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# B. M. S. College of Engineering, Bengaluru-560019

**Autonomous Institute Affiliated to VTU**

## August 2024 Semester End Main Examinations

**Programme: B.E.** **Semester: III**
**Branch: Mechanical Engineering** **Duration: 3 hrs.**
**Course Code:23ME3PCETD / 22ME3PCETD** **Max Marks: 100**
**Course: Engineering Thermodynamics**

**Instructions**: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Use of Thermodynamics Data Hand Book is permitted.
3. Missing data, if any, may be suitably assumed.



**Important Note:** Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

| | | **UNIT - I** | ***CO*** | ***PO*** | **Marks** |
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| 1 | a) | Explain the following with an example:<br>(i) Thermodynamic system.<br>(ii) Thermodynamic property.<br>(iii) Thermometric material. | *CO1* | *PO1* | **06** |
| | b) | Derive the expressions for the following:<br>(i) Electrical work and Electic power.<br>(ii) Pdv work for a polytropic process. | *CO1* | *PO2* | **06** |
| | c) | A piston and cylinder arrangement contains a fluid system, with a stirring device inside the cylinder. The piston is frictionless, and it is held down against the fluid due to the atmospheric pressure of 101.325 kPa. The stirring device is rotated at 10,000 rpm with an average torque against the fluid of 1.275 N-m. Meanwhile the piston of 0.6 m diameter moves out 0.8 m per minute. Find (i) The rate of work done on the fluid, (ii) The rate of work done by the fluid on the surroundings and (iii) the net power transfer to the system. | *CO2* | *PO2* | **08** |
| | | **UNIT - II** | | | |
| 2 | a) | Explain the following:<br>(i) First law of thermodynamics applied to a closed system undergoing a process.<br>(ii) What is PMM-1. Why it is impossible? | *CO1* | *PO1* | **06** |
| | b) | Derive the steady flow energy equation for a single stream entering and leaving a control volume of a steady flow device. | *CO2* | *PO1* | **06** |
| | c) | The internal energy of a certain substance is given by the equation $u = 3.56\, p\, v + 84$. Where '*u*' is internal energy given in kJ/kg, $p$ is pressure in kPa, and $v$ is volume in $m^3$/kg. A system composed of 3 kg of this substance expands from an initial | *CO3* | *PO2* | **08** |

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| | | | pressure of 500 kPa and a volume of 0.22 $m^3$ to a final pressure of 100 kPa in a process in which pressure and volume are related by $Pv^{1.2}$ = constant. If the expansion is quasi-static, Find: (i) final volume, (ii) change in internal energy, (iii) magnitude and direction of work transfer for the process, and (iv) magnitude and direction of the heat transfer. | | | |
| | | | **UNIT - III** | | | |
| | 3 | a) | Write any two limitations of first law of thermodynamics. Establish the equivalence between Clausius and Kelvin-Planck statements. | *CO4* | *PO1* | **06** |
| | | b) | What is a reversible process? Explain any four causes for irreversibilities. | *CO4* | *PO1* | **06** |
| | | c) | Two Carnot engines A and B are connected in series between two thermal reservoirs maintained at 1000 K and 100 K respectively. Engine A receives 1680 kJ of heat from the high-temperature reservoir and rejects heat to the Carnot engine B. Engine B takes in heat rejected by engine A and rejects heat to the low-temperature reservoir. If engines A and B have equal thermal efficiencies, Show the schematic of the arrangement and determine: (i) The temperature at which heat is rejected by engine A, (ii) The efficiencies of both the engines A and B, (iii) The heat rejected by engines A and B, and (iv) The work done during the process by engines A and B. | *CO3/ CO4* | *PO2* | **08** |
| | | | **OR** | | | |
| | 4 | a) | Define entropy and prove that entropy is a property of the system. | *CO4* | *PO1* | **06** |
| | | b) | Derive an expression for the final temperature of mixing two fluids in an adiabatic enclosure and also for the change in entropy of the universe due to the mixing of fluids. | *CO4* | *PO1* | **06** |
| | | c) | A block of iron weighing 100 kg and having a temperature of 100°C is immersed in 50 kg of water at a temperature of 20 °C in an insulated vessel. Specific heats of iron and water are 0.45 and 4.18 kJ/kg-K respectively. Determine the following: i) final temperature of combined system of iron and water, (ii) change in entropy of iron block, (iii) change in entropy of water, (iv) change in entropy of combined system of iron and water, and (v) change in entropy of the universe. | *CO4* | *PO2* | **08** |
| | | | **UNIT - IV** | | | |
| | 5 | a) | Explain the following:<br>(i) Reduced properties, (ii) Law of corresponding states, and<br>(iii) Compressibility chart. | *CO5* | *PO1* | **06** |
| | | b) | Derive the expressions for the constants *a*, *b* and *R* in terms of critical properties of a Vander Waal's gas. | *CO5* | *PO1* | **06** |

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| | | c) | The reduced pressure and temperature for Neon gas is 2 and 1.3 respectively. Determine the following: (i) critical properties (ii) compressibility factor, (iii) pressure, and (iv) temperature. | *CO5* | *PO2* | **08** |
| | | | **UNIT - V** | | | |
| | 6 | a) | With the help of *T-h* diagram explain the following with respect to pure substance: (i) sub cooled liquid, (ii) saturated liquid line, (iii) saturated vapour line, and (iv) critical point. | *CO5* | *PO1* | **10** |
| | | b) | One kg of steam at a pressure of 17.5 bar and dryness 0.95 is heated at a constant pressure, until it is completely dry. Determine: (i) initial and final temperatures, (ii) change in volume, (iii) quantity of heat supplied, and (iv) change in entropy. | *CO5* | *PO1* | **10** |
| | | | **OR** | | | |
| | 7 | a) | Explain ideal Rankine cycle with the help of *T-s* and *h-s* diagrams and also write the expression for the efficiency of a Rankine cycle in terms of specific enthalpies. | *CO5* | *PO1* | **06** |
| | | b) | With the help of *T-s* diagrams, explain the effects of following factors on the efficiency of the Rankine cycle: (i) steam temperature at the inlet of the turbine, and (ii) steam pressure at the inlet of the turbine. | *CO3* | *PO1* | **06** |
| | | c) | Steam at 50 bar, 400°C expands in a Rankine cycle to 0.34 bar. The mass flow rate of steam is 150 kg/s. Neglecting the pump work, determine: (i) condition of steam at the inlet and outlet of the turbine, (ii) the power developed, (iii) the thermal efficiency, and (iv) specific steam consumption in kg/kWh. | *CO3* | *PO2* | **08** |

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