**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI**
**(MID SEMESTER EXAMINATION MO/2023)**

**CLASS: BTECH** **SEMESTER: III**
**BRANCH: PIE** **SESSION: MO/2023**

**SUBJECT: ME289 THERMAL & FLUID ENGINEERING**

**TIME: 02 Hours** **FULL MARKS: 25**

**INSTRUCTIONS:**
**1. The question paper contains 5 questions each of 5 marks and total 25 marks.**
**2. Attempt all questions.**
**3. The missing data, if any, may be assumed suitably.**
***4*. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**

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| Q.1(a) | Define the following terms: system, state, process, and cycle. | [2] | 1 | 1 |
| Q.1(b) | In a piston-cylinder arrangement, 1 kg of air at a pressure of 1 bar and volume of $0.2m^2$ expands under constant pressure to a volume of $0.8m^3$; it then undergoes a constant volume process in such a manner that under isothermal compression, which follows constant volume process, the air returns to its initial state. Represent the cycle on a P-V diagram and determine the net work done by the system. | [3] | 1 | 3 |
| Q.2(a) | A fluid undergoes a cycle consisting of the following processes.<br>(i) It is heated at a constant pressure of 1.05 bar until it has a specific volume of 0.1 $m^3/kg$.<br>(ii) It is then compressed according to the law PV = constant to a pressure of 4.2 bar.<br>(iii) It is then allowed to expand according to the law $PV^{1.3}$ = constant.<br>(iv) Finally, it is heated at constant volume back to its initial state.<br>The work done in the constant pressure process is 515 N-m and the mass of the fluid is 0.2 kg. Calculate the net work done in the cycle. Sketch the cycle on a P-V diagram. | [5] | 1 | 4 |
| Q.3(a) | Distinguish between intensive and extensive properties. | [2] | 1 | 4 |
| Q.3(b) | Steam flows through a small turbine at the rate of 5000 kg/h entering at superheated state of 16 bar, $300^0C$ and leaving at 1 bar with 4 % moisture. The steam enters at 50 m/s at a point 2 m above the discharge and leaves at 40 m/s. Estimate the shaft power assuming that the device is adiabatic.<br>(Use the following properties of steam:<br>At 15 bar and $300^0C$: hg =3034.8 kJ/kgK<br>At 0.1 bar: $h_f$ =417.44 kJ/kgK and hg =2675.5 kJ/kgK ). | [3] | 2 | 4 |
| Q.4(a) | Give the Kelvin-Planck and the Clausius statements of the second law of thermodynamics. | [2] | 2 | 1 |
| Q.4(b) | State and prove Carnot theorem. | [3] | 2 | 1 |
| Q.5(a) | A reversible engine operates between two reservoirs at temperatures of $600^0C$ and $40^0C$. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of $40^0C$ and $-20^0C$. The heat transfer to the heat engine is 2000KJ and the work output of the combination is 360 KJ. Estimate the heat transfer to the refrigerant and net heat transfer to the reservoir at $40^0C$. | [5] | 2 | 2 |

**:::::26/09/2023 E:::::**