Model Question Paper-1 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	What are turbomachines? Classify turbomachines and explain the types with examples.	2	06
	b	Differentiate between positive displacement machines and turbomachines.	1	04
	c	The resisting force F of a supersonic plane during flight can be considered as dependent upon the length of the aircraft L, velocity V, air viscosity μ, air density ρ and bulk modulus of air K. Express the functional relationship between these variables and the resisting force.	3	10
		OR		
Q.02	a	Derive Euler's energy equation for turbomachines using theory of conservation of momentum.	2	08
	b	Explain degree of reaction and how it is used to classify turbomachines.	2	04
	c	The following data refers to a turbomachine. Inlet velocity of whirl=16m/s, velocity of flow=10m/s, blade speed=33m/s, outlet blade speed=8m/s. Discharge is radial with an absolute velocity of 16m/s. If water is the working fluid flowing at the rate of $1m^3/s$, calculate (a) the power in kW, (b) the change in total pressure in kN/m^2, (c) the degree of reaction.	3	08
		Module-2		
Q. 03	a	Derive an expression for static-to-static compression efficiency with the help of a T-S diagram and explain how it is different from total-to-total compression efficiency.	2	10
	b	An air compressor has six stages of equal pressure ratio 1.4. The mass flow rate is 45kg/s. The overall isentropic compression efficiency is 84%. Entry pressure is 1bar and temperature is 313K. Calculate (a) the state of the air at the exit, (b) polytropic efficiency, (c) stage efficiency and (d) power required to drive the compressor. Assume γ=1.4, R=0.287kJ/kg-K, cp=1.005kJ/kg-K.	3	10
		OR		
Q.04	a	Derive an expression for total-to-static expansion efficiency with the help of a T-S diagram and explain how it is different from total-to-total expansion efficiency.	2	10
	b	A two-stage turbine develops 22MW at the shaft. The inlet temperature is 1500K. The overall pressure ratio of the turbine is 8 and the isentropic expansion efficiency 90%. Assume that the pressure ratio of each stage is same. Calculate (a) the pressure ratio of each stage, (b) polytropic efficiency, (c) stage efficiency and (d) the mass flow rate. Assume γ=1.4, R=0.287kJ/kg-K, cp=1.005kJ/kg-K.	3	10
		Module-3		
Q. 05	a	Briefly explain the following for a centrifugal compressor: i. Pressure co-efficient	1	10

		ii. Slip factor iii. Power factor		
	b	The inlet conditions of a centrifugal compressor are 1bar 303K, running at 10krpm. It delivers a free air stream of $1.5m^3/s$. The compression ratio is 5. The velocity of flow is 50m/s and is constant. Assume that the blades are radial at outlet. The slip factor is 0.92. Calculate (a) the temperature of air outlet, (b) the power required, (c) the impeller diameter, (d) the blade angle at inlet and (e) diffuser inlet angle. Assume power factor of 1.11 and isentropic efficiency of 90%.	3	10
		OR		
Q. 06	a	Derive general expressions for degree of reaction in terms of flow angles showing clearly the velocity triangles for one stage.	2	10
	b	The speed of an axial flow compressor is 15krpm. The mean diameter is 0.6m. The axial velocity is constant and is 225m/s. The velocity of whirl at the inlet is 85m/s. The work done is 45kJ/kg of air. The inlet conditions are 1bar and 300K. Assume stage efficiency of 89%. Calculate (a) the fluid deflection angle, (b) the pressure ratio, (c) the degree of reaction, (d) the mass flow rate of air and (e) the shaft power if mechanical efficiency is 95%. The power developed is 425kW.	3	10
		Module-4		
Q. 07	a	With reference to flow passage write a brief description of subsonic, transonic and supersonic turbines.	2	10
	b	What do you understand by velocity compounding and pressure compounding in a turbine?	2	05
	c	Explain the following briefly, i. Loading co-efficient (ψ)Vs Flow co-efficient (ϕ) graph.	2	05
		OR		
Q. 08	a	Mention different types of losses in a radial flow turbine and define nozzle loss co-efficient.	1	10
	b	Describe the various stage losses occurring in a radial turbines.	2	05
	c	Draw and explain Blade-to-gas speed ratio (σ) (Vs) Stage efficiency (η_s)graph for a radial turbine.	2	05
		Module-5		
Q. 09	a	With the help of a neat sketch, explain the parts and working principle of a centrifugal pump.	2	10
	b	A four stage centrifugal pump has four identical impellers keyed to the same shaft running at 500 rpm. The total manometric head developed is 40m, discharge $0.3m^3/s$. If the outlet vane angle is 45^0 for impeller of 5cm outlet diameter, determine the manometric efficiency.	3	10
		OR		
Q. 10	a	Classify and explain draft tube, and what are its functions?	2	10
	b	A Kaplan turbine a 5MW generator at 150rpm under a head of 5.5m. The generator and overall efficiencies are respectively 93% and 88%. The tip diameter of the runner is 4.5m and the hub diameter is 2m. Assuming 94% hydraulic efficiency and no exit whirl, determine inlet and outlet.	3	10