U.S.N.										

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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: III**

Branch: Industrial Engineering and Management **Duration: 3 hrs.**

Course Code: 23IM3ESEPS **Max Marks: 100**

Course: Elements of Power Systems

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. 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
1	a)	Explain zeroth law of thermodynamics with example	CO1	PO1	**04**
	b)	Sir Isaac Newton proposed a linear temperature scale where in the ice point and the normal human body temperature were assumed as the two fixed points and assigned the temperatures of 0^o and 12^o respectively. If the temperature of the human body on the Fahrenheit scale is 98^oF, obtain the relation between the Newton's scale and the Fahrenheit scale	CO2	PO2	**08**
	c)	A mass of gas is compressed in a quasi-equilibrium process from 0.8 bar, 0.1 m^3 to 4 bar, 0.03m^3. Assuming that the pressure and volume are related by the relation PV^n = Constant, find the work interaction during the process. Is it a work producing system or work absorbing system?	CO2	PO2	**08**
		OR			
2	a)	Derive an expression for work done during a polytropic process	CO1	PO1	**04**
	b)	The temperature 't' on a Celsius scale is defined in terms of property 'P' by the relation $P = e^{(t-B)/A}$ where A and B are constants. Experiments gives the value of P of 1.5 and 7.5 at the ice and steam point respectively. Obtain relation and also find the temperature 't' for reading of P = 3.5	CO2	PO2	**08**
	c)	A spherical balloon of 0.8 m diameter contains gas at 1.2 bar. The gas in the balloon is heated until the pressure reaches 4.25 bar, during which the gas pressure is proportional to the cube of diameter of the balloon. Determine the work done by the gas inside the balloon	CO2	PO2	**08**
		UNIT - II			
3	a)	Prove that energy is a property of the system	CO1	PO1	**04**

<table>
<tr><td></td><td></td><td>b)</td><td>A fluid system contained in a piston and cylinder machine, passes through a complete cycle of four processes. The sum of all heat transferred during a cycle is -340 kJ. The system completes 200 cycles per minute. Complete the following table showing the method for each item and compute the net rate of work output in kW.
<table>
<tr><th>Process</th><th>Q (kJ/min)</th><th>W (kJ/min)</th><th>ΔU (kJ/min)</th></tr>
<tr><td>1-2</td><td>0</td><td>4340</td><td>-</td></tr>
<tr><td>2-3</td><td>42000</td><td>0</td><td>-</td></tr>
<tr><td>3-4</td><td>-4200</td><td>-</td><td>-73200</td></tr>
<tr><td>4-1</td><td>-</td><td>-</td><td>-</td></tr>
</table></td><td>CO2</td><td>PO2</td><td>08</td></tr>
<tr><td></td><td></td><td>c)</td><td>A nozzle is a device for increasing the velocity of a steadily flowing stream. At the inlet to certain nozzle, the enthalpy of the fluid passing is 3000 kJ/kg and the velocity is 60 m/s. At the discharge end, the enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is no heat loss from the nozzle. (i) Find the velocity at the exit section of the nozzle (ii) If the inlet area is 0.1 m^2 and the specific volume at the inlet is 0.187 m^3/kg, find the mass flow rate (iii) If the specific volume at the exit of the nozzle is 0.498 m^3/kg, find the diameter at the exit section of the nozzle</td><td>CO2</td><td>PO2</td><td>08</td></tr>
<tr><td></td><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td></td><td>4</td><td>a)</td><td>List the terms involved in the steady flow energy equation (SFEE)</td><td>CO1</td><td>PO1</td><td>04</td></tr>
<tr><td></td><td></td><td>b)</td><td>During the constant pressure in a closed system with P = 1.05 bar and properties of the system changes from V_1 = 0.25 m^3, T_1 = 10°C to V_2 = 0.45 m^3, T_2 = 240°C. The specific heat at constant pressure of the system is given by C_p = [0.4 + {18 /(T+40)}] kJ/kg°C. Assuming the mass of the system as 1 kg. Determine (i) heat transfer (ii) the work transfer (iii) change in internal energy</td><td>CO2</td><td>PO2</td><td>08</td></tr>
<tr><td></td><td></td><td>c)</td><td>Air enters an adiabatic nozzle steadily at 300 kPa, 200oC, & 30 m/s and leaves at 100 kPa, & 180 m/s. The inlet area of the nozzle is 0.008 m2. Determine (i) The mass flow rate through the nozzle (ii) The exit temperature of the air and (iii) The exit diameter of the nozzle. Take Cp = 1.02 kJ/kgK, R = 0.287 kJ/kgK</td><td>CO2</td><td>PO2</td><td>08</td></tr>
<tr><td></td><td></td><td></td><td>UNIT - III</td><td></td><td></td><td></td></tr>
<tr><td></td><td>5</td><td>a)</td><td>State Kelvin-Planck and Clausius statements. Briefly explain heat engine, refrigerator and heat pump with block diagram and expressions</td><td>CO1</td><td>PO1</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>A reversible heat engine operating between two thermal reservoirs at 700°C and 50°C. It drives a reversible refrigerator operating between -25°C and 50°C. The heat transfer to the heat engine is 2500 kJ and the network output from the combined engine and refrigerator plant is 400 kJ. Determine the heat transferred to the refrigerant and the net heat transferred to 50°C reservoir</td><td>CO2</td><td>PO2</td><td>10</td></tr>
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			OR			
	6	a)	With the help of P-V and T-S diagram derive the efficiency of Otto cycle	*CO3*	*PO2*	**10**
		b)	The dual cycle has a compression ratio of 15 and at the beginning of the of the compression process, the pressure is 1 bar and the temperature is 40^{o}C. 1675kJ/kg of heat is supplied to the system until the pressure of 60 bar is reached at the end of compression process. Determine (i) the heat supplied at constant volume per kg of air (ii) the heat supplied at constant pressure per kg of air (iii) the cut off ratio (iv) the work done per kg of air (v) the air standard efficiency of the cycle. C_v = 0.718 kJ/kgK, C_p = 1.005 kJ/kgK, γ = 1.4	*CO3*	*PO2*	**10**
			UNIT - IV			
	7	a)	Define and derive the Archimedes principle	*CO4*	*PO2*	**10**
		b)	A block of wood of specific gravity 0.7 of dimensions 2 m x 1 m x 0.8 m floats in water with its shortest axis vertical. Determine the metacentric height and state the condition of its equilibrium	*CO4*	*PO3*	**10**
			OR			
	8	a)	Derive an expression for the total pressure force and the depth of center of pressure for vertical surface submerged in water	*CO4*	*PO2*	**10**
		b)	A trapezoidal plate of 2 m wide on the bottom, 4 m wide on the top and 1 m deep (height) is immersed in water with its topmost side is parallel to the free surface of water. Determine total pressure force and position of center of pressure	*CO4*	*PO3*	**10**
			UNIT - V			
	9	a)	With suitable assumptions derive the Euler's equation of motion for real fluid and hence deduce it to Bernoulli's equation of motion	*CO4*	*PO2*	**10**
		b)	The inlet and throat of a horizontal Venturimeter are 0.3 m and 0.1 m respectively. The liquid flowing through the meter is water. The pressure intensity at the inlet is 13.734 N/cm^2 while the vacuum pressure head at the throat is 37 cm of mercury. Assuming that 4% of differential head is lost between inlet and throat. Find the value of coefficient of discharge for the Venturimeter and rate of flow	*CO4*	*PO3*	**10**
			OR			
	10	a)	Derive an expression for rate of flow of fluid through the Venturi meter	*CO4*	*PO2*	**10**
		b)	A pipe line carrying oil of specific gravity 0.8 changes in diameter from 300 mm at a position 'A' to 500 mm diameter to a position 'B' which is 5 m at a higher level. If the pressure at A and B are 19.62 N/cm^2 and the 14.91 N/cm^2. The discharge is 150 litres/sec. Determine the loss of head and direction of flow	*CO4*	*PO3*	**10**

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