

## III SEMESTER B.TECH (AUTOMOBILE/ AERONAUTICAL ENGINEERING) END SEMESTER EXAMINATIONS, DEC 2015/JAN 2016

## SUBJECT: THERMODYNAMICS [AAE 2104]

## **REVISED CREDIT SYSTEM**

Time: 3 Hours

MAX. MARKS: 50

## Instructions to Candidates:

- ✤ Answer ALL the questions.
- Use of thermodynamic data hand book is permitted.
- ✤ Missing data may be suitable assumed.
- 1A. State the first law of thermodynamics and mention its limitation. (02)
- **1B.** A fluid at a pressure of 3 bar, and with specific volume of 0.18 m<sup>3</sup>/kg, contained (03) in a cylinder behind a piston expands reversibly to a pressure of 0.6 bar according to a law,  $p = C/v^2$  where 'C' is a constant. Calculate the work done by the fluid on the piston.
- **1C.** Derive the expression for work done and entropy change for a polytropic **(05)** process.
- 2A. State and prove the Kelvin Planck statement of Second law of thermodynamics. (03)
- **2B.** A turbine operating on a steady flow of nitrogen is to produce 0.8 kW of power by expanding nitrogen from 300kPa, 350K (inlet specific volume of  $0.346m^3/kg$ ) to 120kPa. For design purpose, the inlet velocity is assumed to be 30 m/s and the exit velocity has to be 50 m/s. The expansion takes place through a quasi equilibrium process such that  $pv^{1.4} = constant$ . Determine required mass flow rate.
- 2C. A large stationary engine working on carnot cycle produces 15 MW with a (03) thermal efficiency of 40%. The exhaust gas, which we assume to be air, flows out at 800 K and the intake air is 290 K. If 'c<sub>p</sub>' of air is 1.005 kJ/kgK, determine the mass flow rate.
- **3A.** Derive the Maxwell's relations.

(03)

- **3B.** Briefly describe the following terms:
  - i. Clausius- Clapeyron Equation
  - ii. Dryness fraction
  - iii. Joule-Thomson coefficient
  - iv. Mollier diagram
- **3C.** Consider a gas mixture that consists of 3 kg of  $O_2$ , 5 kg of  $N_2$  and 12 kg of CH<sub>4</sub>. **(03)** Determine
  - i. Mole fraction of each component
  - ii. Mass fraction of each component
  - iii. Average molar mass and gas constant of the mixture
- **4A.** Compare Dalton's law of partial pressures and Amagat's law of additive **(04)** volumes.
- 4B. Steam in a closed system expands reversibly and isothermally from 180°C and (04) dryness 65% to a final pressure of 500kPa. Sketch the process on P-v and T-s plots. Calculate the work done by steam.
- **4C.** Explain the concept of exergy.

(02)

- **5A.** Sketch the P-v and T-S diagram for an ideal Brayton cycle and derive the **(03)** expression for its thermal efficiency.
- **5B.** Show the working of a vapor compression cycle using a neat P-h plot and derive **(03)** an expression for its coefficient of performance.
- 5C. In an air standard Diesel cycle, the compression ratio is 16 and at the beginning (04) of isentropic process, the temperature is 15°C and pressure is 0.1MPa. Heat is added until the temperature at the end of constant pressure process is 1480°C. Calculate :
  - i. Cut-off ratio
  - ii. Heat supplied per kg of air
  - iii. Cycle efficiency