Reg. No. :

Question Paper Code : 41385

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018
Third Semester
Mechanical Engineering
ME 6301 – ENGINEERING THERMODYNAMICS
(Common to Automobile Engineering/Mechanical and Automation Engineering
(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

(Use of Steam Table, Mollier chart, Refrigeration tale and Psychometric charts are permtted)
Answer ALL questions.

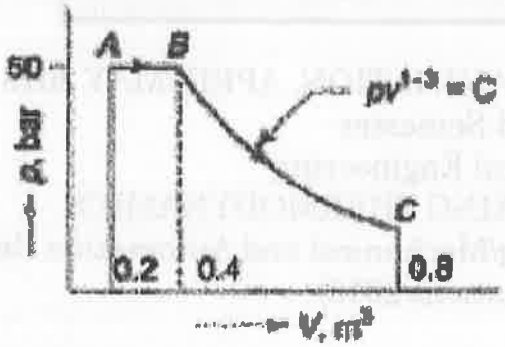
PART – A (10×2=20 Marks)

1. Define the terms Equilibrium, Path and Process.
2. Write the steady flow energy equation for a turbine.
3. State Carnot theorem.
4. Define entropy.
5. Draw the T-S diagram of a reheat cycle.
6. Define dryness and wetness fraction.
7. Write down clausius clapeyron equation.
8. Write down first and second Tds equation.
9. Show sensible heating and cooling process in a psychrometric chart.
10. State Amagat's law.

PART – B (5×13=65 Marks)

11. a) i) Derive the expression for workdone for constant volume and polytrophic process. (8)

ii) Determine the total workdone by a gas system following an expansion process as shown in fig. (5)



(OR)

b) i) Prove energy as a property of the system. (4)

ii) In a steady flow apparatus, 135 kJ of work is done by each kg of fluid. The specific volume of the fluid, pressure and velocity at inlet are m^3/kg, 600 kPa and 16 m/s. The inlet is 32 m above the floor and the discharge pipe is floor level. The discharge conditions are 0.62 m^3/kg, 100 kPa and 270 m/s. The total heat loss between the inlet and discharge is 9 kJ/kg of fluid. In flowing through this apparatus, does the specific Internal energy increase or decrease and by how much ? (9)

12. a) i) A drug shop is required to maintain certain essential items at $-23°C$ in a refrigerator. If a Carnot refrigerator having 200 W of compressor is used for this purpose, estimate the fraction of time the compressor would run in a cold country for a cooling rate of 40000 kJ/day, where the ambient temperature is $18°C$. If the same refrigerator is used in a tropical country where the ambient temperature is $37°C$, what shall be the fraction of the compressor runs. (8)

ii) Prove Carnot theorem. (5)

(OR)

b) One kg of ice at $-5°C$ is exposed to the atmosphere which is at $20°C$. The ice melts and comes into thermal equilibrium with the atmosphere. (13)

a) Determine the entropy increase of the universe.

b) What is the minimum amount of work necessary to convert the water back into ice at $-5°C$?

C_p of the ice is 2.093 kJ/kg K and latent heat fusion of ice is 333.3 kJ/kg.

13. a) Steam initially at 1.5 MPa 300°C expands reversibly and adiabatically in a steam turbine to 40°C. Determine the ideal work output of the turbine per kg of steam. (13)

(OR)

b) A steam power station uses the following cycle : (13)

Steam at boiler outlet 150 bar and 550°C

Reheat at 40 bar to 550°C

Condenser at 0.1 bar.

Using the Mollier chart and assuming ideal processes, find the

a) Quality at turbine exhaust.

b) Cycle efficiency and

c) Steam rate.

14. a) i) Derive the first and second Tds Equation. (5)

ii) Prove $C_p - C_v = -T\left(\frac{\partial v}{\partial T}\right)^2_p\left(\frac{\partial p}{\partial v}\right)_T$. (8)

(OR)

b) Derive Clausius-Clapeyron Equation. (13)

15. a) Explain the Psychometric properties and processes with neat sketch. (13)

(OR)

b) The mixture of 2 kg of hydrogen and 4 kg of nitrogen at initial temperature of 22°C is compressed in a cylinder – piston arrangement so that its temperature rises to 150°C. The mean values of Cp over this temperature range for two constituents are 14.45 kJ/kg K and 1.041 kJ/kg K for hydrogen and nitrogen respectively. Assuming the process to be reversible and polytropic with an index of 1.2 find the heat transfer during the process and change of entropy of each constituent and the mixture. (13)

PART – C (1×15=15 Marks)

16. a) An air pre-heater is used to cool the products of combustion from a furnace while heating the air to be used for combustion. The rate of flow of products is 12.5 kg/s and products are cooled from 300 and 200°C and for the products at this temperature Cp = 1.09 kJ/kg K. The rate of airflow is 11.5 kg/s. The initial temperature is 40°C and the air Cp = 1.005 kJ/kg K. **(13)**

a) Estimate the initial and final availability of the products.

b) What is the irreversibility for the process ?

c) If the heat transfer from the products occurs reversibly through heat engines, what is the final temperature of the air ? What is the power developed by the heat engine ?

Take T_0 = 300 K and neglect pressure drop both the fluids and heat transfer to the surroundings.

OR

b) Atmospheric air at 43°C and 40% relative humidity is to be conditioned to a temperature of 25°C and 50% relative humidity. The method employed is to lower the temperature to dew point of conditioned air and then to raise it to the required temperature. The volume of the conditioned air is 25 m^3/min. Find

a) Dew point

b) Mass of water vapour drained out.

c) Amount of heat required to raise the temperature from the dew point to that of conditioned air **(13)**