Form A: Paper-setting Blank

*Ref. No. Ex/PE/T/221/2017*

*2ND YEAR POWER ENGG. 2ND SEMESTER EXAMINATION, 2017*

*SUBJECT:* ***Engineering Thermodynamics-II***

**Time: Three Hours** **Full Marks 100**

**Answer question No. 1 and any FIVE from the rest.**

| No. of Questions | Use of steam Table, Refrigerant *R134a* and enthalpy table allowed | Marks |
|---|---|---|
| 1. a) | Why the compression ratio of a CI engine is more than that of SI engine? | 2 |
| b) | Explain the utility of a reheater in a reheat rankine cycle. | 4 |
| c) | Why expander is used in gas refrigeration instead of throttling device? Explain with temperature inversion curve. | 4 |
| d) | How will the Relative Humidity and Humidity Ratio of the air contained in a closed room changes as it is cooled? | 2 |
| e) | In a Brayton cycle with air ($\gamma = 1.4$) as working fluid, $T_{min} = 300$ K and $T_{max} = 1000$ K. Determine The pressure ratio corresponding to maximum net work per cycle. | 2 |
| f) | The maximum pressure and temperature in an air standard diesel cycle are 44 bar and 1600 K, respectively. If the minimum pressure and temperature are 1 bar and 300 K, respectively, then determine the cut-off ratio. | 4 |
| g) | What is equivalence ratio related to combustion of gas mixture? Explain rich and lean mixture in terms of equivalence ratio. | 2 |
| 2. a) | Compare air standard efficiency of Otto, Diesel and dual cycle for same maximum pressure and temperature and heat rejection with p-v and T-s diagrams. | 5 |
| b) | Show an air standard Otto cycle on p-v and T-s diagram clearly stating the processes. Derive its thermal efficiency in terms of compression ratio. | 8 |
| c) | An engine operating on Otto cycle having cylinder bore of 15 cm and stroke of 45 cm. If the clearance volume is 2000 $cm^3$, compute the air standard efficiency. | 3 |
| 3. a) | A gas-turbine power plant operating on a Brayton cycle has a pressure ratio of 6. The gas enters the compressor at 0.1 MPa, 27°C. Maximum cycle temperature is 927°C. Assuming a compressor and turbine efficiency of 90% each, determine (a) the back work ratio, (b) the gain in thermal efficiency due to regeneration, and (c) the turbine exit temperature. | 16 |
| 4 | A steam power plant operates on the reheat Rankine cycle. Steam enters the high-pressure turbine at 12 Mpa and 500°C at a rate of 8 kg/s and leaves at 2 MPa. Steam is then reheated at constant pressure to 450°C before it expands in the low-pressure turbine at 10 kPa. Steam leaves the condenser as a saturated liquid. Determine (*a*) the net power output, and (*b*) the thermal efficiency of the cycle. | 16 |
| 5. a) | Cooling Water leaves the condenser of a power plant and enters a cooling tower at 35°C at a rate of 100 kg/sec. Water is cooled to 22°C by the air entering at 1 atm 20°C and 60% relative humidity. Air leaves the cooling tower at 30°C saturated. Determine the volume flow rate of air and amount of makeup water. | 12 |
| b) | What is adiabatic saturation process? Show the Process on T-s diagram? | 4 |
| 6. a) | An ideal gas refrigeration cycle using air as the working fluid is to maintain a refrigerated space at $-23°C$ while rejecting heat to the surrounding medium at 27°C. If the pressure ratio of the compressor is 3, determine (*a*) the maximum and minimum temperatures in the cycle, (*b*) the coefficient of performance, and (*c*) the rate of refrigeration for a mass flow rate of 0.08 kg/s. | 8 |

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| | | |
|---|---|---|
| **b)** | A refrigerator uses refrigerant-134a as the working fluid and operates on an ideal vapor-compression refrigeration cycle between -20°C and 0.9 MPa. The mass flow rate of the refrigerant is 0.05 kg/s. Show the cycle on a *T-s* diagram with respect to saturation lines. Determine (*a*) the rate of heat removal from the refrigerated space and the power input to the compressor, (*b*) the rate of heat rejection to the environment, and (*c*) the coefficient of performance. | **8** |
| **7. a)** | Considering the 1st *Tds* equation and 2nd *Tds* equation show that $\therefore (c_p - c_v) = \frac{Tv\beta^2}{K_T}$ where $\beta$= volume expansivity and $K_T$ =isothermal compressibility | **10** |
| **b)** | What is Joule Thomson Coefficient? Write the expression for Joule Thomson coefficient and determine its value for ideal gas. | **6** |
| **8 a)** | One kmol of ethane ($C_2H_6$) is burned with an unknown amount of air during a combustion process. An analysis of the combustion products reveals that the combustion is complete, and there are 3 kmol of free $O_2$ in the products. Determine (*a*) the air–fuel ratio and (*b*) the percentage of theoretical air used during this process (c) Assuming complete combustion and a total pressure of 1 atm, determine the dew-point temperature of the products. | **12** |
| **b)** | Define enthalpy of formation. | **2** |
| **c)** | What is adiabatic flame temperature? When its value will be maximum? | **1+1** |