**BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI (RAJ)**

**Second Semester (2015-2016)**

**Course No: BITS F111 Thermodynamics**

**Mid semester test (Open book)**

**Max Mark 90 Friday, 15th March 2016 Duration 90 min**

* The Question paper has two parts**: Part A (3Mx10=30 marks) and Part B(20Mx3=60Marks)**
* Answer **Part A** in the **question paper** itself in the space provided**. Submit Part A before 30 min.**
* Answer **Part B** in the answer book

Name: ID: Section No.:

**PART A**

1. A diver's tank gauge shows 40 kPa at sea level. If he sees the gauge reading ZERO at a certain depth in sea, does it mean that all the gas inside has been emptied? Justify. What will the diver do to breathe then?

1. A balloon containing an ideal gas is initially kept in an insulated room. The room is then evacuated, the balloon ruptures, and the gas fills up the entire room. At the end of process, internal energy and enthalpy will increase, decrease, or remain constant? Justify your answer.

1. Determine the readings of the two pressure gauges (outer tank (A) first) if the inner tank (B) (see figure) has absolute pressure of 500 kPa, the outer tank has absolute pressure of 50 kPa and the atmosphere a pressure of 100 kPa.

A

B

1. Can a finite amount of work be done on a system during a constant volume process? If yes, give an example.
2. Is an adiabatic, isothermal expansion of an ideal gas possible? If yes, given an example?
3. Draw the throttling process on T-h diagram for an ideal gas. Clearly mention the state on the plot as well as assumption.
4. Can a kitchen be cooled by leaving the door of an electric refrigerator open? Justify your answer with the help of first law of thermodynamics.
5. If a block of iron and a block of tin, having equal volumes each received the same energy input by heat transfer, which block would experience a greater temperature rise? Why?
6. Consider a device with one inlet and one outlet. If the volume flow rates at the inlet and at the outlet are same, is the flow through this device necessarily steady? Justify four answer.

1. A system contains saturated liquid vapor mixture of water of specific volume v1=0.7m3/kg and Pressure P1=150kPa initially. The system undergoes a process from P1 to P2 (Ptriple<P2<P1) such that the quality of mixture remains constant. State whether the specific volume at state 2 increases or decreases or remains constant. Show the process on P-v diagram.

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* Please write proper unit and highlight the final answer

Name: **PART B** Section No.:

1. A piston–cylinder device as shown in Fig.1 contains 20 kg water at 100 kPa and 52.2569 percent quality. At this state, the piston rests on the stops at the bottom. The mass of the piston is such that a 200 kPa pressure is required to float it. Heat is now slowly transferred to the water. When the temperature reaches to 150°C, the piston just touches the first linear spring. When the pressure and temperature reaches to 300 kPa and 400°C the piston just touches the second linear spring. As the piston touches the upper stop, the pressure is 400kPa. The heating continues until the final temperature reaches to 700°C. Assume both the springs with the same spring constant

Determine (*a*) the final pressure (*b*) the work done during this process (kJ) (c) the heat transferred during this process (kJ) (d) show the process on a *P-V* diagram.

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1. An air compressor as shown in Fig. 2 is powered by a direct-coupled two-stage adiabatic steam turbine that is also driving a generator. Steam enters the turbine with a mass flow rate of 13 kg/s at 500°C and 6 MPa. The steam expands in the turbine to a saturated vapor at 300 kPa where 10 percent of the steam is removed for some other use. The remainder of the steam is further expanded in the second stage and leaves the turbine where pressure is 20 kPa and quality is 85 percent.

Air enters the compressor at 98 kPa and 300 K at a rate of 10 kg/s with a low velocity and exits at 1 MPa and 620 K with a velocity of 90 m/s. The compressor is cooled at a rate of 1500 kJ/ min. Determine the net power delivered to the generator by the steam turbine.

1. A balloon is initially contains 40m3 of helium gas at atmospheric conditions of 100kPa and 17°C. The balloon is connected by a valve to a large reservoir that supplies helium gas at 125kPa and 25°C. Now the valve is opened and the helium is allowed to enter the balloon until the pressure equilibrium with the helium at the supply line is reached. The material of the balloon is such that the volume increases linearly with pressure. If no heat transfer takes place during the process, determine (a) the mass of helium that entered the balloon (b) the final temperature in the balloon.

Fig.2