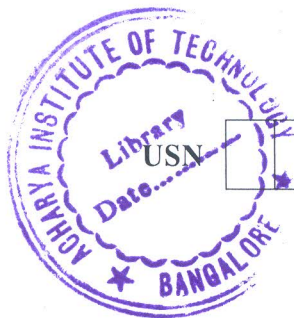


CBCS SCHEME

15AE33



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Third Semester B.E. Degree Examination, Aug./Sept.2020 Aero Thermodynamics

Time: 3 hrs.

Max. Marks: 80

- Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of Thermodynamics data handbook is permitted.*

Module-1

- 1 a. State Zeroth Law of thermodynamics and extract the concept of temperature from it. (04 Marks)
b. In 1709, Sir Issac Newton proposed a new temperature scale. On this scale, the temperature was a linear function of Celsius scale. The reading on this at ice point (0°C) and normal human body temperature (37°C) were 0°N and 12°N respectively. Obtain the relation between the Newton scale and the Celsius scale. (08 Marks)
c. What is Thermodynamic system? Explain the types of thermodynamic system. (04 Marks)

OR

- 2 a. Derive an expression for displacement work in a polytropic process $pV^n = \text{constant}$. Show on a p-v diagram, four expansion process for $n = 0$, $n = 1$, $n = 1.4$ and $n = \infty$. Name each of the process. (06 Marks)
b. A spherical balloon has an initial diameter of 25cm and contains air at 1.2 bar. When heated, the diameter increases to 30cm. During heating, the pressure is found to be proportional to diameter. Calculate the workdone. (06 Marks)
c. Distinguish between heat and work. (04 Marks)

Module-2

- 3 a. Explain Joules experiment with a neat sketch. (06 Marks)
b. Prove that internal energy is a property of the system. (06 Marks)
c. Write the first law of thermodynamics for any process in:
i) Closed system ii) Open system. (04 Marks)

OR

- 4 a. The properties of a certain fluid are related as follows: $U = 196 + 0.718T$ and $PV = 0.287(T + 273)$, U is specific internal energy in kJ/kg, P is pressure in kN/m^2 , V is specific volume in m^3/kg . A closed system consisting of 2kg of this fluid expands in an irreversible adiabatic process related by $PV^{1.2} = C$. The initial conditions are 1MPa and 200°C and final pressure is 100kPa. Determine the work transfer and change in internal energy for the process. (08 Marks)
b. Write the steady flow energy equation for an open system and explain the terms involved in it. Simplify SFEE for the following system: i) Steam Turbine ii) Nozzle. (08 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and/or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-3

- 5 a. State Kelvin Plan and Clausius statements of second law of thermodynamics and show that they are equivalent. (06 Marks)
- b. A reversible refrigerator operates between 35°C and -15°C. If heat rejected to 35°C is 1.5kW, determine the rate at which heat is leaking into refrigerator. (06 Marks)
- c. Represent schematically and give performance equation for
 i) Heat engine
 ii) Refrigerator
 iii) Heat pump. (04 Marks)

OR

- 6 a. Define Clausius inequality and entropy of a system. Show that for an irreversible process,
 $ds \geq \frac{\delta Q}{T}$. (08 Marks)
- b. One kg of water at 273K is heated to 373K by first bringing it in contact with reservoir at 323K and then reservoir at 373K. What is the change in entropy of the universe? (04 Marks)
- c. Prove that entropy is a property of the system. (04 Marks)

Module-4

- 7 a. Derive Vander Waal's constants in terms of critical properties. (08 Marks)
- b. Define: i) Critical point ii) Trippe point iii) Drynes fraction iv) Pure substance. (08 Marks)

OR

- 8 a. A rigid vessel of volume 0.3m³ contains 10kg of air at 300K. Determine the pressure that would be exerted by air on the vessel, using i) Perfect gas equation ii) Vander Waal's equation. Take for air, R = 287.1J/kg-K, Molecular weight = 28.96, Vander Waal's constants a = 135.8kNm⁴/(kgmol)², b = 0.0365m³/kg.mol. (06 Marks)
- b. 0.1m³ of air at 5MPa, 356°C contained in a cylinder expands reversibly and isothermally to 0.25MPa. Calculate for air i) Work transfer ii) Heat transfer iii) Change in entropy assuming that air behaves as an ideal gas with R = 287J/kg-K. (06 Marks)
- c. Write the Maxwell relations and explain the terms involved. (04 Marks)

Module-5

- 9 a. Compare Otto and Diesel cycles with the help of P-V and T-S diagram. (04 Marks)
- b. A Carnot engine rejects heat to the sink at 32°C and has a thermal efficiency of 52.3%. The work output from the engine is 120kJ. Determine: i) The maximum working temperature of the engine ii) The heat added in kJ. (04 Marks)
- c. With the help of T-S and P-V diagrams, evaluate an expression for the air standard efficiency of a Diesel cycle. (08 Marks)

OR

- 10 a. Consider a steam power plant operating on a simple Rankine cycle. Steam enters the turbine at 3MPa and 350°C and is condensed in the condenser at a pressure of 75kPa. Determine the thermal efficiency of the cycle. (04 Marks)
- b. Explain with T-S diagram, limitations of carnot cycle and how we can overcome the same in Rankine cycle. (08 Marks)
- c. What are the methods for increasing the efficiency of Rankine cycle? (04 Marks)
