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

Autonomous Institute Affiliated to VTU

July 2024 Semester End Main Examinations

Programme: B.E. **Semester: V**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 22ME5PCTFE **Max Marks: 100**
Course: Thermal and Fluid Engineering

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)	Define turbo machine and With a neat diagram, explain the parts of a turbo machine.	*CO1*	*PO1*	**06**
	b)	Draw the velocity triangle at inlet and exit of a turbo machine in general and show that the energy transfer per unit mass is given by $\frac{E}{m}=\frac{1}{2}\left[\left(V_1^2-V_2^2\right)+\left(V_{r2}^2-V_{r1}^2\right)+\left(U_1^2-U_2^2\right)\right]$ Where V_1 and V_2 are the absolute velocities at inlet and exit, V_{r1} and V_{r2} are the relative velocities at inlet and exit of the rotor and U_1 and U_2 are the blade velocities at inlet and exit of the rotor. Also explain the different velocity components involved in it.	*CO1*	*PO1*	**08**
	c)	Four turbines of specific speed 890 (Metric) each is installed in a hydel station. Each of turbine runs at 50 rpm and share equally a total discharge of 260 m^3/s available under a head of 1.73 m. Assuming each turbine has an efficiency of 82.5%. Find the power of each turbine in kW.	*CO1*	*PO2*	**06**
		OR			
2	a)	Draw the neat sketch of a Francis turbine and explain the function of a draft tube.	*CO1*	*PO1*	**06**
	b)	Obtain an expression for maximum hydraulic efficiency for a Pelton wheel in terms of nozzle velocity coefficient, bucket velocity coefficient and exit angle of relative velocity.	*CO1*	*PO1*	**08**
	c)	A Kaplan turbine working under a head of 15 m develops 7350 kW. The outer diameter of the runner is 4 m and hub diameter is 2 m. The guide blade angle at the extreme edge of the runner is 30^0. The hydraulic and the overall efficiency of the turbine are 90% and 85% respectively. If the velocity of whirl is zero at outlet determine (i) runner vane angle at inlet and outlet at the extreme edge of the runner (ii) speed of the turbine.	*CO1*	*PO2*	**06**

			UNIT - II			
	3	a)	Derive an expression for overall pressure ratio for a centrifugal compressor in terms of impeller tip speed, slip, power input factor and isentropic efficiency of compressor.	*CO2*	*PO1*	**08**
		b)	A centrifugal compressor runs at 15000 rpm and produces a stagnation pressure ratio of 4 between the impeller inlet and outlet. The stagnation condition of air at the compressor intake are 1.033 bar and 25^0C respectively. The absolute velocity of the air at compressor intake is axial. If the compressor has radial blades at the exit such that relative velocity at exit is 135 m/s and the total to total efficiency of the compressor is 0.78, draw the velocity triangle at the exit of the rotor and compute the slip coefficient. The rotor diameter at the outlet is 58 cm	*CO2*	*PO2*	**08**
		c)	Briefly explain the following with respect to centrifugal compressors: (i) Surging and (ii) Choking	*CO2*	*PO1*	**04**
			UNIT - III			
	4	a)	Explain the phenomenon of cavitation in centrifugal pump.	*CO2*	*PO1*	**04**
		b)	Obtain an expression for the minimum starting speed of a centrifugal pump.	*CO2*	*PO1*	**08**
		c)	A centrifugal pump is designed to run at a speed of 1450 rpm with a maximum discharge of 1800 litres/min against a total head of 20 m. The suction and delivery pipes are designed such that they are equal in size of 100 mm in diameter. If the inner diameter and outer diameter of the impeller are 120 mm and 240 mm respectively, determine the blade angles, if the water enters radially. Also find the power required to drive the pump.	*CO2*	*PO2*	**08**
			UNIT - IV			
	5	a)	Explain availability function for closed system (Non flow Process) and open system (Steady Flow process).	*CO3*	*PO1*	**06**
		b)	In a certain process, a vapour, while condensing at 420^oC, transfers heat to water evaporating at 250^oC. The resulting steam is used in a power cycle which rejects heat at 35^oC. What is the fraction of the available energy in the heat transferred from the process vapour at 420^oC, that is lost due to the irreversible heat transfer at 250^oC?	*CO3*	*PO2*	**10**
		c)	Give the exergy balance for a closed system.	*CO3*	*PO1*	**04**
			UNIT - V			
	6	a)	With the help of P-v and T-s diagrams, show that for the same maximum pressure, temperature and the same heat rejection of the cycle, $\eta_{Diesel} > \eta_{Dual} > \eta_{Otto}$	*CO4*	*PO2*	**06**

		b)	A diesel engine has a compression ratio of 14 and cut-off takes place at 6% of the stroke. Find the air standard efficiency.	*CO4*	*PO2*	**06**
		c)	Explain the phenomenon of knocking and detonation in SI engine.	*CO4*	*PO1*	**08**
			OR			
	7	a)	Derive an expression for air standard efficiency of an Otto cycle, stating the assumptions made.	*CO4*	*PO1*	**10**
		b)	The following observations were recorded in a test of one hour duration on a single cylinder oil engine working on four stroke cycle. Bore = 300 mm Stroke = 450 mm Fuel used = 8.8 kg Calorific value of fuel = 41800 kJ/kg Average speed = 200 rpm Mean effective pressure = 5.8 bar Brake friction load = 1860 N Quantity of cooling water = 650 kg Temperature rise = 22°C Diameter of the brake wheel = 1.22 m Calculate (i) Mechanical efficiency and (ii) Brake thermal efficiency. Draw the heat balance sheet.	*CO4*	*PO2*	**10**

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