 5 kg of R-134a at -20°C and 100 kPa is compressed to 500 kPa in a reversible adiabatic process. Find the final temperature and work done during the process. Represent the process in a T-s diagram. **(10M)**
3. Water at 200kPa and 10°C enters the mixing chamber at a rate of 2.5 kg/s where it is mixed steadily with steam entering at 200kPa and 150°C.The mixture leaves the chamber at 200kPa and 70°C.Heat is lost to the surrounding air which is at 20°C at a rate of 3kJ/s. Neglecting the changes in kinetic energy and potential energy, determine the rate of entropy generated and the extent of irreversibility during the process. **(12M)**

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SECOND SEMESTER 2010-11

COURSE: ES C112 Thermodynamics

Test : 2 (Open Book)

Max. Marks: 40 **Date: 17.4.11**

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

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

1. A piston-cylinder setup has a volume of 0.6m^3 and contains 0.6 kg of steam at 400 kPa. Heat is transferred in a constant pressure process until a temperature of 250°C is reached. Determine the amount of heat transferred and work done during the process. Represent the process in a P-v diagram. **(7)**

2. The compressor in a plant receives nitrogen at 100kPa and 250K with a low velocity. Nitrogen exits the compressor at 1000kPa and 500K with velocity of 20m/s. It then flows into a heat exchanger where it is cooled to 350K.The power input to the compressor is 50kW.Determine the heat transfer in the heat exchanger.**(7)**

3. A rigid container has 1.5 kg of ammonia at 60 °C, 300 kPa. It is now cooled to a final temperature of -20 °C. Find the final pressure, work done and amount of heat transferred in the process.**(7)**

4. An exhaust fan of area 1 m^2 gives out air at 40 °C, 125 kPa from a kitchen. The outgoing rate is 0.66 m^3/s. Calculate the mass flow rate. Also calculate the inlet velocity, if air inside the kitchen is at 100 kPa and 38 °C.**(6)**

5. A 10-L rigid tank contains R-22 at -10^{0}C with a quality of 80%. A 10-A electric current, from a 6V battery is passed through a resistor inside the tank for 10 min, after which the R-22 temperature is 40^{0}C. What was the heat transfer during this process?**(6)**

6. The front of a jet engine acts as a diffuser, receiving air at 900 km/h, -5^{0}C, and 50 kPa, bringing it to 80 m/s relative to the engine before entering the compressor. If the flow area is reduced to 80% of the inlet area, find the temperature and pressure in the compressor inlet.**(7)**

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SECOND SEMESTER 2010-11

COURSE: ES C112 Thermodynamics

Test : I (Closed Book)

Max. Marks: 50 **Date: 27.2.11**

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

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

1. How does the boiling process at super critical pressure differ from the boiling at sub critical pressures?.**(3)**

2. A Manometer is used to measure the pressure in a tank which is filled with a fluid of specific gravity 0.85.The height to which the fluid raises is 55 cm .If the atmospheric pressure is 96 kPa , determine the absolute pressure in the tank.**(3)**

3. A cylinder containing ammonia is fitted with a piston restrained by an external force that is proportional to cylinder volume squared. Initial conditions are 10°C, 90% quality and a volume of 5 L. A valve on the cylinder is opened and additional ammonia flows into the cylinder until the mass inside has doubled. If at this point the pressure is 1.2 MPa, what is the final temperature? .**(10)**

4. Two vertical cylindrical storage tanks are full of liquid water (density = 1000 kg/m^3) with the top open to the atmosphere. One is 10 m tall and 2 m in diameter; the other is 2.5 m tall with 4 m diameter. What is the force at the bottom of each tank and what is the pressure at the bottom of each tank ?.**(8)**

5. A gas is contained in a vertical, frictionless piston-cylinder device. The piston has a mass of 5kg and a cross sectional area of 30cm^2 .A compressed spring above the piston exerts a force of 50N on the piston. If the atmospheric pressure is 100 kPa ,determine the pressure inside the cylinder **(9)**

6. The pressure gauge on an air tank shows 75 kPa , when the diver is 10 m down in the ocean. At what depth will the gauge pressure be zero? What does that mean? .**(9)**

7. Water at 120 °C with a quality of 25 % has its temperature raised 20 °C in a constant volume process. What is the new quality and pressure? Show the process in a T-v diagram. **(8)**

BITS, PILANI – DUBAI CAMPUS
SECOND SEMESTER 2010 – 2011

First Year Sections 2, 4 & 6

Quiz 2 A

Course Code: ES C112	Date: 2. 5 .11	**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

1. A heat engine produces a power of 5MW, when it operates between 400K and 300K.Find the amount of heat input to the heat engine and its thermal efficiency.(**4**)

2. A heat engine that pumps water out of an underground mine accepts 500 kJ of heat and produces 200 kJ of work. How much is the heat rejected out?(**1**)

3. Heat is transferred to heat engine from furnace at a rate of 90 MW. If the rate of waste heat rejection to cold body is 50 MW, determine the net power output for the heat engine.(**2**)

4. The food compartment of refrigerator is maintained by removing heat from it at a rate of 8 kJ/s. If the power required input is 4 kW, calculate the coefficient of performance of the refrigerator **(2)**

5. A heat pump has a coefficient of performance of 1.7. Determine the heat transferred to and from this heat pump, when 50 kJ of work is supplied. **(4)**

6. What are perpetual motion machines? **(1)**

x----------x

BITS, PILANI – DUBAI CAMPUS
SECOND SEMESTER 2010 – 2011
First Year Sections 2, 4 & 6

Quiz 1 **A**

Course Code: ES C112	Date: 21. 3 .11	**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. Differentiate heat from work **(2)**

2. ${}_1W_2 \neq W_2 - W_1$,why? **(2)**

3. Find the work done when helium expands from 125kPa, 350K and 0.25 m^3 to 0.5m^3 in a polytropic process with n=1. **(2)**

4. How long a storage battery will run if it has electrical energy of 1000 J and delivers power at the rate of 1.2 V and 5 mA ? **(2)**

5. 5 kg of iron rod is taken for 200 m on a horizontal belt running with a force of 1000 N and then lifted to 10 m height for a construction work. Find the total work done. (**2**)

6. 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 volume and temperature of the air **(3)**

7. A 2-m^2 window has a surface temperature of 25°C, and the outside wind is blowing air at 2°C across it with a convection heat transfer coefficient of h=125W/m^2K. What is the total heat transfer loss? **(3)**