VIT
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

REG.NO.:

NAME OF THE SCHOOL
CONTINUOUS ASSESSMENT TEST - II
FALL SEMESTER 2024-2025

SLOT:

Programme Name & Branch	**: B.Tech (BME / BMA / BMEE)**
Course Code and Course Name	**: BMEE203L - Engineering Thermodynamics**
Faculty Name(s)	**: Kamatchi, Mohan CG, Nishant Tiwari, Premkarthik Kumar, Vijesh Joshi**
Class Number(s)	**: VL2023240504670/ 5934/5913/8426/5923**
Date of Examination	**: 14th October 2024, 9:30am – 11am**
Exam Duration	**: 90 minutes** **Maximum Marks: 50**

General instruction(s):

- Answer All Questions
- M - Max mark; CO – Course Outcome; BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)
- Course Outcomes (Type the CO statements covered in this question paper. Use the CO number as per the syllabus copy)
  CO2 - Analyse the properties of pure substances, ideal and real gases
  CO4 - Apply the second law of thermodynamics and entropy principles for engineering systems.
- Use of steam table and Mollier chart is permitted
- Assume missing data if any

<table>
<tr><th>Q. No</th><th>Question</th><th>M</th><th>CO</th><th>BL</th></tr>
<tr><td>1.</td><td>Liquid water at 50°C and 0.123 bar needs to be converted into dry saturated steam at a pressure of 15 bar. The desired steam flow rate is 5 kg/sec. Determine the rate at which heat has to be supplied. Finally, this steam is expanded isentropically to 0.01 bar. Determine the quality of the steam at this state.</td><td>10</td><td>CO2</td><td>BL4</td></tr>
<tr><td>2.</td><td>In the R&D division of “ABC Laboratories” company, the management decided to provide funding for an innovative idea to operate a refrigerator using the output of an engine. The temperature constraints for the engine and the refrigerator were as follows: (a) Engine: T_max = 300°C and T_min = 30°C; (b) Refrigerator: T_max = 30°C and T_min = -15°C.
Two of the scientists Vinod and Pallavi proposed their ideas. The maximum efficiency and the COP for the engine and the refrigerator that they can achieve are as given in table 1
<table>
<tr><td>Name</td><td>Engine (Max efficiency)</td><td>Refrigerator (Max COP)</td></tr>
<tr><td>Vinod</td><td>42%</td><td>8</td></tr>
<tr><td>Pallavi</td><td>40%</td><td>4</td></tr>
</table>
Table 1
Using the Carnot cycle approach, determine which claim is feasible so that the funds can be used effectively.
For the feasible proposal, suggest the respective high thermal reservoir temperatures to ensure the engine efficiency = 40% of η_carnot and COP = 50% of COP_carnot assuming that the respective low thermal reservoir temperatures for the engine and the refrigerator remain same.</td><td>10</td><td>CO4</td><td>BL5</td></tr>
</table>

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3.	Refer the Question number 2. During experiments, the winning scientist (either Vinod or Pallavi) measured the following: • Heat supplied to the engine: 5000 kJ • Heat rejected by the engine: 3000 kJ • Work to be done on the refrigerator: 1400 kJ • Heat removed from the refrigerated space: 2000 kJ Task: Only for the winning scientist, find out (a) how different the actual efficiency and COP are as compared to the claimed values. (b) Net-work produced out of the combination of engine and the refrigerator.	10	CO4	BL4
4.	A 100 kg of ice at -10°C falls out on the side of the road from a moving van by mistake. The ambient air was at 25°C. Determine the entropy increase of the universe due to melting of ice. Assume Cp of ice as 2.093 kJ/kg K and the latent heat of fusion of ice as 333.3 kJ/kg.	10	CO4	BL3
5.	In a factory, the engineers' committee found that the required power supply for machine operations is 1.3 MW. They decided to install a simple thermal power plant that works based on Rankine cycle. In order to minimize the losses, the firm wants to ensure at least 45% thermal efficiency. The firm plans to buy the following: (a) a boiler to operate at 8 bar pressure to produce steam at 600°C at the rate of 1.2 kg/s (b) a turbine with isentropic efficiency of 90%. (c) a condensor that operates at 0.02 bar and, (d) a pump that consumes 1/10th of the actual work produced by the turbine. Find out whether this plan can ensure required power supply with the desired thermal efficiency.	10	CO4	BL5

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