Registration No:

Total Number of Pages: 04 **B.TECH**
PME3I103

3rd Semester Regular Examination 2016-17
ENGINERING THERMODYNAMICS
BRANCH: MECHANICAL
Time: 3 Hours
Max Marks: 100
Q.CODE: Y636
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 **Answer the following questions: *multiple type*** **(2 x 10)**

a) The efficiency of Diesel cycle approaches to Otto cycle efficiency when
(i) cut-off is increased
(ii) cut-off is decreased
(iii) cut-off is zero
(iv) cut-off is constant

b) For a steady flow process from state 1 to 2, enthalpy changes from h_1= 400 kJ/kg to h_2 = 100 kJ/kg and entropy changes from s_1= 1.1 kJ/kg-K to s_2= 0.7 kJ/kg-K. Surrounding environmental temperature is 800 K. Neglect changes in kinetic and potential energy. The change in availability of the system is
(i) 420 kJ/kg (ii) 300 kJ/kg (iii) 180 kJ/kg (iv) 90 kJ/kg

c) One kilomole of an ideal gas is throttled from an initial pressure of 0.5 MPa to 0.1 MPa. The initial temperature is 300 K. The entropy change of the universe is
(i) 13.38 kJ/K (ii)401.3 kJ/K (iii) 0.0446 kJ/K (iv) -0.0446 kJ/K

d) Which combination of the following statements is correct?
P: A gas cools upon expansion only when its Joule-Thomson coefficient is positive in the temperature range of expansion.
Q: For a system undergoing a process, its entropy remains constant only when the process is reversible.
R: The work done by a closed system in an adiabatic process is a point function.
S: A liquid expands upon freezing when the slop of its fusion curve on Pressure Temperature diagram is negative.
(i) R and S (ii) P and Q (iii) Q, R and S (iv) P, Q and R

e) One reversible heat engine operates between 1600 K and T_2 K and another reversible heat engine operates between T_2 K and 400 K. If both the engines have the same heat input and output, then temperature T_2 is equal to
(i) 800K (ii) 1000K (iii) 1200K (iv) 1400K

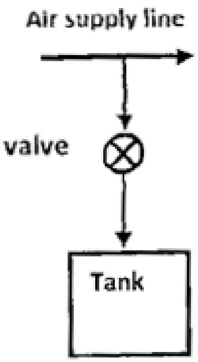
f) Otto cycle efficiency is higher than Diesel cycle efficiency for the same compression ratio and heat input because in Otto cycle

(i) Combustion is at constant volume
(ii) Expansion and compression are isentropic
(iii) Maximum temperature is higher
(iv) Heat rejection is lower

g) Which of the following statement is wrong?

(i) The closed cycle gas turbine plants are external combustion plants.
(ii) In the closed cycle gas turbine, the pressure range depends upon the atmospheric pressure.
(iii) The advantage of efficient internal combustion is eliminated as the closed cycle has an external surface.
(iv) In open cycle gas turbine, atmosphere acts as a sink and no coolant is required.

h) A rigid, insulated tank is initially evacuated. The tank is connected with a supply line through which air (assumed to be ideal gas with constant specific heats) passes at 1 MPa, 350°C A valve connected with the supply line is opened and the tank is charged with air until the final pressure inside the tank reaches 1 MPa. The final temperature inside the tank



(i) Is greater than 350°C (ii) Is less thsn 350°C (iii) Is equal to 350°C

(iv) May be greater than, less than, or equal to350°C , depending on the volume of the tank

i) 170 kJ of heat is supplied to a system at constant volume. Then the system rejects 180 kJ of heat at constant pressure and 40 kJ of work is done on it. The system is finally brought to its original state by adiabatic process.If the initial value of internal energy is 100 kJ, then which one of the following statements is correct?

(i) The highest value of internal energy occurs at the end of the constant volume process
(ii) The highest value of internal energy occurs at the end of constant pressure process.
(iii) The highest value of internal energy occurs after adiabatic expansion
(iv) Internal energy is equal at all points

j) What will be the loss of available energy associated with the transfer of 1000 kJ of heat from constant temperature system at 600 K to another at 400 K when the environment temperature is 300 K?
(i) 150 kJ (ii) 250 kJ (iii) 500 kJ (iv) 700 kJ

Q2 **Answer the following questions: *Short answer type*** **(2 x 10)**

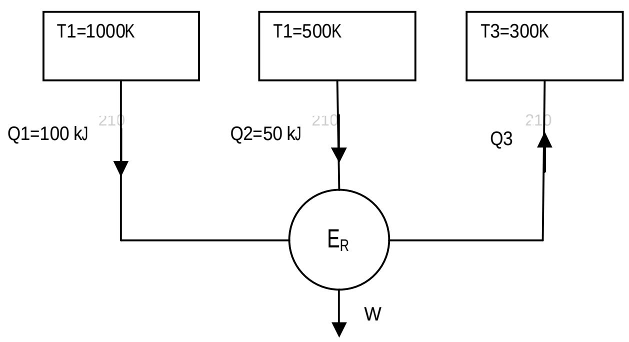
a) Explain Joule-Kelvin effect
b) What do you mean by second law efficiency? Write down the second law efficiency for a power plant. .
c) Why is Carnot cycle not practicable for a steam power plant?
d) Write down the Maxwell's equations.
e) Define steam rate and heat rate in boiler performance calculations.
f) What is the effect of regeneration on the (i) the cycle efficiency (ii) Specific out put (iii) mean temperature of heat addition of a steam power plant?
g) Compare Otto and Diesel cycle for same maximum pressure and temperature condition.
h) Draw the T-s and h-s diagrams for the Vapor compression refrigeration cycle
i) What is a tonne of refrigeration?
j) Why multistage compression is needed?

<u>Part – B (Answer any four questions)</u>

Q3 **a)** Explain the following terms: Availability, Irreversibility, Dead State. **(10)**

In a steam boiler, hot gases from the fire transfer heat to water which vaporizes at constant temperature. In a certain cases, the gases are cooled from 1100°C to 550°C while water evaporates at 220°C. the specific heat of gases is 1005 J/kgK and latent heat of water at 220°C is 1858000 J/kg. all the heat transferred from the gases goes to water. How much does the total entropy of the combined system of gas and water increase as a result of the irreversible heat transfer? Assume mass of water as 1 kg.
If the surrounding temperature is 30°C, find

b) Figure shown below shows a reversible heat engine E_R having heat interactions with three constant temperature systems. Calculate the thermal efficiency of the heat engine. **(5)**



Q4 a) Write down the First and Second Tds equations. **(10)**

Derive the following

$$C_p - C_v = \frac{TV\beta^2}{k_T}$$

Where β and k_T are volume expansivity and isothermal compressibility respectively.

b) Briefly discuss Clausius-Clapeyron equation. **(5)**

Q5 a) A 4-cylinder single stage air compressor has a bore of 200mm and a stroke of 300mm and runs at 400 rpm. At a working pressure of 620 kPa (gauge) it delivers 3.1 m^3 of air per minute at 270°C. Calculate (a) mass flow rate (b) free air delivery (c) effective swept volume(d) volumetric efficiency (d) (e) isothermal efficiency (f) the actual power needed to drive the compressor, if the mechanical efficiency is 85%. Take free air conditions at inlet as 101kPa and 21°C. **(10)**

b) Derive **(5)**

$$\eta_{vol} = 1 + C - C\left(\frac{p_2}{p_1}\right)^{1/n}$$

for air compressor, where C is clearance ratio, p1,p2 are pressures at inlet and exit of compressor and n is compression(=expansion) index.

Q6 a) In a reheat cycle steam at 550°C expands in h.p turbine till it is saturated vapour. It is reheated at constant pressure to 400°C and then expands in l.p. turbine to 40°C. if the moisture content at turbine exhaust is given to be 0.15, find i) the reheat pressure ii) the pressure of the steam at inlet to the h.p. turbine iii) the net work output per kg iv) cycle efficiency. Assume all processes are ideal. **(10)**

b) What is a cogeneration plant? What are the thermodynamic advantages of such a plant? **(5)**

Q7 a) With neat sketch, Describe the working principle of a Vapor absorption cycle. Derive the COP of the vapor absorption system. **(10)**

b) An air receiver of volume 6 m^3 contains air at 15 bar and 41°C. A valve is opened and some air is allowed to blow out to atmsophere. The pressure of the air in the receiver drops rapidly to 12 bar when valve is then closed. Calculate the mass of air which left the receiver. **(5)**

Q8 a) A vapor compression system having a capacity of 10TR uses R-12 as a refrigerant. The evaporator and condenser temperatures are -10°C and 40°C respectively. The liquid refrigerant leaving the condenser is subcooled to 30°C. **(10)**

Assuming isentropic compression, calculate the following:

(i) the mass of refrigerant flowing through the evaporator

(ii) the power required to drive the compressor

COP of the system

b) Write short notes on binary vapor cycle. **(5)**

Q9 **Write short notes on:** **(5X3)**

a) Air Motor

b) Ideal Zet propulsion

c) Actual Rankine Cycle.