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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S4 (S, FE) / S2 (PT) (S) Examination January 2024 (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	Derive the equation for the force exerted by a jet of water on a curved plate when the plate is moving in the direction of the jet.	3
2	Explain speed ratio and jet ratio with respect to the Pelton wheel turbine.	3
3	Why does the draft tube of a reaction turbine have an enlarging area in the direction of flow?	3
4	Define the phenomenon of cavitation in hydraulic machines.	3
5	Why is priming necessary for a centrifugal pump?	3
6	Plot the constant speed performance curves of a centrifugal pump.	3
7	Explain in brief how and when separation of flow takes place in a reciprocating pump.	3
8	Define volumetric efficiency of a reciprocating air compressor with clearance volume. Write the effect of pressure ratio on volumetric efficiency.	3
9	List the methods for improving thermal efficiency and specific output of a simple gas turbine plant.	3
10	Sketch the layout of a gas turbine plant with regeneration and draw the corresponding T-S diagram.	3

PART B

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

Module -1

11	Diameters at the entrance and exit of an inward flow reaction turbine are 1 m and 0.6 m respectively. The head of the turbine is 32 m and its hydraulic efficiency is 90%. The velocity of flow at the outlet is 2 m/s and the discharge is radial at the exit. The vane angle at the outlet is 15^0 and the width at the inlet and outlet is 0.1 m. Determine (i) guide blade angle (ii) the vane angle at the inlet (iii) speed of turbine (iv) flow rate, and (v) power developed.	14

12 a) Prove that the maximum efficiency when a jet of water impinges on a series of plates mounted on a wheel appearing successively is 50%. 6

b) A Pelton wheel is to be designed for the given operating conditions: The power to be developed is 5500 kW with a net head of 300 m. The speed of the turbine is 600 rpm. Assuming an overall efficiency of 85% and the ratio of jet diameter to wheel diameter as 1/10, determine the diameter of the jet, the diameter of the wheel and the quantity of water required. Take C_v as 0.98 and speed ratio as 0.46. 8

Module -2

13 The impeller of a centrifugal pump is 30 cm in diameter and 5 cm in width at the outer periphery. The impeller vane angle at the outer periphery is 60^0. The pump delivers 17 m^3/min and the impeller rotates at 1000 rpm. Assuming radial entry at the inlet, calculate (i) speed and direction of water leaving the impeller (ii) torque exerted by impeller on water (iii) shaft power required, and (iv) manometric head. Assume mechanical efficiency as 90% and hydraulic efficiency as 75%. 14

14 a) Derive an expression for head developed in the impeller of a centrifugal pump. 6

b) A centrifugal pump running at 1450 rpm against a head of 24 m has a discharge of 0.118 m^3/s. The impeller diameter is 250 mm, its width at outlet is 50 mm and manometric efficiency is 80%. Determine the vane angle at the outer periphery of the impeller. 8

Module -3

15 a) Describe using an indicator diagram, how the acceleration and friction in suction and delivery pipes affect the work done by a reciprocating pump. 6

b) The diameter and stroke of a single cylinder single-acting reciprocating pump are 10 cm and 30 cm respectively. The water is to be lifted to a height of 22 m above the centre line of the pump. The diameter and length of the delivery pipe are 6 cm and 25 m respectively. Determine the maximum speed the pump can run so that no separation occurs during delivery. Assume the separation pressure head as 2.5 m of water and the atmospheric pressure head as 10.3 m of water. 8

16 The diameter and stroke of a single-acting reciprocating pump are 10 cm and 20 cm respectively. The diameter of the suction and delivery pipe is 7.5 cm and the lengths of the suction and delivery pipe are 10 m and 20 m respectively. The suction head is 2.8 m and the delivery head is 16 m. If the pump is running at 60 rpm, determine the absolute pressure head in the cylinder (i) at the beginning of 14

suction and delivery stroke (ii) at the middle of suction and delivery stroke (iii) at the end of suction and delivery stroke, and (iv) power required to run the pump. Assume coefficient of friction, f as 0.01 for both the pipes and atmospheric pressure head as 10.3 m of water.

Module -4

17	a)	Explain the working of an axial flow compressor.	8
	b)	Compare the features of centrifugal and axial flow compressors.	6
18		The low-pressure cylinder of a 2-stage double-acting reciprocating air compressor running at 150 rpm has a 50 cm diameter and 75 cm stroke. It draws in air at a pressure of 1.01 bar, 23^0C and adiabatically compresses it to 3 bar pressure. The air is then passed through an intercooler at constant pressure and the temperature is reduced to 36^0C. The polytropic index of compression in the high-pressure cylinder is 1.3 and the pressure is raised to 12 bar. Determine the power required to drive the compressor. The efficiencies of the compressor and motor are 88% and 85% respectively. Assume R as 0.287 KJ/kg K, C_p as 1 KJ/kg K and ratio of specific heats as 1.4.	14

Module -5

19	a)	Derive an expression for optimum pressure ratio for maximum specific work output of a gas turbine plant.	10
	b)	How does the actual cycle differ from the ideal cycle for a constant pressure open cycle gas turbine?	4
20		Air is drawn in a gas turbine plant at 20^0C and 1 bar. The pressure ratio is 7:1. The compressor is driven by the high-pressure turbine and the output power is taken from low-pressure turbine. The isentropic efficiency of the compressor, high pressure and low-pressure turbines are 80, 82 and 85% respectively. If the maximum cycle temperature is 640^0C, determine (i) the pressure and temperature of gases entering the low-pressure turbine (ii) net power developed (iii) work ratio, and (iv) thermal efficiency. Take C_p as 1.005 KJ/kgK and the ratio of specific heats as 1.4.	14

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