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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Sixth Semester B.Tech Degree Regular and Supplementary Examination July 2021

Course Code: ME364

Course Name: TURBOMACHINERY

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any three full questions, each carries 10 marks. Marks

1	a)	Classify turbomachines.	(5)
	b)	What is mass flow capacity and blade Mach number? Explain the physical significance of each.	(5)
2	a)	Explain principle of physical similarity.	(5)
	b)	Define Specific Speed. Explain how Specific Speed facilitates selection of a turbo machine.	(5)
3	a)	For the same pressure ratio and total to total efficiency stage work done is depended namely on initial temperature T_{01} or T_1. Justify?	(5)
	b)	Derive the various components of energy transfer in a turbo machine. Explain each component of energy transfer.	(5)
4	a)	Derive an expression for polytropic efficiency η_p as a function of stage efficiency η_{st} for a compressor.	(5)
	b)	Preheat factor is always less than 1. Justify.	(5)

PART B

Answer any three full questions, each carries 10 marks.

5	a)	Prove that flow through the vaneless space in a centrifugal fan is a free vortex flow.	(5)
	b)	A centrifugal blower with a radial impeller produces a pressure equivalent to 100 cm column of water. The pressure and temperature at its entry are 0.98 bar and 310 K. The electric motor driving the blower runs at 3000 rpm. The	(5)

efficiencies of the fan and drive are 82% and 88% respectively. The radial velocity remains constant and has a value of $0.2u_2$. The velocity at the inlet eye is $0.4u_2$. If the blower handles 200 m^3/min of air at the entry conditions, determine:

(a) power required by the electric motor,

(b) impeller outer diameter,

(c) inner diameter of the blade ring,

(d) blade angle at entry,

(e) impeller widths at entry and exit

6	a)	Draw the velocity triangles for the different types of impeller design in a centrifugal fan.	(6)
	b)	For a centrifugal compressor, Prove that $R = 1 - \frac{V_{w2}}{2u_2}$ where R is degree of reaction, V_{w2} is the whirl velocity component at the exit and u_2 is the vane velocity in tangential direction.	(4)
7	a)	What is surging phenomenon. With the help of performance characteristic curve, explain surging in a compressor.	(10)
8	a)	Draw the enthalpy-entropy diagram of a centrifugal compressor stage	(6)
	b)	With the help of velocity triangle, explain the significance of slip in a centrifugal compressor.	(4)

PART C

Answer any four full questions, each carries 10 marks.

9	a)	Draw the velocity triangle for an axial flow compressor stage.	(6)
	b)	With the help of neat diagram explain the distribution of pressure and velocity in a stage of an axial flow compressor.	(4)
10	a)	Explain rotating stall.	(3)
	b)	For an axial flow compressor, prove that $R = 1 - \frac{V_f}{2u}(tan \propto_2 - tan \propto_1)$ where V_f is flow velocity perpendicular to vane velocity, R is degree of reaction, u is the vane velocity in tangential direction, $\propto_2$ and $\propto_1$ are the inlet guide vane angle.	(7)
11	a)	Explain positive incidence flow separation with a neat diagram.	(5)

b) Explain the variation of stage loading coefficient ψ with flow coefficient ϕ in an axial flow compressor. (5)

12 a) Draw the velocity triangles of an axial flow turbines for degree of reaction R=0, R=1, R=0.5 respectively. (6)

b) Name the sources of losses in an axial turbine rotor (4)

13 a) Derive the expression for Degree of Reaction for axial turbine stage (10)

$$R = 1 - \frac{\varphi^2}{2\psi}(tan^2\alpha_2 - tan^2\alpha_1)$$

Hence derive $\psi = 2(1 - R + \varphi \tan \alpha_1)$

Comment on the utility of this equation

14 a) The rotor of a 90^0 IFR turbine, which is designed to operate at the nominal condition, is 23.76 cm in diameter and rotates at 38,140 rev/min. At the design point, the absolute flow angle at rotor entry is 72^0. The rotor mean exit diameter is one-half of the rotor diameter and the relative velocity at rotor exit is twice the relative velocity at rotor inlet. Draw the velocity triangle. Determine the contributions of each component of energy transfer in the rotor to the specific work (10)

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