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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 $\mu$ , air density $\rho$ and bulk modulus of air K. Express the functional relationship between these variables and the resisting force.	3	10
Q.02	а	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	а	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 $\gamma$ =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 $\gamma$ =1.4, R=0.287kJ/kg-K, cp=1.005kJ/kg-K.	3	10
	1	Module-3		1
Q. 05	a	Briefly explain the following for a centrifugal compressor:	1	10
		i. Pressure co-efficient		

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ii.Slip factoriii.Power factorbThe inlet conditions of a centrifugal compressor are 1bar 303K, running at velocity of 1ow is 30m/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 (c) diffuser inlet angle. Assume power factor of 1.11 and isentropic efficiency of 90%.30aDerive general expressions for degree of reaction in terms of flow angles showing clearly the velocity triangles for one stage.2bThe speed of an axial flow compressor is 15krpm. The mean diameter is 0.6m. The axial velocity is constant and is 225m/s. The volk done is 45kl. We done					10AL4(
b       The inlet conditions of a centrifugal compressor are Ibar 303K, running at 10krpm. II 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 (c) diffuser inlet angle. Assume power factor of 1.11 and isentropic efficiency of 90%.       Image: temperature of a constant and is constant. Assume that the blades are radial at outlet. The slip factor is 0.92. Calculate (a) the themperature of air outlet, (b) the power required, (c) the impeller diameter, (d) the blade angle at inlet and (c) diffuser inlet angle. Assume power factor of 1.11 and isentropic efficiency of 90%. $V = 0$ 0       a       Derive general expressions for degree of reaction in terms of flow angles showing clearly the velocity triangles for one stage.       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 volocity of whird at the inlet is 85m/s. The own do not is 45L/kg of air. The indet conditions are 1bar and 30K. 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.       10 $V$ of a       With reference to flow passage write a brief description of subsonic, transonic 2       10         in a turbine? $V$ $V$ $V$ $V$ of do you understand by velocity compounding and pressure compoun					
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