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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S4 (R,S) / S2 (PT) (R,S) Examination June 2023 (2019 Scheme)

Course Code: MET206

Course Name: FLUID MACHINERY

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer all questions; each question carries 3 marks) Marks

1	Determine the force exerted by the jet on a moving plate held normal to the jet.	3
2	Differentiate between Pelton and Francis turbines.	3
3	Describe the significance of draft tubes in turbines along with its working principle.	3
4	Differentiate free vortex and forced vortex with examples	3
5	Construct an ideal indicator diagram and explain the various processes involved in a single stage reciprocating pump.	3
6	Explain the working of air vessels with the help of a schematic diagram.	3
7	Explain free air delivery in a compressor.	3
8	Describe degree of reaction in an axial compressor.	3
9	List down the assumptions involved in Brayton cycle analysis.	3
10	Describe the stability loop in the combustion chamber with a suitable diagram.	3

PART B

(Answer one full question from each module, each question carries 14 marks)

Module -1

11	a)	Derive the work done by a series of radially curved vanes mounted on a wheel.	7
	b)	A jet of water having velocity of 40 m/s strikes a curved vane which is moving with a velocity of 20 m/s. The jet makes an angle of 30° with the direction of motion of vane at inlet and leaves at an angle of 90° to the direction of motion of vane at outlet. Determine the vane angles at inlet and outlet so that the water enters and leaves the vane without shock	7
12	a)	Explain the constructional details of a Kaplan turbine with the help of a neat diagram.	7

b) A Francis turbine has a constant flow velocity of 4 m/s. Peripheral velocity at inlet is 30 m/s and whirl velocity at inlet is 25 m/s. Assuming a hydraulic efficiency of 0.90 and zero whirl at the exit, determine a) the net head available to the turbine, b) inlet blade angle, and c) inlet guide vane angle. 7

Module -2

13 a) With a neat sketch, illustrate the governing employed in a Pelton turbine. 6

b) The impeller of a centrifugal pump has external and internal diameters of 500 mm and 250 mm respectively, and width of outlet 50 mm. It runs at 1200 rpm and works against a head of 48 m. The velocity of flow through the impeller is 3 m/s and is constant. The vanes are backward curved at an angle of 40° at outlet. Determine 8

i) Inlet vane angle

ii) Work done by the impeller per second

iii) Manometric efficiency

14 a) Describe cavitation in centrifugal pump with the aid of Net Positive Suction Head. Construct a typical head-discharge characteristic curve of centrifugal pump. 7

b) The inlet and outlet diameters of an impeller of a centrifugal pump are 30 cm and 60 cm respectively. The velocity of flow at outlet is 2 m/s and vanes are backward curved at 45° at the outlet. Determine the minimum starting speed of the pump if manometric efficiency = 0.70 7

Module -3

15 a) Derive the work done by a single acting reciprocating pump experiencing the effect of acceleration and friction in suction and delivery pipes, with the help of an indicator diagram. 8

b) A single acting reciprocating pump running at 60 rpm delivers 0.53 m^3 of water per minute. The diameter of piston is 200 mm and stroke length is 300 mm. The suction and delivery heads are 4 m and 12 m respectively. Determine 6

i) Theoretical discharge

ii) Percentage slip of the pump

iii) Power required to run the pump

16 a) Describe the working of a vane compressor, with the help of a neat figure. 6

b) The length and diameter of a suction pipe of a single acting reciprocating pump are 5 cm and 10 cm respectively. The pump has a plunger of diameter 150 mm and of stroke length of 300mm. The centre of the pump is 4 m above the water surface. The atmospheric pressure head is 10.3 m of water and pump is running at 40 rpm. Determine (i) pressure head due to acceleration at the beginning of suction stroke (ii) maximum pressure due to acceleration, and (iii) pressure head in the cylinder at the beginning and end of the stroke 8

Module -4

17 a) Derive the work done for a reciprocating compressor without clearance volume undergoing polytropic compression with the aid of a P-V diagram. 6

b) A single acting reciprocating air compressor running at 100 rpm has cylinder diameter 200 mm and stroke length 300 mm. Inlet conditions are 1 bar and 300 K and discharge at 8 bar. Find the indicated power of the compressor and mass of air delivered per minute by the compressor. Assume polytropic compression PV^n =constant, n=1.25, and R=287 J/kg K 8

18 a) Explain surging and chocking occurring in centrifugal compressor with the help of suitable diagram. 6

b) A centrifugal compressor running at 1200 rpm delivers 600 m^3/min of free air. The air is compressed from 1 bar and 300 K to a pressure ratio of 4 with an isentropic efficiency 0.85. The blades are radial to the impeller outlet and flow velocity of 60 m/s may be assumed constant. The outer to inner diameter ratio is 2.0 and slip factor is 0.9. Calculate i) final temperature of air ii) power input to the compressor iii) impeller diameter at inlet and outlet, and iv) width of impeller at inlet. 8

Module -5

19 a) Derive the optimum pressure ratio for maximum specific output for a gas turbine cycle without considering machine efficiencies, with the help of T-s diagram. 7

b) The pressure ratio and maximum temperature of a Brayton cycle are 7 and 1000 K and enters the compressor at 1 bar and 303 K for 2 kg/s of air flow. Calculate compressor work input, turbine work output and thermal efficiency. Cp=1.005 kJ/kgK 7

20 a) Explain, with a neat labelled diagram, any one of the combustion chambers used in gas turbine cycle. 6

b) In a gas turbine plant, the compressor takes in air at a temperature of 15°C and compresses it to four times the initial pressure with an isentropic efficiency of 0.85. The air is then passed through a heat exchanger heated by the turbine exhaust before reaching the combustion chamber. The inlet temperature of turbine is 600° C and its efficiency is 0.80. Calculate thermal efficiency and work ratio of the cycle if heat exchanger is perfect. Take R= 287 J/kg K, and $\gamma = 1.4$ 8

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