Code No: R21032 **R10** SET - 1

II B. Tech I Semester Supplementary Examinations May – 2013
THERMODYAMICS
(Com. to ME, AE, AME, MM)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
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1. a) What are different forms of work energy? Explain each briefly.
   b) Why does free expansion have zero work transfer?

2. a) Make an energy analysis of the steam turbine and rotary compressor.
   b) The gas leaving the turbine jet engine flows steadily into the jet pipe with enthalpy 960 KJ/kg and velocity 250 m/s. The exit from the pipe is at enthalpy 860 KJ/kg, and exhaust is in line with intake. Neglecting heat loss from the system, determine the velocity of gas leaving the pipe.

3. Two kg of air at 500 KPa, 80^0C expands adiabatically in a closed system until its volume is doubled and its temperature becomes equal to that of the surroundings which is at 100 KPa, 5^0C. For this process, determine: a) the maximum work, b) the change in availability and c) the irreversibility for air, take Cv = 0.718 KJ/Kg-K and R = 0.287 KJ/Kg-K.

4. a) List out different colorimeters used to find the quality of wet steam, Explain any one of them.
   b) In a steam engine the steam at the beginning of the expansion process is at 7 bar, dryness fraction 0.98 and expansion follows the low $PV^{1.1}$ = constant, down to a pressure of 0.34 bar, calculate The work done during expansion per kg of steam.

5. a) Prove that the partial molar Gibbs function is equal to the chemical potential.
   b) A vessel contains at 1.2 bar and 23^0C a mixture of 1 mole of CO_2 and 3 moles of air. Calculate for the mixture i) The mosses of CO_2, O_2 and N_2 and the total mass ii) The percentage carbon content by mass iii) Apparent molecular weight and gas constant for the mixture

6. a) Explain: i) Saturated air, ii) Vapour presser and iii) Partial pressure
   b) Air (N_2 = 77%, O_2 = 23% by weight) at 20^0C and 10 bar is contained in a vessel of capacity of $0.5m^3$. Some quantity of carbon dioxide is forced into the vessel so that the temperature remains at 20^0C but the pressure rises to15bar. Fined the masses of oxygen, nitrogen and carbon dioxide in the cylinder the universal gas constant 8.3143 KJ /kg K.

7. a) What is a cycle? What is the difference between an ideal and actual cycle.
   b) Derive an expression for efficiency of Brayton cycle in terms of pressure ratio.

8. a) State the merits & demerits of regenerative cycle and reheat Rankine cycle.
   b) Find the C.O.P of a refrigeration system if the work input is 75kJ/kg and refrigeration effect produced is 160 kJ/kg
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1. a) State the conditions for a process to be reversible.
   b) A mass of gas is compressed in a quasi-static process from 75 kpa, 0.1 m^3 to 0.45 Mpa, 0.03 m^3. Assuming that the pressure and volume are related by PV^n=constant, find network done by gas system.

2. a) Derive the expression for the first law of applied to i) a cycle, ii) a process
   b) Air expands in reversible adiabatic manner through a horizontal nozzle from 800 kpa and 350^0C to an exit pressure of 100 kpa. Determine the exit velocity and the mass flow rate, if the exit area is 5 cm^2. Neglect the inlet velocity .Assume γ =1.4,C_p=1.005,kJ/kg-K and R=0.287 kJ/kg-K.

3. An engine working on Carnot cycle absorbs Q_1 units of heat from a source at T_1 and rejects Q_2 units of heat to a sink at T_2. T_e temperature of the working fluid is θ_1, θ_2, where $\theta_1<T_1$ and $\theta_2<T_2$ If $\theta_1= T_1$-K Q_1 and $\theta_2= T_2$+K Q_2. Where k is constant, then show that efficiency of the engine is given by: η= 1-(T_2/ T_1-2K Q_1)

4. a) Determine an expression for the work done in a closed isothermal process?
   b) Gas from a bottle of compressed helium is used to inflate an inelastic flexible balloon, originally floded completely flat to a volume of 0.65m^3.If the barometer read 760mmHg, what is the amount of work done upon the atmosphere by the balloon? Sketch the system before and after the process.

5. a) Prove that PV^n=constant for an adiabatic process.
   b) A container of 3 m^3 capacity contains 10kf of CO_2 at 27^0C. Estimate the pressure exerted by CO_2 by using i) Perfect gas equation, ii) Vander Waals equation

6. a) Define: i) Specific humidity and ii) Relative humidity
   b) One kg of air at 35^0C DBT and 60 % RH is mixed with 2 kg of air at20^0C DBT and 13^0C dew-point temperature. Calculate the specific humidity of the mixture.

7. An air-standard cycle has a compression ratio of 6. The temperature at the start of compression process is 25^0C and the pressure is 1 bar. If the maximum temperature of the cycle is 1150^0C, calculate the heat supplied per kg of air, Net work done per kg of air, and Thermal efficiency of cycle. Assume γ =1.4,C_v=0.718,kJ/kg-K for air.

8. a) Discuss the advantages and disadvantages of vapour absorption of vapour absorption refrigeration system over the vapour compression system.
   b) A bell Coleman refrigeration cycle works between 1 bar and 6 bar .the adiabatic efficiency of compression is 85% and expansion is 90%. Find the COP of the system and its tonnage when the air is 1kg/sec. The ambient temperate is 27^0C and refrigerator temperature is 0^0C.

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1. a) What do you understand by microscopic and macroscopic view points?
   b) An open system defined for a fixed region and a control volume are synonymous. Explain

2. a) What is Zeroth law of thermodynamics and define thermometric properties.
   b) Explain the working of constant volume gas thermometer with a neat figure.

3. a) What is a PMM2?
   b) A heat pump operates between two identical bodies of specific heat C and T_1. The operation of the pump cools down one of the bodies T_2. Show that for the operation of pump the minimum work input is given by $W_{min}=C\ [(T_1^2/T_2^2) + T_2 - 2T_1]$

4. a) Draw the phase equilibrium diagram for a pure substance on T-s diagram with constant property lines
   b) A steam boiler initially contains 5 m^3 of steam and 5 m^3 of water at 1 Mpa. Steam is taken out at constant pressure until 4 m^3 of water is left. What is the heat transfer during the process?

5. a) Explain "internal energy", "heat and work"
   b) To a closed system 100 KJ of work is supplied. If the initial volume is 0.5m^3 and pressure of a system changes as P= (8-4V), Where P is in bar and V is in m3, determine the final volume and pressure of the system
   i) The stone is to just enter water
   ii) The stone just comes to rest in drum and
   iii) The heat transferred to surroundings is such that water and stone remain in the same temperature. Assume g=9.81 m/s^2
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6. a) Prove that at adiabatic saturation: tdb=twb=t*.

   b) A mixture of ideal air and water vapour at a DBT of 22^0C and a total pressure of 730mm of Hg abs. has a temperature of adiabatic saturation of 15^0C. Calculate:

   i) the specific humidity in gms /kg of dry air.

   ii) The partial pressure of water vapor

   iii) The relative humidity, and

   iv) Enthalpy of the mixture per kg of dry air

7. a) Describe diesel gas power cycle with help of P-V and T-S diagrams. Derive an expression for air standard efficiency

   b) A diesel engine has a clearance volume of 220 cm^3 and bore and stroke of 15 cm and 20 cm respectively. The inlet conditions are 100KN/m^2 and 20^0C. The maximum temperature of the engine is 1400^0C. Calculate, i) Ideal thermal efficiency of cycle and ii) m.e.p.

8. a) Explain the important components of a simple vapour compression refrigeration system. Also discuss the functions of each component.

   b) Discuss the effect of sub cooling on C.O.P.of the vapor compression refrigeration cycle. Would you derive large sub cooling and why?

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1. A system of volume V contains a mass m of gas at pressure P and temperature T. The macroscopic properties of the system obey the following relationship $(P+(a/V^2)(V\text{-}b))=mRT$. Where a,b,R are constants obtain an expression for the displacement work done by the system during a constant temperature expansion from volume V_1 to V_2. Calculate the work done by a system which contains 10kg of this gas expanding from $1m^3$ to $8m^3$ at temperature of 300K. Use the values
a= $15.7\times10\ Nm^4$, $b=1.07\times10^{-2}m^3$ and R=0.278KJ/kg-K

2. A piston and cylinder machine contains a fluid system which passes through a complete cycle of four processes. During a cycle, the sum of all heat transfers is170 kJ. The system completes 100 cycles per minute. Complete the following table showing the method for each item, and complete the net rate of work output in KW.

Process	**Q(kj/min)**	**W(kf/min)**	**E(kj/min)**
a-b	0	2170	---
b-c	21000	0	---
c-d	-2100	---	-36600
d-a	---	---	---

3. a) State the limitations of first law of thermodynamics.
   b) A reversible heat engine operates between 875K and 310K and delivers a reversible refrigerator operating between 310K and 255K. The engine receives 2000KJ of heat and the network output from the arrangement equals to 350KJ. Calculate the cooling effect of refrigerator.

4. a) Draw T-S diagram of water and show dew point temperature, dry bulb temperature and critical temperature.
   b) Find the entropy of 1 kg of super heated steam at a pressure of 12 bar and a temperature of 250^0C. Take specific heat of super heated steam as 2.1 kJ/ kg k

5. a) Deduce the relationship between absolute temperature and absolute pressure in an adiabatic process.
   b) 1.5 kg of air at pressure 6 bar occupies a volume of $0.2m^3$. If this air is expanded to a volume of $1.1m^3$. Find the work done and heat absorbed or rejected by the air for each of the following methods of trying one the process. i) Isothermally and ii) Adiabatic ally

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6. a) State Dalton's law of partial pressures.
   b) Atmospheric air at 30^0C and a relative humidity of 65% is cooled at a constant pressure of $100KN/m^2$ to 20^0C.Calculate i) the final relative humidity and ii) the change in specific humidity.

7. a) Draw the variation of thermal efficiency against compression ratio of an Otto cycle.
   b) An air standard diesel cycle has a compression ratio of 17.The pressure at the beginning of compression stroke is 1bar and the temperature is 23^0.The maximum temperature is 1430^0C. Determine the thermal efficiency and the mean effective pressure for this cycle .Take γ =1.4

8. In an open cycle air refrigeration machine, air is drawn from a cold chamber at -2^0C and 1 bar and compressed to 11 bar. It is then cooled at this pressure, to the cooler temperature of 20^0C and then expanded in expansion cylinder and returned to the cold room. The compression and expansion are isentropic, and follows the low PV^1 = C. Sketch the p-v and T-s diagrams of the cycle and the for a refrigeration of 15 tones, find
   a) Theoretical C.O.P;
   b) Rate of the air in kg/min;
   c) Piston displacement per minute in the compressor and expander;
   d) Theoretical power per ton of refrigeration.