Model Question Paper-2 with effect from 2019-20 (CBCS Scheme)

USN | | | | | | | | | | |

Fourth Semester B.E. Degree Examination

Turbomachines

TIME: 03 Hours **Max. Marks: 100**

Note: Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.

		Module -1	*Bloom's Taxonomy Level	Marks
Q.01	a	Explain the components of a turbomachine with neat sketch.	2	06
	b	Prove that for turbo machines work produced or consumed is equal to change in stagnation enthalpy.	3	04
	c	Show that the discharge of a centrifugal pump is given by $Q = ND^3 f[\frac{gH}{N^2D^2}, \frac{\mu}{ND^2\rho}]$ where N is the speed of the pump in rpm D the diameter of the impeller, g the acceleration due to gravity, H the mano metric head, m viscosity fluid and ρ the density of the fluid.	3	10
		OR		
Q.02	a	Derive alternate form of Euler's energy equation for turbo machines.	2	08
	b	What is degree of reaction? Briefly explain the significance when degree of reaction is 0.5, less than 0.5 and greater than 0.5 with the velocity diagrams.	3	06
	c	The following data refers to an axial flow compressor. Machine: Axial flow compressor Degree of reaction: R=0.5 Inlet blade angle: $\beta_1=45^o$ Axial flow is constant: $V_{f1}=V_{f2}=100$ m/s Speed of blade: n=6000 rpm Diameter of the blade: d=0.5 m Blade speed: $u_1=u_2$ Mass of air: m=2 kg/s Calculate (a) the fluid angles at inlet and outlet and (b) the power required.	3	06
		Module-2		
Q. 03	a	Prove that for compression process, the overall isentropic efficiency is less than the stage efficiency.	2	12
	b	Air enters a compressor at a static pressure of 1.5 atm, a static temperature of 15°C and a flow velocity of 50 m/s. At the exit the static pressure is 3 atm, the static temperature 100^0C and flow velocity 100 m/s. The outlet is 2 m above the inlet. Calculate (a) the isentropic change in total enthalpy and (b) the change in total enthalpy.	3	08
		OR		
Q.04	a	Prove that for expansion process, the overall isentropic turbine efficiency is greater than the stage efficiency.	2	12
	b	Air flows through an air turbine where its stagnation pressure is decreased in ratio 5:1.The total-to-total efficiency is 0.8 and the air flow rate is 5 kg/s. The inlet total temperature is 280 K. Calculate (a) the actual power output, (b) the actual exit total temperature, (c) the actual exit static temperature if the exit flow velocity is 100 m/s, and (d) the total-to-static efficiency of the device.	3	08
		Module-3		
Q. 05	a	Briefly explain the following for a centrifugal compressor: i. Surging	2	10

		ii. Choking iii. Losses		
	b	Initial conditions of air entering a centrifugal compressor are 1 bar and 10°C static. The power input to the compressor is 450 kW. The total pressure at exit is 5 bar. The velocity of air at inlet is 150 m/s and the speed of the compressor is 20,000 rpm. The hub diameter is 12 cm. Assume isentropic efficiency as 0.8 and slip factor as 0.9. Calculate (a) the change in total temperature, (b) the impeller diameter at outlet and inlet, and (c) the mass flow rate of air.	3	10
		OR		
Q. 06	a	Derive general expressions for degree of reaction in terms of blade angles showing clearly the velocity triangles for one stage.	2	10
	b	A centrifugal compressor runs at a speed of 550 m/s with no prewhirl. Suppose the slip is 0.95 and isentropic efficiency of compressor is 0.85. Calculate the following for standard sea level: (a) Pressure ratio, (b) the work required, and (c) the power required. Assume, mass flow rate of 25 kg/s and c_p=1.005 kJ/kg-K, and ambient temperature of 15°C.	3	10
		Module-4		
Q. 07	a	How do you differentiate between an impulse and a reaction turbine? With neat sketches explain the working of an impulse and a reaction stage.	2	10
	b	At a stage in a 50% reaction axial flow turbine the rotor speed is 210m/s. Steam emerges from the nozzle inclined at 28^0 to the wheel plane with axial component equal to blade speed. Determine the rotor blade angles and the utilization factor.	3	10
		OR		
Q. 08	a	Draw Enthalpy-Entropy diagram for a radial turbine and explain the same.	2	10
	b	An inward flow reaction turbine has outer and inner diameter of the wheel as 1 m and 0.5 m respectively, the vanes are radial at inlet and discharge is radial at outlet. Water enters the vanes at an angle of 10^0. Assuming velocity of flow to be constant and equal to 3 m/s find: i) The speed of the wheel ii) The vane angle at outlet iii) The degree of reaction.	3	10
		Module-5		
Q. 09	a	Briefly explain the following for a centrifugal pump: i. Mano metric efficiency (η_{mano}) ii. Mechanical efficiency (η_{mech}) iii. Hydraulic efficiency (η_H). iv. Volumetric efficiency (η_{vol}) v. Overall efficiency (η_o)	2	10
	b	Elaborate the working principle of Pelton wheel with figure.	2	10
		OR		
Q. 10	a	Briefly discuss the classification of hydraulic turbines.	2	10
	b	Elaborate the working principle of Kaplan turbine with figure.	2	10