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Question Paper Code: R3703

B.E./B.Tech. DEGREE EXAMINATION, NOV 2024

Third Semester

Mechanical Engineering

R21UME303 – ENGINEERING THERMODYNSMICS

(Regulations R2021)

Duration: Three hours Maximum: 100 Marks

PART A - (10 x 1 = 10 Marks)

1. Properties do not change with time in CO1-U

   (a) Laminar flow (b) Turbulent flow (c) Unsteady flow (d) Steady flow

2. The application of law of thermodynamics to the enthalpy change was done by CO1- U

   (a) Newton (b) Hess's (c) Lewis (d) Sophocles

3. Kelvin –Planck's law deals with CO1- U

   (a) Conservation of work (b) conservation of heat

   (c) conversion of heat into work (d) conversion of work into heat

4. When a gas is heated at constant volume CO1- U

   (a) temperature will increase (b) pressure will increase

   (c) temperature and pressure will increase (d) none of the above

5. Rankine cycle efficiency for a power plant is 29.6%. The Carnot cycle efficiency will be CO1- U

   (a) Equal to Rankine cycle efficiency (b) More than Rankine cycle efficiency

   (c) Less than Rankine cycle efficiency (d) There is no comparison for the two

6. Heat rate is given by (in kJ/kWh) CO1- U

   (a) cycle efficiency (b) 3600 / cycle efficiency

   (c) cycle efficiency / 3600 (d) cycle efficiency * 3600

7. The first TdS equation is CO1- U

(a) $TdS=Cv*dT + T(\partial T/\partial p)dV$ (b) $TdS=Cv*dT - T(\partial p/\partial T)dV$

(c) $TdS=Cv*dT + T(\partial p/\partial T)d$ (d) $TdS=Cv*dT - T(\partial T/\partial p)dV$

8. A pure substance which exists in a single phase has ____ independent variables. CO1- U

(a) zero (b) one (c) two (d) three

9. In adiabatic evaporative cooling, heat transfer between chamber and surroundings is CO1- U

(a) zero (b) high

(c) low (d) none of the mentioned

10. The wet bulb temperature is the ____ temperature recorded by moistened bulb. CO1- U

(a) lowest (b) highest

(c) atmospheric (d) none of the mentioned

PART – B (5 x 2= 10Marks)

11. Explain the First Law of Thermodynamics for closed system. CO1 -U

12. Illustrate the principle of increase of entropy. CO1 -U

13. State the advantages of regenerative cycle. CO1 -U

14. Illustrate the assumptions made in deriving ideal gas equation using the kinetic theory of gases. CO4-App

15. Explain Relative Humidity CO1 -U

PART – C (5 x 16= 80Marks)

16. (a) A Fluid is confined in a cylinder by a spring loaded frictionless piston, so that the pressure in a fluid is a linear function of volume P=a+bV.The Internal Energy of the fluid is given by the following equation U= 34+3.15PV Where U is in KJ, P is in KPa, V is in m^3 .If fluid changes from an initial state of 170 KPa, 0.03 m^3 to a final state of 400 KPa, 0.06 m^3 with no work transfer other than that done on the piston. Find the direction and magnitude of work and heat transfer. CO2 - App (16)

Or

(b) One kg of gas expands at constant pressure from 0.085 m^3 to 0.13m^3.If the initial temperature of the gas is 225^o Find the final CO2 - App (16)

temperature, net heat transfer, change in internal energy and pressure of gas.

17. (a) A Closed system contains air pressure of 1 bar, temperature 300K,and volume 0.018 m^3 . The system undergoes a thermodynamic cycle consisting of the following three process in series i) Constant volume heat addition till the pressure becomes 5 bar ii) constant pressure cooling and isothermal heating to initial state . Draw the PV Diagram and find out change in entropy for every process. State Cv= 0.718 KJ/KgK R= 0.287 KJ/KgK — CO2 - App — (16)

Or

(b) 5 m^3 of air at 2 bar, 27°C is compressed up to 6 bar pressure following $PV^{1.3}$=C. it is subsequently expanded adiabatically to 2 bar. Considering the two processes to be reversible determine the network, net heat transfer, and change in entropy. — CO2 - App — (16)

18. (a) A Steam boiler generate steam 30 bar and at 300^0 C at the rate of 2Kg/s. The steam is expanded isentropic in turbine to a condenser at a Pressure of 0.05 bar condense at a constant pressure and pumb back to the boiler. Find the Efficiency of the cycle, heat supplied in the boiler, quality of steam after the expansion. — CO4 - App — (16)

Or

(b) A steam power plant operates on a theoretical reheat cycle. Steam at 25 bar pressure and 400°C is supplied to a high pressure turbine. After its expansion to dry state the steam is reheated to a constant pressure to its original temperature. Subsequent expansion occurs in the low pressure turbine to a condenser pressure of 0.04 bar. Considering feed pump work, make calculation to determine
(i) Quality of steam at the entry to the condenser
(ii) Thermal efficiency
(iii) Specific steam consumption. — CO4 - App — (16)

19. (a) A vessel of volume 0.3m^3 contains 15 kg of air at 303K. Determine the pressure exerted by the air using 1. Perfect gas equation, 2. Vander waals equation, 3. Generalized compressibility chart. Take critical temperature of air is 132.8K ,critical pressure of air is 37.7 bar and Z = 0.99 — CO3 - App — (16)

Or

(b) A vessel of volume 0.4 m^3 contains 15 kg of air at 323K. Determine the pressure exerted by the air using 1. Perfect gas equation, 2. Vander waals equation, 3. Generalized compressibility chart. Take critical temperature of air is 132.8K ,critical pressure of air is 37.7 bar and Z = 0.99 — CO3 - App — (16)

20. (a) Air at Atmospheric pressure 1.013 bar has a dry bulb temperature 32^0C and wet bulb temperature 26^0 CDetermine 1) partial pressure of water vapour 2) specific humidity 3) dew point temperature 4) relative humidity 5) degree of saturation 6) density of air 7) density of water vapour 8) enthalpy of mixture. — CO4 - App — (16)

Or

(b) A perfect gas mixture consists of 4kg of N_2 and 6kg of CO_2 at pressure of 4 bar and a temperature of 25˚C. Calculate C_v and C_p of the mixture. If the mixture is heated at constant volume to 50˚C. Find the change in internal energy, enthalpy and entropy of the mixture. Take: For N_2: Cv=0.745 kJ/kg-K, C_p=1.041kJ/kg-K for CO_2, C_v=0.653KJ/kg-K, C_p=0.842KJ/kg-K. — CO4 - App — (16)