BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: B.TECH **SEMESTER : VI**
BRANCH: MECHANICAL **SESSION : SP/2023**

SUBJECT: ME349 TURBOMACHINERY

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	What are the different components of energy transfer in turbomachines?	[2]	1	2
Q.1(b)	What is the Eulers equation of turbomachines?	[2]	1	1
Q.1(c)	A model of a centrifugal pump absorbs 5 kW at a speed of 1500 rpm, pumping water against a head of 6 m. The large prototype pump is required to pump water to a head of 30 m. The scale ratio of diameter is 4. Assuming the same efficiency and similarities, find (a) the speed, (b) the power of prototype and (c) the ratio of discharge of prototype and model.	[6]	3	3
Q.2(a)	What are the differences between impulse and reaction turbines?	[3]	1	1
Q.2(b)	Define the degree of reaction and vane efficiency of the impulse turbine.	[2]	1	1
Q.2(c)	Steam at 300 m/s is supplied to single stage impulse turbine through a nozzle. The nozzle angle is 25°, the mean diameter of the blade rotor is 100 cm and it has a speed of 2000 rpm. Find inlet and outlet blade angles if there is no axial thrust. If the blade velocity coefficient is 0.9 and steam flow rate is 10 kg/s find the power developed.	[5]	5	4
Q.3(a)	Explain the working principle of a centrifugal compressor with Enthalpy-Entropy diagram.	[3]	2	2
Q.3(b)	A single stage reciprocating air compressor takes in $8m^3$/min of air at 1 bar and 30^0 C and delivers it at 6 bar. The clearance is 5% of the stroke. The expansion and compression are polytropic with the value of n=1.3. Calculate: (a) the temperature of delivered air; (b) volumetric efficiency (c) power required to drive the compressor.	[3]	5	4
Q.3(b)	A centrifugal compressor runs at a speed of 15000 rpm and delivers 30 kg of air per second. Exit radius is 0.35 m, relative velocity at exit is 100 m/s at an exit blade angle of 75°. Assume axial inlet and T_{01} = 300 K and P_{01} = 1 bar. Calculate (a) the torque, (b) the power required to drive the compressor, (c) the ideal head developed, (d) the work done.	[4]	5	4
Q.4(a)	Explain the working principle of an axial flow compressor with stage velocity triangles.	[5]	1	2
Q.4(b)	An axial compressor stage has the following data. Stagnation temperature and pressure at entry are 20°C and 1 bar, and the degree of reaction is 50%. Flow coefficient: ϕ= 0.5 Mean blade ring diameter: d_m = 35 cm Speed: N = 18,000 rpm Air angles at rotor and stator exit: $\alpha_1 = \beta_2 = 60°$ Blade height at entry: h = 5 cm Work done factor: φ = 0.88 Isentropic efficiency: η = 0.85 Mechanical efficiency: η_m = 0.96 Calculate (a) the air angles at the rotor and stator entry and (b) the mass flow rate of air.	[5]	5	4
Q.5(a)	Explain the fan laws for the same fan and fans of different sizes?	[4]	2	2
Q.5(b)	Define some methods of reducing fan noise	[3]	1	1
Q.5(b)	What are the losses in centrifugal fans?	[3]	1	1

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