COLLEGE OF ENGINEERING, PUNE

(An Autonomous Institute of Government of Maharashtra.)
SHIVAJI NAGAR, PUNE - 411 005

END Semester Examination

ME-201- Engineering Thermodynamics

Course: B.Tech   Branch: Mechanical Engineering

Semester: Sem III

Year: 2014-2015   Max.Marks:60

Duration: 3 Hours   Time:- 10.0 am to 1.0 pm   **Date: 28 /11/2014**

Instructions: **MIS No.** | | | | | | | | |

1. Figures to the right indicate the full marks.
2. Mobile phones and programmable calculators are strictly prohibited.
3. Writing anything on question paper is not allowed.
4. Exchange/Sharing of anything likes stationery, calculator is not allowed.
5. Assume suitable data if necessary.
6. Write your MIS Number on Question Paper
7. Use of compressibility chart and steam table is allowed.

Q1 Attempt **FIVE** of the following. **10**

a An iron casting of mass 50 kg at 300°C is cooled by dipping into the oil tub containing 100 kg of at 20°C.The casting is removed from the oil when the cooling has stopped. Find the temperature of the casting. Assume the heat lost by the casting is given to water only and there are no other heat losses. Take specific heat of casting = 480 J/ kg K specific heat of oil = 3200 J/ kg K

b Is this statement correct? *The pressure of an ideal gas mixture is equal to the sum of the partial pressures of each individual gas in the mixture.* If not, how would you correct it?

c What is difference between entropy and entropy generation?

d State zeroth law of thermodynamics? Give its engineering application.

e What do you understand by dead state?

f Represent Brayton cycle on p-v and T-s diagram.

Q2 **a** Find the enthalpy and entropy of steam when the pressure is 2MPa and the specific volume is $0.09 m^3/kg$. **5**

b A rigid tank contains12 kmol of O_2 and 10 kmol of CO_2 gases at 290 K and 750 kPa. Estimate the *volume* of gas tank by i) by ideal gas equation ii) by Kay's rule. **5**

OR

b One mol of an ideal gas at $P_1$and T_1 is allowed to expand reversibly and isothermally till the pressure reduces to one half of the original pressure, followed by constant volume cooling till its pressure one fourth of the original pressure value. Then it is restored to the initial state by reversible adiabatic process. Calculate the net work done by the gas. **5**

Q3 **a** Write SFEE, apply it to insulated nozzle. **5**

In a steady flow system , the working fluid flowing at 5 kg/sec enters the system at bar with a velocity of 300 m/sec, its internal energy is 150 kJ/kg and specific volume 0.4 m^3/kg. The pressure, velocity, internal energy and specific volume values at exit are 1.5 bar, 150 m/s. 100 kJ/kg and 1.2 m^3/kg respectively. The substance looses 5 kJ/kg heat as it passes through the system. Determine the power of system, stating whether it is from or to the system.

b State Kelvin Plank and Clausius statement of second law of thermodynamics. Prove equivalence of Kelvin Plank and Clausius statement. Is the second law independent of the first law? **5**

OR

b A reversible heat engine operates between the reservoirs at a temperature of 600°C and 40°C.The engine drives a reversible refrigerator which operates between the reservoirs at a temperature of 40°C and -20°C.The heat transferred to a heat engine is 2000 kJ and the net output of the combined refrigerator and heat engine plant is 360kJ. **5**

i) Evaluate the heat transferred to a refrigerant and the net heat transferred to the reservoir at 40°C.

ii) Reconsider (i) given that the efficiency of the heat engine and COP of refrigerator are each 40% of their maximum value.

Q4 **a** Derive the expression for Clausius inequality. State three probabilities about occurrence of processes. **5**

OR

a Prove that availability for open system is- **5**

$$a = (h_1 - T_0 S_1) - (h_2 - T_0 S_2)$$

b Determine the maximum useful work that can be obtained if superheated steam at 3MPa and 300°C is allowed to undergo a process in which steam is reduced to dry saturated steam 0.2 MPa and the ambient conditions are 0.1MPa and 300°K. **5**

Q5 **a** Derive the expression of air standard efficiency for Otto cycle. Show that the efficiency of Diesel cycle is lower than the Otto cycle for same compression ratio. Comment why the higher efficiency of Otto cycle compared to Diesel cycle for the same compression ratio is only of an academic interest and not practical importance. **5**

b In an ideal Otto cycle the air at 1.05 bar and 15 ^{0}C is compressed until the pressure is 13 bar. Heat is added at constant volume until the pressure rises to 35 bar. Calculate the compression ratio, maximum temperature in the cycle, air standard efficiency and work done. Take c_v=0.718,R=0.287 **5**

Q6 **a** What is effect of following on the performance of Rankine cycle **5**

i. lowering condenser pressure

ii. superheating the steam

iii. increasing the boiler pressure

b In a thermal power plant operating on Rankine cycle superheated steam at 2.5MPa and 250°C enters a reversible adiabatic turbine and leaves at 10kPa pressure. The low pressure steam is condensed to saturated liquid at 10kPa and fed back to the boiler. Estimate the thermal efficiency of the power plant. **5**