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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fourth Semester B.Tech Degree Supplementary 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	Show that the force exerted by a jet of water on an inclined fixed plate in the direction of jet is given by: $F_x = \rho A V^2 Sin^2\alpha$.	(3)
2	Explain the purpose of providing scroll casing and guide vanes for a reaction turbine.	(3)
3	What is priming of a centrifugal pump? Explain clearly why priming is essential before starting a centrifugal pump?	(3)
4	Explain the terms manometric efficiency, mechanical efficiency and overall efficiency as applied to centrifugal pumps.	(3)
5	Define slip, percentage slip and negative slip of a reciprocating pump	(3)
6	Explain in brief how and when separation of flow takes place in a reciprocating pump.	(3)
7	Explain 'Surging' in centrifugal compressor	(3)
8	Compare axial flow compressor with centrifugal flow compressor	(3)
9	Draw a neat diagram of a closed cycle gas turbine plant and state its merits and demerits.	(3)
10	Explain the important factors to be considered during combustion chamber design of a gas turbine power plant.	(3)

PART B

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

Module -1

11	a)	Show that for a series of curved radial vanes, the work done by the jet per second is given by , $\rho a V_1 [V_{W_1} u_1 \pm V_{W_2} u_2]$	(7)
	b)	A free jet of water of area A and velocity V strikes a vertical plate normally. The	(7)

plate is moving with a velocity u in the direction of the jet. Obtain the value of the ratio u/V for maximum efficiency of this power transmission system. What is the value of corresponding maximum efficiency?

12 a) A jet of water having a 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 30^0 with the direction of motion of vane at inlet and leaves at an angle of 90^0 to the direction of motion of vane at outlet. Draw the velocity triangles at inlet and outlet and determine the vane angles at inlet and outlet so that the water enters and leaves the vane without shock. (7)

b) Prove that the work done per second per unit weight of water in a reaction turbine is given by $\frac{1}{g}(V_{W_1}u_1 \pm V_{W_2}u_2)$ (7)

Module -2

13 a) Define the term 'Governing of hydraulic turbine'. By means of a neat sketch, explain the governing mechanism of Pelton turbine. (7)

b) What is a draft tube? Explain its functions and draw simple sketches of any two types of draft tubes (7)

14 a) Define the specific speed of a turbine. Derive an expression for it. (5)

b) An inward flow reaction turbine has external and internal diameters of 1.0 m and 0.6 m respectively. The hydraulic efficiency of the turbine is 90 % when the head on the turbine is 36 m. The velocity of flow at outlet is 2.5 m/s and discharge at outlet is radial. If the vane angle at outlet is 15^0 and width of the wheel is 100 mm at inlet and outlet, determine: (9)

(i) The guide blade angle

(ii) Speed of the turbine

(iii) Vane angle of the runner at inlet

(iv) Volume flow rate of turbine

(v) Power developed

Module -3

15 a) Considering the effect of acceleration and friction in suction and delivery pipes, draw the indicator diagram for a single acting reciprocating pump. Also, starting from the fundamentals, derive an expression for work done per second. (9)

b) Explain with neat sketches the function of air vessels in a reciprocating pump. (5)

16 a) The cylinder bore diameter of a single acting reciprocating pump is 150 mm and (8)

its stroke is 300 mm. The pump runs at 50 rpm and lifts water through a height of 25 m. The delivery pipe is 22 m long and 100 mm in diameter. Find the theoretical discharge and the theoretical power required to run the pump. If the actual discharge is 4.2 litres/s, find the percentage slip. Also determine the acceleration head at the beginning and middle of the delivery stroke.

b) With neat sketches, explain the working of (6)

a) Hydraulic Ram b) Hydraulic Intensifier

Module -4

17 a) What do you mean by multistage compression? Give any four advantages of multistage compression. (6)

b) A single-stage, single-acting, reciprocating air compressor takes in 1 m^3 air per minute at 1 bar and 17^0C and delivers it at 7 bar. The compressor runs at 300 rpm and follows the law $pV^{1.35}$ = constant. Calculate the cylinder bore and stroke required, assuming stroke-to-bore ratio of 1.5. Calculate the power of the motor required to drive the compressor, if the mechanical efficiency of the compressor is 85 % and that of motor transmissions is 90 %. Neglect clearance volume and take R = 0.287 kJ/kg.K for air. (8)

18 a) With the help of a neat sketch, explain the working of a Roots blower. Derive an expression for the Roots efficiency in terms of pressure ratio. (7)

b) A centrifugal compressor running at 12000 rpm delivers 600 m^3/min of free air. The air is compressed from 1 bar and 27^0C to a pressure ratio of 4 with an isentropic efficiency of 85%. The blades are radial at the impeller outlet and flow velocity of 60 m/s may be assumed throughout constant. The outer radius of impeller is twice the inner one and slip factor is 0.9. Calculate, (7)

a) Final temperature of air

(b) Power input to compressor

c) Impeller diameter at inlet and outlet

d) Width of impeller at inlet

Module -5

19 a) In a gas turbine plant air enters the compressor at 1 bar and 7^0C. It is compressed to 4 bar with an isentropic efficiency of 82 %. The maximum temperature at the inlet to the turbine is 800^0C. The isentropic efficiency of the turbine is 85%. The calorific value of the fuel used is 43.1 MJ/kg. The heat losses are 15% of the (9)

calorific value. Calculate the following:

(i) Compressor work in kJ/kg

(ii) Heat supplied in kJ/kg

(iii) Turbine work in kJ/kg

(iv) Net work in kJ/kg

(v) Thermal efficiency

(vi) Air/fuel ratio

(vii) Specific fuel consumption in kg/kW h

(viii) Ratio of compressor work to turbine work.

Assume C_{pa} = 1.005 kJ/kg.K, γ_a = 1.4, C_{pg} = 1.147 kJ/kg.K, γ_g = 1.33.

b) With the help of a schematic and T-s diagram, explain the working of a reheat gas turbine plant (5)

20 a) In a closed-cycle turbine plant the working fluid at 38^{0}C is compressed with an adiabatic efficiency of 82 %. It is then heated at constant pressure to 650^{0}C. The fluid then expands down to initial pressure in a turbine with an adiabatic efficiency of 80%. The fluid after expansion is cooled to 38^0 C. The pressure ratio is such that work done per kg is maximum. For the working fluid, take C_{pa} = 1.005 kJ/kg.K and C_{pg} = 1.147. Calculate the pressure ratio and cycle efficiency. (7)

b) Sketch the schematic and T-s diagrams of regenerative gas turbine plant and deduce an expression for its thermal efficiency. (7)

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