Reg. No. :

Question Paper Code : 91835

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019

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 approved Thermodynamics Tables, Mollier diagram, Psychrometric chart and Refrigerant property tables permitted in the Examinations)

Answer ALL questions.

PART – A (10×2=20 Marks)

1. State the first law for a closed system undergoing a process and a cycle.
2. Why does free expansion have zero work transfer ?
3. What is triple point ? For a pure substance, how many degrees of freedom are there at triple point.
4. A vessel of 2 m^3 contains a wet steam of quality 0.8 at 210° C. Determine the mass of the liquid and vapour present in the vessel.
5. Is iced water a pure substance ? Why ?
6. What is the effect of reheat on (a) the network output, (b) the cycle efficiency and (c) steam rate of a steam power plant ?
7. What are reduced properties ? Give their significance.
8. What is the importance of Joule-Thomson coefficient ?
9. State and prove the Amagat's law of partial volume.
10. What is sensible cooling ?

PART – B (5×13=65 Marks)

11. a) A piston-cylinder device contains 0.15 kg of air initially at 2 MPa and 350°C. The air is first expanded isothermally to 500 kPa, then compressed polytropically with a polytropic exponent of 1.2 to the initial pressure and finally compressed at the constant pressure to the initial state. Determine the boundary work for each process and the network of the cycle. **(13)**

(OR)

b) i) Air enters the compressor of a gas-turbine plant at ambient conditions of 100 kPa and 25°C with a low velocity and exits at 1 MPa and 347°C with a velocity of 90 m/s. The compressor is cooled at a rate of 1500 kJ/min and the power input to the compressor is 250 kW. Determine the mass flow rate of air through the compressor. Assume C_p = 1.005 kJ/kg K. **(7)**

ii) Derive steady flow energy equation. **(6)**

12. a) i) Discuss about clausius inequality. **(7)**

ii) With suitable examples explain high and low grade energy. **(6)**

(OR)

b) Two kg of air at 500 kPa, 80°C 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°C. For this process determine

i) The maximum work.

ii) The change in availability and

iii) The irreversibility **(13)**

13. a) A vessel of volume 0.04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9 kg. Find the pressure, the mass, the specific volume, the enthalpy, the entropy and the internal energy. **(13)**

(OR)

b) A reheat Rankine cycle receives steam at 35 bar and 0.1 bar. Steam enters the first stage steam turbine 350°C. If reheating is done at 8 bar to 350°C, calculate the specific steam consumption and reheat Rankine cycle efficiency. **(13)**

14. a) i) A vessel of volume 0.28 m^3 contains 10 kg of air at 320 K. Determine the pressure exerted by the air using a) perfect gas equation b) Vander walls equation c) Generalised compressibility chart. (Take critical temperature of air as 132.8 K and critical pressure of air as 37.7 bar). **(8)**

ii) Draw a neat schematic of a compressibility chart and indicate its salient features. **(5)**

(OR)

b) What is meant by phase change process ? Derive Clausius-Clapeyron equation for a phase change process. Give the significance of this equation. **(13)**

15. a) In an engine cylinder a gas has a volumetric analysis of 13% CO_2, 12.5% O_2 and 74.5% N_2. The temperature at the beginning of expansion is 950°C and the gas mixture expands reversibly through a volume ratio of 8:1, according to the law $pv^{1.2}$ = constant. Calculate per kg of gas :

i) The work done.

ii) The heat flow

iii) Change of entropy per kg of mixture.

The values of c_p for the constituents CO_2, O_2 and N_2 are 1.235 kJ/kg K, 1.088 kJ/kg K and 1.172 kJ/kg K respectively. **(13)**

(OR)

b) With the help of psychrometric chart discuss the following :

Simple heating and humidification process and

Simple cooling and dehumidification process **(13)**

PART – C **(1×15=15 Marks)**

16. a) A reversible heat engine operates between two reservoirs at temperature of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°C and – 20°C. The heat transfer to the heat engine is 2000 kJ and the network output for the combined engine refrigerator is 360 kJ. Calculate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C. **(15)**

(OR)

b) i) The sling psychrometer in a laboratory test recorded the following readings :

Dry bulb temperature = 35° C

Wet bulb temperature = 25° C

Calculate the following :

1) Specific humidity

2) Relative humidity

3) Vapour density in air

4) Dew point temperature

5) Enthalpy of mixture per kg of dry air

Take atmostpheric pressure = 1.0132 bar **(10)**

ii) Write a short note on mixing of air streams in psychrometry. **(5)**
