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

SCHOOL OF MECHANICAL ENGINEERING

CONTINUOUS ASSESSMENT TEST – I

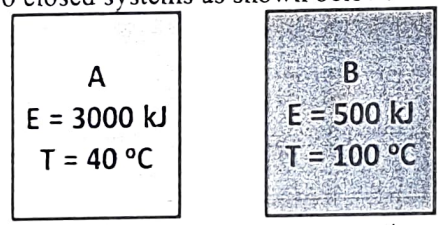
SLOT:D2+TD2

FALL SEMESTER 2022-2023

Programme Name & Branch : B.Tech-BME, BMM, BMA
Course Code/Name : BMEE203L /Engineering Thermodynamics
Faculty Name(s) : Dr. Nataraj G, Dr. Anuj Kumar, Dr. Somasundharam S, Dr. Mohamed Ibrahim M, Dr. Anoop Kumar
Class Number(s) : VL2022230100602, VL2022230100604, VL2022230100603, VL2022230100596, VL2022230100599,

Duration: 90 min. **Max. Marks: 50**

General instruction(s): 1. *Assume suitable data, if required,*
2. Steam Tables and Mollier chart are permitted

Q. No	Question	Marks	Course Outcome (CO)	Bloom's Taxonomy (BL)
1.	a) Consider two closed systems as shown below.  If these systems are brought into contact, then which of the following is true? a. Energy transfer occurs from A to B b. Energy transfer occurs from B to A (2.5 marks)	10	1	2
	b) In an air-conditioned room (where AC is continuously switched ON for more than two hours), you may have felt that wooden/plastic materials are hotter than metal bodies. In your experience, which of the following statement is true? a. Wooden/plastic materials are at higher temperature than metal bodies, so we feel they are hotter than metal bodies. b. Both wooden/plastic materials and metal bodies are at same temperature. (2.5 marks)			
	c) The temperature of a system drops by 45°F during a cooling process. Express this drop in temperature in K, and °C. (2.5 marks)			
	d) Which of the following is/are true about internal energy? a. It is a macroscopic form of energy. b. It is a microscopic form of energy. c. It is function of temperature only for ideal gases. d. It includes chemical, nuclear, and thermal energies. e. Latent heat of a substance is a category of internal energy. f. Sensible heat a substance is a category of an internal energy. (2.5 marks)			
2.	A 1.8-m^3 rigid tank contains steam at 220 °C. One-third of the tank volume is in the liquid phase and the rest is in the vapor form.	10	2	3

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	Determine, (*a*) the pressure of the steam (2 marks), (*b*) the quality of the saturated mixture (5 marks) and (*c*) the density of the mixture (3 marks).			
3.	Determine the specific volume of superheated water vapor at 3.5 MPa and 450 °C, using (*a*) ideal gas equation (3 marks), (*b*) the generalized compressibility chart (5 marks) and (*c*) the steam tables (2 marks). Take, the gas constant, the critical pressure, and the critical temperature of water are, R = 0.4615 kJ/kg.K, P_{cr} = 22.06 MPa and T_{cr} = 647.1 K.	10	2	3
4.	A piston–cylinder device contains 0.15 kg of air initially at 2 MPa and 350 °C. The air is first expanded isothermally to 500 kPa, 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 (7 Marks) and the net work of the cycle (3 Marks). Take the gas constant of air, R = 0.287 kJ/kg.	10	3	3
5.	Steam flows steadily through an adiabatic turbine. The inlet conditions of the steam are 4 MPa, 500 °C, and 80 m/s, and the exit conditions are 30 kPa, 92 percent quality, and 50 m/s. The mass flow rate of the steam is 12 kg/s. Determine, (*a*) the change in kinetic energy (3 Marks), (*b*) the power output (4 Marks), and (*c*) the turbine inlet area (3 Marks). Take enthalpy of steam at inlet and exit condition to be 3446.0 kJ/kg and 2437.7 kJ/kg and specific volume of steam at inlet condition as 0.086442 m^3/kg.	10	3	4

Vellore Institute of Technology

Vellore – 632014, Tamil Nadu, India

SCHOOL OF MECHANICAL ENGINEERING

FALL SEMESTER 2022-2023

SLOT: D1+TD

CONTINUOUS ASSESSMENT TEST – I

Programme Name & Branch	: B.Tech- Automotive, Mechanical, Manufacturing Engineering
Course Code	: BMEE203L
Course Name	: Engineering Thermodynamics
Class Number(s)	: VL2022230100580, VL2022230100583, VL2022230100582, VL2022230100593, VL2022230100584
Faculty Members	: Dr. Senthil Kumar A, Dr. Porpatham E, Dr. Thundil Karuppa Raj R, Dr. Immanuel Selwyn Raj A, Dr. Praveen Kumar G
Date of Examination	: 01- 09-2022
Duration	: 90 minutes

Max. Marks: 5 x 10 = 50

General instruction(s): 1. ***Assume suitable data, if required.***
2. Steam Tables and Mollier chart are permitted

Answer ALL the Questions

Q. No	Question	Marks	Course Outcome (CO)	Bl Taxono (BL)
1	a) A 4 kW resistance heater in a water heater runs for 3 hours to raise the water temperature to the desired level. Determine the amount of electric energy used in both kWh and kJ. [2 Marks] b) What is meant by thermodynamic equilibrium? What does it imply? [2 Marks] c) An air balloon is found to have a spherical shape with 30 cm diameter in an air-conditioned room at 15°C. If the balloon is taken to the outside atmosphere at 40°C, What will be the diameter of the balloon after the air in the balloon reaches the atmospheric temperature? The balloon elastic force remains constant. [2 Marks] d) Consider two closed systems A and B. System A contains 3000 kJ of thermal energy at 20°C, whereas system B contains 200 kJ of thermal energy at 50°C. Now the systems are brought into contact with each other. Determine the direction of any heat transfer between the two systems [2 Marks] e) Why does the free expansion have zero work transfer? [2 Marks]	10	1	

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SLOT: D1+TD1

2	Steam initially at 15 bar, 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. Use steam table.	10	2	3
3	Determine the specific volume of superheated water vapor at 15 MPa and 350°C, using a) The ideal-gas equation [4 Marks] b) The steam tables [3 Marks] c) Determine the error involved in the two cases [3 Marks]	10	2	3
4	3 kg of air undergoes the following processes: Polytropic compression from state 1 to state 2, where P_1=150 kPa, T_1=360 K, P_2=750 kPa and n=1.2; constant pressure cooling from state 2 to state 3; and isothermal expansion from state 3 to state 1, completing the cycle. Find: a) The temperatures, pressure and volumes at each state [5 Marks] b) Determine the processes and cycle heat and work [5 Marks]	10	3	3
5	Air enters an adiabatic nozzle steadily at 300 kPa, 200°C, and 45 m/s and leaves at 100 kPa and 180 m/s. The inlet area of the nozzle is 110 cm^2. Determine: a) The mass flow rate through the nozzle [4 Marks] b) The exit temperature of the air [3 Marks] c) The exit area of the nozzle [3 Marks]	10	3	4