Reg.No. \_\_\_\_\_\_\_\_\_\_\_\_



**End Semester Examination – Nov/Dec– 2017**

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| **Code :** | **17ME3025** | **Duration :** | **3hrs** |
| **Sub. Name :** | **ADVANCED THERMODYNAMICS** | **Max. marks :** | **100** |

**ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)**

(Use of approved Thermodynamics property tables are permitted)

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| **Q. No.** | **Sub Div.** | **Questions** | **Course**  **Outcome** | **Marks** |
| 1. | a. | A turbo compressor delivers 2.33 m3/s at 0.276 MPa, 43oC which is heated at this pressure to 430oC and finally expanded in a turbine which delivers 1860 kW. During the expansion, there is a transfer of 0.09 MJ/s to the surroundings. Calculate the turbine exhaust temperature if changes in kinetic and potential energy are negligible. | CO1 | 10 |
| b. | Derive steady flow energy equation and reduce it to various thermal systems such as heat exchanger, compressor, turbine, pump and a nozzle. | CO1 | 10 |
| (OR) | | | | |
| 2. | a. | In a counter flow heat exchanger, 12 kg/s of air at 1000 K is cooled to 400 K using cooling water which enters the exchanger at 283 K and leaves at 366 K. If the ambient condition happens to be at 300 K and 0.1 MPa, Determine i. water flow rate, ii. change in the availability of air, iii. change in the availability of water, iv. loss in availability, and v. second law efficiency. | CO1 | 10 |
| b. | In oil cooler, oil flows steadily through a bundle of metal tubes submerged in a steady stream of cooling water. Under steady flow conditions, the oil enters at 90oC and leaves at 30oC, while the water enters at 25oC and leaves at 70oC. The enthalpy of oil at ToC is given by: h = 1.68T + 10.5 x 10-4 T2 kJ/kg. What is the cooling water flow required for cooling 2.78 kg/s of oil. | CO1 | 10 |
| 3. | a. | A 36 g of water at 30oC are converted into steam at 250oC at constant atmospheric pressure. The specific heat of water is 4.2 kJ/kgK and the latent heat of vaporization is 2260 kJ/kg. For water vapor assume PV = mRT where, R = 0.4619 kJ/kgK and Cp/R = a+bT+cT2, where, a=3.634, b=1.195x10-3 K and c=0.135x10-6 K2. Calculate the entropy change of the system. | CO2 | 10 |
| b. | In a gas turbine engine, air at 0.2 MPa and 400 K is compressed to the pressure of 2 MPa and 800 K. If the ambient temperature and pressure happen to be 300 K and 0.1 MPa, respectively, determine i. the first law efficiency and ii. the second law efficiency of this compressor. | CO2 | 10 |
| (OR) | | | | |
| 4. | a. | 1 kg of steam is expanded in a piston-cylinder device from the initial state of 3 MPa and 523K to a final state of 100 kPa and 423K. During this process 10kJ of heat is transferred to the surrounding at a pressure of 100 kPa and 298K. Estimate i. The availability of steam at state 1 and state 2 and ii. The reversible work. | CO2 | 10 |
| b. | Derive the equation for availability for a non-flow and steady flow process. | CO2 | 10 |
| 5. | a. | Derive the Van der Waals (VW) equation of state and prove that the gas constant is . | CO3 | 10 |
|  | b. | Derive the relation for partial derivative which is used extensively to test the exactness of a differential. | CO3 | 5 |
| c. | Briefly explain the use of compressibility chart. | CO3 | 5 |
| (OR) | | | | |
| 6. | a. | A methane cylinder of 0.5m3 contains gas at 10 MPa and 298 K. Determine the mass of methane gas in this cylinder by using i. Ideal gas law and ii. compressibility chart. | CO3 | 5 |
| b. | An ideal gas in a piston-cylinder at 300 K and 0.97 m3/kg undergoes a process by which its temperature and specific volume are changed by 2 K and 0.02 m3/kg, respectively. Determine the change in the pressure of the gas. | CO3 | 5 |
| c. | Derive Maxwell’s equations for finding entropy, enthalpy, Gibbs free energy and Helmholtz function. | CO3 | 10 |
| 7. |  | Describe the general relations for change in internal energy, enthalpy and entropy in terms of measurable properties such as pressure, specific volume and temperature. | CO4 | 20 |
| (OR) | | | | |
| 8. | a. | Derive Clausius–Clapeyron equation for estimating the heat of phase transition from the vapour pressure at a given temperature. | CO4 | 10 |
| b. | Write a short notes on the applications of Maxwell equations. | CO4 | 10 |
|  | | **Compulsory**: |  |  |
| 9. |  | Write a short notes on the following:   1. First and second laws of thermodynamics applied to combustion process. 2. Adiabatic flame temperature and Stability criteria. | CO5 | 10+10 |

ALL THE BEST