Registration No: | | | | | | | | | | |

Total Number of Pages: 03 **B.TECH**

15BE2103

2nd Semester Regular Examination 2015-16
THERMODYNAMICS
BRANCH: All
Time: 3 Hours
Max Marks: 100
Q.CODE: W567

Answer Part-A which is compulsory and any four from Part-B.
The figures in the right hand margin indicate marks.

Part – A (Answer all the questions)

Q1 Select the most appropriate one from the given options **(2 x 10)**

a) A thermo flask containing hot coffee is an example of (i) open system, (ii) closed system, (iii) perfectly Isolated system, (iv) none of the above

b) A property having the unit kJ/kg implies it as an (i) extensive property, (ii) intensive property, (iii) cannot be predicted (iv) none of the above

c) Heat from a furnace wall reaches an observer at a distance of 10 meters from it by (i) conduction, (ii) convection. Only (iii) radiation only (iv) both (ii) and (iii)

d) The temperature at triple point of water is (i) 1^0C, (ii) 0.01^0C, (iii) 0.001^0C, (iv) none of the above

e) Which of the following is not a thermometric property (i) volume, (ii) pressure, (iii) resistance (iv) none of the above

f) A thermodynamic cycle consisting of four processes where heat transfer in different processes are 10kJ, 39kJ, - 25kJ, - 12kJ and work transfer in corresponding processes are 24 kJ, - 5kJ, - 26kJ and 19 kJ respectively. The claim of a cycle is (i) true (ii) impossible (iii) Data insufficient (iv) None of the above

g) Which of the following is not an absolute temperature scale (i) Rankine (ii) Celsius (iii) kelvin (iv) both (i) and (ii)

h) The throttling process is also known as (i) Constant Pressure process (ii) constant temperature process (iii) constant enthalpy process (iv) none of the above

i) The entropy change of a process is negative when (i) heat is added to the system, (ii) heat is removed from the system (iii) the system is isolated (iv) none of the above

j) In a vapour compression refrigeration system the position of components in sequence is (i) compressor, evaporator, expansion valve, condenser (ii) compressor,condenser. evaporator, expansion valve, (iii) compressor, condenser, expansion valve, evaporator (iV) none of the above

Q2 Answer the following questions in brief. **(2 x 10)**

a) Distinguish between macroscopic and microscopic concept of thermodynamics.

b) Distinguish between Fixed mass and control volume concept.

c) Define thermodynamic work and give example of one positive and one negative work transfer.

d) Write the causes for internal and external irreversibility (two from each)?

e) "Heat transfer is always associated with change in temperature". Is it true or false? Justify your answer with example?

f) State the limitations of first law of thermodynamics.

g) Define Dryness fraction? What is its value when the system is at saturated liquid and saturated vapour state?

h) 1kg of butane gas is expanded isentropically from pressure of 2 bar to 0.5 bar. Assuming butane as an ideal gas, find its Characteristic gas constant value.

i) Find the entropy change of 2kg of water during evaporation at 10 bar pressure

j) Draw the schematic diagram of a simple steam power plant.

Part – B (Answer any four questions)

Q3 **a)** 0.25 m^3 of air at 5 bar and 130 ^{0}C is contained in a system. A reversible adiabatic expansion takes place till the pressure falls to 1.02 bar. The gas is then heated at constant pressure till enthalpy increases by 72.5 kJ. Calculate **(10)**

(i) Work done

(ii) The index of expansion, if the above processes are replaced by a single reversible polytrophic process giving the same work between the same initial and final states.

Take C_P =1.005 kJ/kg-K and C_V = 0.715 kJ/kg-K.

b) Prove that internal energy of a system is a point function. **(5)**

Q4 **a)** An air compressor compresses air from 0.1 MPa/300K to 1 MPa. The velocity of the air at the compressor inlet and outlet are 40m/s and 100m/s respectively. The cross sectional area of the inlet and exit pipe of the turbine are 100 m^2 and 20 m^2 respectively. The compressor casing is well insulated yet there is a heat loss to the surroundings is of the order of 5 percent of compressor work. Determine (i) The air temperature at the compressor outlet and (ii) power input to the compressor. **(10)**

b) Derive the steady flow energy equation from first law of thermodynamics for an open system with assumptions. **(5)**

Q5 **a)** A reversible heat engine operates between two reservoirs at temperature of 900K and 310K.The engine drives a reversible refrigerator which operates between the reservoirs at temperature of 310k and 255K. The heat transfer to the engine is 2000kJ and the net work output of the combined engine refrigerator plant is 350kJ. Determine **(10)**

(i) the heat transfer to the refrigerant and the net heat transfer to the reservoir at 310K.

(ii) (ii) Repeat the same for (i) with the efficiency of the engine and the COP of refrigerator are each 35% of their maximum possible value.

b) Prove the equivalence of Kelvin- plank and Clausius Statement of 2^{nd} law of thermodynamics. **(5)**

Q6 **a)** A rigid tank of 0.03 m^3 volume contains a mixture of liquid water and water vapour at 80kPa. The mass of the mixture in the tank is 12 kg. Calculate the heat added and the quality of the mixture when the pressure in the tank is raised to 7MPa. **(10)**

b) Name the graphical charts used commonly for steam properties calculation and show different constant properties lines on them. **(5)**

Q7 **a)** A gas mixture contains 3 kg of Nitrogen and 5 kg of Carbon dioxide at a pressure of 3bar and a temperature of 20 ^{0}C is heated at constant volume to 40 ^{0}C. Find the change in internal energy, enthalpy and entropy of the mixture. Given C_V of nitrogen is 0.4kJ/kg-k and C_V of Carbon dioxide is 0.755 kJ/kg-k. **(10)**

b) 0.9 kg of steam, initially at a pressure of 15 bar and a temperature of 2500C, expand reversibly and adiabatically to 1.5 bar. Find the final temperature and work done. **(5)**

Q8 **a)** Two kg of ice at -15^{0}C is exposed to the atmosphere which is at 37^{0}C. The ice melts and comes to thermal equilibrium with the atmosphere Determine (i) the entropy increase of the atmosphere (ii) what is the minimum amount of work necessary to to convert the water back into ice at -15^{0}C. Given C_P of ice is 2.093kJ/kg-K and the latent heat of fusion of ice is 333.3 kJ/kg. **(10)**

b) How the entropy of an irreversible process is determined? **(5)**

Q9 **a)** With the help of neat sketch explain the working principle of both reciprocating engine and refrigerator. Explain how 2^{nd} law of thermodynamics principles applied to them?. **(10)**

b) A dwelling requires 527.5 MJ per day to maintain its temperature at 230C when the outside temperature is 100C. If a heat pump cycle is used to supply this energy. Determine the theoretical work input for one day of operation in kJ. **(5)**