Code No: 07A3EC08 **Set No. 1**

II B.Tech I Semester Regular Examinations, November 2008
THERMODYNAMICS
(Common to Mechanical Engineering, Aeronautical Engineering and Automobile Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain the control volume and its significance.
   (b) If a gas of volume 6000 cm^3 and at a pressure of 100 kPa, is compressed quasistatically to pV^2=constant until the volume becomes 2000 cm^3. Calcuate the final pressure and the work transfer. [6+10]

2. (a) Constant pressure gas thermometer-explain in detail.
   (b) The readings t_A and t_B of two celsius thermometers A and B agree well at ice point (0^0 C) and steam point (100^0). At other points between these two, the temperatures are related by t_A=p+qt_B+rt_B^2, Where p,q and r are constants. When the two thermometers are immersed in a well stirred oil bath, while A reads 51, B reads 50.
      i. Determine what A reads when B reads 30.
      ii. Discuss the question of which thermometer is correct. [6+10]

3. (a) Explain the causes of Irreverisbility.
   (b) An invertor claims to have developed an engine that takes in 105 MJ at a temperature of 400k, rejets 42 MJ at a temperature of 200 k, and delivers 15 Kwh of mechanical work. Listing out all the reasons, suggest your advice inventing money to put this engine in the market. [8+8]

4. (a) Explain the significance of Tripple point in case of pure substance.
   (b) Explain in detail the formation of steam with the help of T-H diagram indicating the salient points. [8+8]

5. An ideal gas cycle of three processes uses Argon (Mol. wt. 40) as a working substance. Process 1-2 is a reversible adiabatic expansion from 0.015 m3, 650 kPa, 270^oC to 0.066 m^3. Process 2-3 is a reversible isothermal process. Process 3-1 is a constant pressure process in which heat transfer is zero. Sketch the cycle in the p-v and T-s planes, and find
   (a) the work transfer in process 1-2,
   (b) the work transfer in process 2-3, and
   (c) the net work of the cycle. Take γ= 1.67. [16]

6. A vessel is divided into three compartments (a), (b), and (c) by two partitions. Part (a) contains Oxygen and has a volume of 0.15 m^3, (b) has a volume of 0.25 m^3 and contains Nitrogen, while (c) is 0.05 m^3 and holds Carbon diaoxide. All three parts are at a pressure of 2.5 bar and a temperature of 15^0C. When the partitions are removed and the gases mix, determine the change of entropy of each constituent, the final pressure in the vessel and the partial pressure of each gas. The vessel may be taken as being completely isolated from its surroundings. [16]

7. (a) What are cyclic and non-cyclic heat engines? Give examples.
   (b) State the four processes that constitute the Ericsson cycle. Show that the regenerative Ericsson cycle has the same efficiency as the Carnot cycle. Mention the merits and demerits of the Stirling and Ericsson cycles. [6+10]

8. For an ideal vapor-compression refrigerating system using R134a and dry compression, the refrigerated region is to be kept at 3^oC, and the ambient air to which heat is rejected is at 30^oC. The rate of heat removal from the refrigerated region is 200 kJ/min. A minimum temperature difference of 10 degree Celsius is to be maintained for heat transfer at the condenser and at the evaporator. For a fixed condensation temperature of 40^oC, plot coefficient of performance and refrigerant flow rate versus temperature difference between the evaporating refrigerant and the refrigerated space in the range of 10 degree Celsius to 30 degree Celsius. [16]

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Code No: 07A3EC08 **Set No. 2**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) Energy is a point function. Explain and prove.
   (b) Prove that heat and work are path functions. [8+8]
2. (a) State the first law of thermodynamics and prove that for non flow process it leads to Q=W+ΔU.
   (b) Define PMMI and the relevance of it. [8+8]
3. (a) Show that the COP of heat pump is greater than the COP of a refrigerator by unity.
   (b) Prove that the efficiency of a reversible engine operating between two given constant temperatures is the maximum. [8+8]
4. (a) Why cannot a throttling calorimeter measure the quality if the steam is very wet?
   (b) Find the enthalpy, entropy and volume of steam at 1.4 Mpa, 380^0 C. Using steam tables only. [6+10]
5. (a) Write down the van der Waals equation of state. How does it differ from the ideal gas equation of state?
   (b) A gas occupies 0.034 m3 at 600 kPa and 85^oC. It is expanded in the non-flow process according to the law $pV^{1.2}$ = constant to a pressure of 60 kPa after which it is heated at constant pressure back to its original temperature. Sketch the process on the p-v and T-s diagrams, and calculate for the whole process the work done, the heat transferred. Take $C_p = 1.047$ and $C_v = 0.775$ kJ/kg K for the gas. [6+10]
6. A gaseous mixture contains 23 % by volume of Nitrogen, 45% by volume of Hydrogen, and 32% by volume of Carbon-dioxide. Calculate the Molecular weight of the mixture, the characteristic gas constant R for the mixture and the value of the reversible adiabatic index γ. (At 10^oC, the c_p values of Nitrogen, Hydrogen, and Carbon dioxide are 1.04, 13.95, and 0.85 kJ/kg K respectively.) A cylinder contains 0.095 m^3 of the mixture at 1.1 bar and 10^oC. The gas undergoes a reversible non-flow process during which its volume is reduced to one-fifth of its original value. If the law of compression is $Pv^{1.25}$ = constant, determine the work and heat transfers in magnitude and direction and the change in entropy. [16]
7. (a) Derive the expression for efficiency of air standard Otto cycle

(b) An engine equipped with a cylinder having a bore of 12 cm and a stroke of 40 cm operates on an Otto cycle. If the clearance volume is 1600 cm3, compute the air standard efficiency. [8+8]

8. (a) Derive the expression for COP of Bell Coleman cycle when the compression and expansion are isentropic

   (b) An air refrigerating plant operates between 1.6 bar and 8 bar. The capacity of the plant is 5.5 ton. The temperature of the air entering the compressor and into an air engine is -4^{o}C and 29^{o}C respectively. The compression and expansion processes are polytropic with exponent n = 1.35. Determine the COP and the net power input for the plant. [8+8]

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Code No: 07A3EC08 **Set No. 3**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) What do you understand by state function and path function?
   (b) Prove that work is a path function and properties are point functions. [6+10]
2. (a) Why should specific heat not be defined in terms of heat transfer?
   (b) During one cycle, the working fluid in an engine engages in two work interactions: 15 KJ to the fluid and 44 KJ from the fluid, and three heat interations, two of which are 75 kJ of the fluid and 40 KJ from the fluid. Evalute the magnitude and direction of the third heat transfer. [6+10]
3. (a) Explain the concept of heat pump ealborately.
   (b) A heat engine performs many cycles during which it develops 21 kJ work and receives 85 kJ heat from the source. Evaluate the thermal efficiency and the heat rejected by the engine. [8+8]
4. (a) Define sensible heat and dry steam.
   (b) A spherical shell of diameter 50 cm contains steam at a pressure of 40 bar and 0.85 dryness fraction. Calculate the mass of water and steam. [6+10]
5. (a) Explain the significance of Vander walls equation and its limitations
   (b) A tank of volume 1.3 m^3 is filled with argon at 6 bar and 260^{o}C. If the gas within the tank changes its state isentropically when it flows from the tank until the pressure drops to the atmospheric pressure of 1 bar, determine the mass of the gas that has left the tank during the process. [6+10]
6. A system consisting of three tanks, all interconnected by pipes and valves, contains Nitrogen, Oxygen, and Argon. One tank contains 5 kg of Nitrogen at 650 kPa, 23^{o}C; another 3.5 kg of Argon at 450 kPa, 48^{o}C; and the third 7 kg of Oxygen at 300 kPa, 80^{o}C. After the valves are opened and the system is allowed to come to equilibrium, compute for the mixture
   (a) the temperature
   (b) the apparent molar mass
   (c) the constant-pressure specific heat
   (d) the gas constant
   (e) the pressure and

(f) the partial pressure of each constituent. [16]

7. A four - cylinder petrol engine working on an air - standard Otto cycle has a swept volume of 2000 cm^3 and the clearance volume in each cylinder is 60 cm^3. Determine the cycle efficiency. If the air at the beginning of the compression stroke is at 100 kpa and 300k, and the maximum cycle temperature is 1650 k, determine the mean effective pressure of the cycle. [16]

8. A R-12 vapour compression refrigeration system is operating at a condenser pressure of 10 bar and an evaporator pressure of 2.2 bar. Its refrigeration capacity is 14 tonnes. The values of enthalpy at the inlet and outlet of the evaporator are 650 and 200 kJ/kg. The specific volume at inlet to the reciprocating compressor is 0.085 m^3/kg. The index of compression for the compressor is 1.15. Determine:

   (a) the power input in kW required for the compressor and

   (b) the COP. Take 1 tonne of refrigeration as equivalent to heat removal at the rate of 3.517 kW. [16]

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Code No: 07A3EC08 **Set No. 4**

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THERMODYNAMICS
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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Differentiate the cyclic process and non cyclic process.
   (b) A vacuum gauge connected to a tank reads 30 Kpa at a location where the barometer reads 755 mm Hg. Calcuate the absolute pressure in the tank assuming density of Hg to be 13,590 kg/m^3. [6+10]

2. (a) Derive the expression for stedy flow energy equation.
   (b) A blower handles 1 kg/sec of air at 20 ^{0}C and consumes a power of 15 kw. The inlet and outlet velocities of air are 100 m/s and 150 m/s respectively. Find the exit air temperature, assuming adiabatic conditions. [8+8]

3. (a) State and prove carnot theorems.
   (b) A rerversible reversed heat engine operates between -13 ^{0}C and 37^0 C. Calculate its coefficient of performance as a refrigerator and as a heat pump. [8+8]

4. (a) Why do the isobars on mollier diagram diverge from one another?
   (b) Find the enthalpy and entropy of steam when the pressure is 2 Mpa and the specific volume is 0.09 m^3/kg. Use the steam table only. [6+10]

5. A gas in a cylinder fitted with a piston undergoes a cycle composed of three processes. First, the gas expands at constant pressure with a heat addition of 42.0 kJ and a work output of 12.0 kJ. Then it is cooled at constant volume by a removal of 48 kJ of heat. Finally, an adiabatic process restores the gas to its initial state. Determine
   (a) the work of the adiabatic process and
   (b) the stored energy of the gas at each of the other two states if its stored energy in the initial state is assigned the value of zero. [16]

6. The number of moles, the pressures, and the temperatures of gases a, b, and c are given as follows

Gas	m (kg mol)	p (kPa)	t (^{0}C)
N_2	1	330	95
CO	3	410	190
O_2	2	680	285

   If the containers are connected, allowing the gases to mix freely, find
   (a) the pressure and temperature of the resulting mixture at equilibrium, and

(b) the change of entropy of each constituent and that of the mixture. [16]

7. (a) What is an air standard cycle? Why are such cycles conceived?

   (b) Find the air standard efficiencies for Otto cycles with a compression ratio of 6 using ideal gases having specific heat ratios 1.35, 1.43 and 1.62. What are the advantages and disadvantages of using helium as the working fluid? [6+10]

8. A food-freezing system requires 22 tonnes of refrigeration at an evaporator temperature of - 30^{o}C and a condenser temperature of 27^{o}C. The refrigerant, R-12, is subcooled 3^{o}C before entering the expansion valve, and the vapour is superheated 4^{o}C before leaving the evaporator. A six-cylinder single-acting compressor with stroke equal to bore is to be used, operating at 1550 rpm. Determine

   (a) the refrigerating effect

   (b) the refrigerant flow rate

   (c) the theoretical piston displacement per sec

   (d) the theoretical power required in kW

   (e) the COP

   (f) the heat removed in the condenser, and

   (g) the bore and stroke of the compressor. [16]

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