**Q. Code: 102964**

**Reg. No.** | | | | | | | | | |

# B.E. / B.TECH. DEGREE EXAMINATIONS, DEC 2019

Third Semester

## ME16301 – ENGINEERING THERMODYNAMICS

***(Common to AE and ME)***

**(Regulation 2016)**

**Time: Three Hours** **Maximum : 100 Marks**

*(Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart and Psychrometric Chart permitted)*

Answer **ALL** questions

**PART A - (10 X 2 = 20 Marks)**

| | | CO | RBT |
|---|---|---|---|
| 1. | State the first law for a closed system undergoing a process and a cycle. | 1 | R |
| 2. | What are intensive and extensive properties? | 1 | U |
| 3. | Compare source with sink. | 1 | U |
| 4. | List the causes of entropy increase. | 1 | U |
| 5. | What is meant by dryness fraction of steam? | 2 | R |
| 6. | What is binary vapour cycle? | 2 | U |
| 7. | Define compressibility factor. | 2 | R |
| 8. | State Clausis Clapeyron equation. | 2 | R |
| 9. | State Dalton's law of partial pressures. | 3 | R |
| 10. | Define Dry bulb and Wet bulb temperature. | 3 | R |

**PART B - (5 X16 = 80 Marks)**

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|---|---|---|---|---|---|
| 11. | (a) | A piston-cylinder device contains 0.15 kg of air initially at 20 bar and $350^0$C. The air is first expanded isothermally to 5 bar, 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. | (16) | 1 | AP |
| | | **(OR)** | | | |
| | (b) | A turbine operating under steady flow conditions receives steam at the following state: pressure 13.8 bar, specific volume 0.143 $m^3$/kg, internal energy 2590 kJ/kg, velocity 30 m/s. The state of the stream leaving the turbine is: pressure 0.35 bar, specific volume 4.37 $m^3$/kg, Internal energy 2360 kJ/kg, velocity 90 m/s. Heat is lost to the surroundings at the rate of 0.25 kJ/s. If the rate of steam flow is 0.38 kg/s, what is the power developed by the turbine? | (16) | 1 | AP |
| 12. | (a) | If three Carnot engines of same efficiency connected in series such that the 1200 K reservoir supplies 2400 kJ of heat and 150 K | (16) | 1 | AP |

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|---|---|---|---|---|---|
| | | reservoir receives 300 kJ of heat, find out the intermediate temperatures, the efficiency and the work output of all the engines. | | | |
| | | **(OR)** | | | |
| | (b) | Two kg of air at 5 bar, $80^0$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 1 bar, 5°C. For this process determine: (i) the maximum work, (ii) the change in availability and (iii) the irreversibility | **(16)** | **1** | **AP** |
| 13. | (a) | Steam initially at 15bar, 300°C expands reversibly and adiabatically in a steam turbine to 40°C. Determine the ideal work output of the turbine per kg of steam. | **(16)** | **2** | **AP** |
| | | **(OR)** | | | |
| | (b) | A steam power plant operates on a simple ideal Rankine cycle between the pressure limits of 30 bar and 0.5 bar. The temperature of the steam at the turbine inlet is $300^0$C, and the mass flow rate of steam through the cycle is 35 kg/s. Show the cycle on a T-s diagram with respect to saturation lines, and determine (i) the thermal efficiency of the cycle and (ii) the net power output of the power plant. | **(16)** | **2** | **AP** |
| 14. | (a) | Derive Maxwell's equations and write down the first and second Tds equations. | **(16)** | **2** | **R** |
| | | **(OR)** | | | |
| | (b) | (i) What is Joule-Thomson coefficient? Why is it zero for an ideal gas? | **(4)** | **2** | **U** |
| | | (ii) Derive an expression for Clausius Clapeyron equation applicable to fusion and Vapourization | **(12)** | **2** | **R** |
| 15. | (a) | Atmospheric air at 101.325 kPa and 288.15 K contains 21% oxygen and 79% nitrogen by volume. Calculate the (i) mole fractions and partial pressure of oxygen and nitrogen and (ii) molar mass, gas constant and density of the air. Take molar mass of oxygen and nitrogen as 32 and 28 kg/kmol. | **(16)** | **3** | **AP** |
| | | **(OR)** | | | |
| | (b) | Atmosphere air at 1.0132 bar has a DBT of $30^0$C and WBT of $25^0$C. Compute :(i) the partial pressure of water vapour, (ii) specific humidity, (iii) the dew point temperature, (iv) the relative humidity, (v) the degree of saturation, (vi) the density of air in the mixture, (vii) the density of vapour in the mixture and (viii) the enthalpy of the mixture. Use the thermodynamic tables only. | **(16)** | **3** | **AP** |