Exam Date & Time: 06-Jan-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

V SEMESTER B.TECH. (MECHANICAL ENGINEERING)
END SEMESTER EXAMINATIONS (MAKEUP) - JANUARY 2024
COURSE: TURBO MACHINES (MME 3154)

TURBO MACHINES [MME 3154]

Marks: 50 **Duration: 180 mins.**

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Answer all the questions. Section Duration: 180 mins

1A) Develop the expression for power coefficient and flow coefficient for an incompressible flow machine using dimensional analysis. (4)

1B) Derive Euler's Turbine equation with the sketch showcasing relavant velocity vectors. Mention the assumptions made. (3)

1C) Prove that for a 25% reaction axial flow turbine, the ratio of blade speed to absolute velocity at rotor inlet is equal to 2/3 cos(theta), where (theta) is the nozzle angle. Assume maximum utilization factor with no axial thrust. (3)

2A) Express the energy transfer of a radial bladed impeller in terms of head and flow rate. Assume shock-less entry condition. Draw the velocity triangles also. (3)

2B) In an inward flow reaction turbine water enters the turbine such that the inlet nozzle angle is 25° and blade angle is 105°. The meridional component of velocity is constant throughout. If the exit of water is radial what is the utilization factor and degree of reaction. Determine work done /kg by the turbine if the available head on the turbine is 5m. (5)

2C) In a mixed flow turbo machine fluid enters such that absolute velocity is radial at inlet while at outlet the relative velocity is radial. What is the energy transfer to the fluid if relative velocity at outlet is the same as tangential blade speed at inlet? The following data may be used: Radius at entry = 80 mm, Radius at exit = 250 mm, Speed = 300 RPM, Inlet blade angle = 45°. (2)

3A) Each stage of a 4 stage air compressor delivering 44 kg/s operates at a pressure ratio of 1.2 with a stage efficiency of 65%. Calculate overall efficiency and pressure ratio. Compute power required to drive the compressor if air temperature at inlet is 20°C. Find also the exit air temperature. (4)

3B) Develop an expression for the overall efficiency of a multi stage compressor in terms of stage pressure ratio and polytropic efficiency. (3)

3C) Deduce an expression for static pressure rise in a centrifugal pump. (3)

4A)	A centrifugal compressor runs at 15,000 rpm and has 20 radially tipped blades with an outer tip diameter of 600 mm. The absolute velocity at compressor inlet is radial to ensure shockless entry. The compressor has radial blades at exit such that exit meridional component is 135 m/s. and total-to-total efficiency is 70%. The stagnation conditions at inlet are 1 bar and 25°C. Find the Slip and Slip factor, the actual exit blade angle. What is the actual and isentrophic temperature rise through the compressor?	(4)
4B)	What do you mean by pre-whirl? Discuss the phenomena using a velocity triangle.	(2)
4C)	Deduce an expression for hydraulic efficiency of a pelton turbine and show that it is a function of blade speed ratio only.	(4)
5A)	Derive an expression for utilization factor of a Curtis impulse turbine. Draw the velocity triangles also.	(4)
5B)	A Pelton Turbine has a mean bucket speed of 10 m/s with a jet of water flowing at a rate of 750 liters/s under a head of 30 m. The bucket deflects the jet through an angle of 160°. Compute the power and efficiency of the turbine. Assume coefficient of jet as 0.98.	(3)
5C)	An axial flow impulse steam turbine has mean rotor of 0.5 m and runs at 3300 rpm. Speed ratio is 0.45 and the nozzle angle at rotor inlet is 20°. The blade velocity coefficient is 0.9. Find the rotor blade angle at inlet and outlet assuming axial discharge.	(3)

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