Department of Mechanical Engineering
Chittagong University of Engineering and Technology (C U E T)
Level 4, Term-II, Examination 2023

Course No: ME421	Full Marks: 210	Time: 03 hours
Course Title: Fluid Machinery	Date: 20/ 05 / 2025	

The figures in the right margin indicate full marks. The questions are of equal value. There are 04 questions in each section. Answer any 03 questions from each section. Use separate script for each section.

Marks

Section: A

1 a) What are rotodynamic machines? Deduce the Euler's pump-turbine equation. 17

b) Differentiate between pressure relief valve and pressure reducing valve. 06

c) A pressure relief valve with a poppet area of 650 mm^2 and a spring constant of 450 kN/m has its spring is initially compressed by 5 mm. The poppet must move by 2.5 mm from its fully closed position in order to pass full pump flow through the valve. Determine: (i) the cracking pressure of the valve, and also (ii) the pressure of the valve needed for full pump flow through the valve. 12

2 a) Establish a relationship between the speed of the jet and the speed of the wheel of a Pelton turbine considering maximum efficiency. 17

b) A Pelton wheel is working under a head of 250 m developing 1000 kW at 300 rpm. The overall efficiency of the turbine is 85% and the coefficient of the nozzle is 0.98. The velocity ratio is 0.46; determine (i) diameter of the wheel and diameter of the jet, (ii) size of bucket and number of buckets. 18

3 a) What kind of turbine is a Francis turbine? Compare a Francis turbine with a Kaplan turbine. 13

b) A Kaplan turbine working under a head of 20 m develops 12000 kW shaft power. Outer and hub diameters of the runner are 3.5 m and 1.75 m. Guide blade angle at extreme edge of runner is 35°. Hydraulic and overall efficiencies are 88% and 84%. If velocity of whirl is 0 at outlet, determine (i) Runner vane angles at inlet and exit at extreme edge of runner, (ii) speed of turbine. 22

4 a) Differentiate between fan, blower and compressor. 06

b) Compare axial flow compressor with centrifugal flow compressor. 09

c) The rotational speed of a two-bladed axial flow fan is 2900 rpm. At the mean radius of 16.5 cm, the rotor blades operate at $C_L = 0.8$ with $C_D = 0.045$. The inlet guide vanes produce a flow angle of 20° to the axial direction and the axial velocity through the stage is constant at 20 m/s. For the mean radius, determine (i) the rotor relative flow angles, (ii) the stage efficiency, (iii) the rotor static pressure increase, and (iv) the size of the blade chord needed for this duty. 20

Section: B

5 a) Derive an expression for the minimum speed for starting a centrifugal pump. 09

b) What is priming? Why it is necessary? 08

c) A three stage centrifugal pump has impellers 40 cm in diameter and 2 cm wide at out let. The vanes are curved back at the out let at 45° and reduce the circumferential area by 10%. The manometric efficiency is 90% and the overall efficiency is 80%. Determine the head generated by the pump when running at 1000 rpm, delivering 50 liters per second. What should be the shaft power? 18

6 a) Estimate the percentage of work saved by fitting air vessels in a single acting reciprocating pump and also in a double acting reciprocating pump. 17

b) A single acting reciprocating pump has a plunger diameter of 250 mm and stroke of 450 mm and it is driven with SHM at 60 rpm. The length and diameter of delivery pipe are 60 m and 100 mm respectively. Determine the power saved in overcoming friction in the delivery pipe by fitting an air vessel on the delidery side of the pump. Assume friction factor = 0.01. 18

7 a) Explain the working principle of air lift pump with neat sketch. 10

b) Write short notes on Hydraulic accumulator and hydraulic Intensifier. 10

c) Find the number of pumps required to take water from a deep well under a total head of 156 m. Also the pumps are identical and are running 1000 rpm. The specific speed of each pump is given as 20 while the rated capacity of each pump is 150 liters/s. 15

8 a) Distinguish between a fluid coupling and a torque converter. With neat sketch describe the working of a torque converter. 17

b) A Pelton wheel develops 6500 kW at 200 rpm under a head of 220 m with an overall efficiency of 85%. Determine: 18

(i) Unit speed, unit discharge and unit power, and

(ii) The speed, discharge and power when the turbine is working under a head of 140 m.

********** The End **********

Department of Mechanical Engineering
Chittagong University of Engineering and Technology (CUET)

Level 4, Term-II, Examination 2022

Course: ME 421	Full Marks: 210	Time: 3 hours
Course Title: Fluid Machinery	Date: 04/03/2024	

The figures in the right margin indicate full marks. The questions are of equal value. There are 04 questions in each section. Answer any 03 questions from each section. Use separate script for each section.

Section – A

Q.1 (a) State and deduce the Euler's equation of work done for fluid machinery form the RTT's. 17

A (b) Design a Pelton wheel for the following data: 18
Head of water = 150 m, power to be developed = 600 kW and speed of the wheel = 360 rpm. Assume, reasonably, the missing data.

Q.2 (a) What is the physical significance of unit quantities on the performance of the hydraulic turbine? Derive the expressions of "unit speed" and "unit power" from the concept of unit turbine. 17

(b) In a hydroelectric station, water is available at the rate of 175 m^3/s under a head of 18 m. if the available turbines run at a speed of 150 rpm with overall efficiency of 82%, determine the number of turbine required, in case of 18
(i) Francis turbine with maximum specific speed of 460 rpm
(ii) Kaplan turbine with maximum specific speed of 350 rpm.

Q.3 (a) Describe the functions and working principle of air vessels in a reciprocating pump. 15

(b) The piston of a double acting reciprocating pump has a diameter of 120 cm and a stroke of 60 cm. the pump runs at 20 rpm and discharges through a 15 cm main 76 m long (friction factor, $f = 0.03$), the vertical lift being 46 m. If no air vessel is used, determine the heads in the cylinder at the ends and middle of the stroke. 20

Q.4 (a) State is the purpose of a directional control valve? Name the three ways by which a directional control valve may be actuated. 05

(b) Explain why a pressure relief is used in a hydraulic system. 05

(c) Draw the general layout of a hydraulic system and also a pneumatic system showing the basic components in them. 12

(d) For the crane system shown in Fig. Q.4(d), determine the hydraulic cylinder force required to lift a 2000 N load. 13

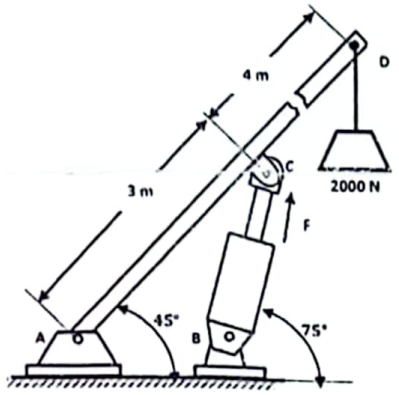

Fig.Q.4(d)

Section – B

Q.5 (a) Differentiates among compressors, fans and blowers. 05

(b) Deduce the work done and efficiency equation of fan with help of parametric analysis. 12

(c) A centrifugal fan running at 1500 rpm has inner and outer diameters of the impeller as 0.2 m and 0.24 m. The absolute and relative velocities of air at entry are 21 m/s and 20 m/s, respectively, and those at exit are 25 m/s and 18 m/s, respectively. The flow rate is 0.6 kg/s, and the motor efficiency is 80%. Determine 18

(i) the stage pressure rise, (ii) the degree of reaction and (iii) the power required to drive the fan. Assume the flow to be incompressible with the density of air as 1.22 kg/m³.

Q.6 (a) Explain the effects of blade profile on the working of a centrifugal compressor. 09

(b) What are the methods adopted to increase the efficiency of the centrifugal pump by altering the shape of the casing of chamber surrounding the impeller? Briefly explain with neat sketches. 08

(c) A three-stages centrifugal pump has impeller 40 cm in diameter and 2 cm wide. If the blade angle at outlet is 45° and the area occupied by the thickness of the vanes may be assumed 8% of the outlet area. If the pump delivers 3.6 m³/min when running at 920 rpm, determine (i) power of the pump, and (ii) Manometric head. 18

Q.7 (a) Why is Pelton wheel called an impulse turbine? Derive the equation for the maximum efficiency of a Pelton wheel. 17

(b) A Kaplan turbine operating under a net head of 20 m developed 36750 kW win an overall efficiency of 86%. The speed ratio is 2 and the flow ratio 0.69. The hub diameter of the wheel is 0.35 times the outside diameter of the wheel. Find the diameter and speed of the turbine. 18

Q.8 (a) Starting from the Euler equation, show that the manometric efficiency of a centrifugal pump is a function of tangential velocity, flow velocity and the vane angle at the out let of the impeller. 12

(b) Discuss with the help of neat sketch, different heads and main components of a centrifugal pump. 08

(c) Water is transported from tank A to a tank B by a pump. The dimensions of the system are show in Fig.Q.8(c). The total length of the suction pipe and the delivery pipe are 30 m and 20 m, respectively. The total head losses in the suction pipe and the delivery pipe are 1 m and 2 m, respectively. Determine the water power of the pump needs to deliver if the flow rate is 40 liters/sec. Neglect the velocity head. 15

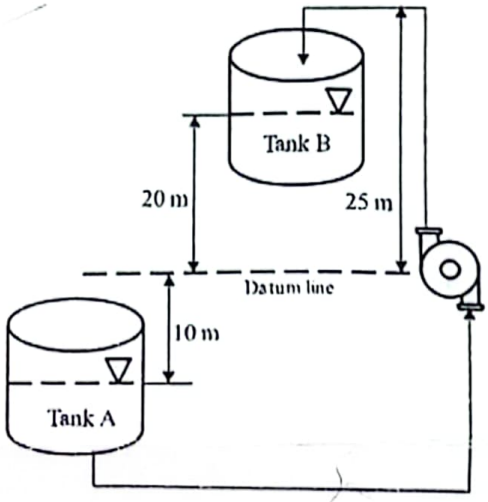

Fig.Q.8(c)

****The End****

Department of Mechanical Engineering
Chittagong University of Engineering and Technology (C U E T)
Level 4, Term II Examination 2021

Course No: ME 421	Full Marks: 210	Time: 03 hours
Course Title: Fluid Machinery	Date: **26 / 02 / 2023**	

The figures in the right margin indicate full marks. The questions are of equal value. There are 04 questions in each section. Answer any 03 questions from each section. Use separate script for each section.

Marks

Section: A

1. a) Explain the term choking in nozzle flows. 5
   b) Show that the sonic velocity in an ideal gas depends on the temperature and nature of the gas. 12
   c) A converging-diverging nozzle is to be designed to expand air isentropically to atmospheric pressure from a large tank in which properties are held constant at 5°C and 304 kPa (abs). The desired flow rate is 1 kg/s. determines the exit area of the nozzle. 18

2. a) Air flows in a variable cross-sectional area duct. Derive the relation for velocity change in term of area change $\frac{dA}{A}$ of the duct, assuming one dimensional isentropic flow and hence explain how an accelerating flow can be obtained. 17
   b) Air flowing with a velocity of 600 m/s, a pressure of 60 kPa, and a temperature of 260K undergoes a normal shock. Determine (i) the Mach number before and after the shock, and (ii) the entropy change across the shock. 18

3. a) Prove that the work done by a single stage reciprocating compressor without clearance volume for isentropic compression is $W = mc_p (T_1 - T_2)$, where the symbols have their usual meaning. 17
   b) Estimate the minimum work required to compress 1.5 kg of air from 1.0 bar 27°C to 20 bar in two stages, if the law of compression is $pv^{1.25}$ = constant and intercooling is perfect. Take R = 287 J/kg-K. 18

4. a) What is cavitation in pump? What are its consequences? How can cavitation be avoided? 7
   b) Show that the maximum acceleration head in a reciprocating pump, without air vessel is given by the relation $H_a = \left(\frac{l}{g}\right) \times \left(\frac{A}{a}\right) \times w^2 r$, where, l = length of pipe, A/a = ratio of cylinder area to pipe area and w = angular velocity of crankshaft. 10
   c) A double acting reciprocating pump has a bore of 175 mm and a stroke of 350 mm. The suction pipe has a diameter of 150 mm and is fitted with an air vessel. Determine the crank angle, at which there is no flow of water to or from the vessel. Assume crank speed at 150 rpm and plunger has simple harmonic motion. 18

Section: B

5. a) Derive Euler's equation of energy transfer in rotodynamic machines. 15
   b) Design a Pelton wheel for a head of 150 meters at a speed of 360 rpm. Power to be developed by the turbine is 600 kW. Assume the overall efficiency of the wheel as 85%. 20

6. a) Explain the significance of specific speed of water turbine. 8
   b) What factors decide whether a Kaplan, Francis or a Pelton type turbine would be used in a hydroelectric project? 9
   c) A Francis turbine works under a head of 25 m and produces 11800 kW while running at 120 rpm. The turbine has been installed at a station where atmospheric pressure is 10 m of water and vapor pressure is 0.2 m of water. Determine (i) specific speed of the turbine, and (ii) the maximum permissible height of the draft tube. 18

7. a) Explain why priming is necessary in a centrifugal pump. 5
   b) Discuss the various methods adopted to increase the efficiency of a centrifugal pump by altering the shape of the casing of chamber surrounding the impeller 12
   c) A centrifugal pump delivers 30 liters of water per second against a head of 12 m and running at 1500 rpm requires 6 horse power. Determine the discharge, head of the pump and power required if the pump runs at 1800 rpm. 18

P.T.O.

8. a) How the speed of a reaction turbine governed by servo motor, discuss with neat sketch. 20

b) Write short notes (any four) on the following:

(i) Sonic boom
(ii) Jet pump
(iii) Torque converter
(iv) Muschel curve
(v) NPSH

**********END OF QUESTION**********

TABLE A–13

One-dimensional isentropic compressible flow functions for an ideal gas with $k = 1.4$

Ma	Ma*	A/A^*	P/P_0	ρ/ρ_0	T/T_0
0	0	∞	1.0000	1.0000	1.0000
0.1	0.1094	5.8218	0.9930	0.9950	0.9980
0.2	0.2182	2.9635	0.9725	0.9803	0.9921
0.3	0.3257	2.0351	0.9395	0.9564	0.9823
0.4	0.4313	1.5901	0.8956	0.9243	0.9690
0.5	0.5345	1.3398	0.8430	0.8852	0.9524
0.6	0.6348	1.1882	0.7840	0.8405	0.9328
0.7	0.7318	1.0944	0.7209	0.7916	0.9107
0.8	0.8251	1.0382	0.6560	0.7400	0.8865
0.9	0.9146	1.0089	0.5913	0.6870	0.8606
1.0	1.0000	1.0000	0.5283	0.6339	0.8333
1.2	1.1583	1.0304	0.4124	0.5311	0.7764
1.4	1.2999	1.1149	0.3142	0.4374	0.7184
1.6	1.4254	1.2502	0.2353	0.3557	0.6614
1.8	1.5360	1.4390	0.1740	0.2868	0.6068
2.0	1.6330	1.6875	0.1278	0.2300	0.5556
2.2	1.7179	2.0050	0.0935	0.1841	0.5081
2.4	1.7922	2.4031	0.0684	0.1472	0.4647
2.6	1.8571	2.8960	0.0501	0.1179	0.4252
2.8	1.9140	3.5001	0.0368	0.0946	0.3894
3.0	1.9640	4.2346	0.0272	0.0760	0.3571
5.0	2.2361	25.000	0.0019	0.0113	0.1667
∞	2.2495	∞	0	0	0

TABLE A–14

One-dimensional normal shock functions for an ideal gas with $k = 1.4$

Ma_1	Ma_2	P_2/P_1	ρ_2/ρ_1	T_2/T_1	P_{02}/P_{01}	P_{02}/P_1
1.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.8929
1.1	0.9118	1.2450	1.1691	1.0649	0.9989	2.1328
1.2	0.8422	1.5133	1.3416	1.1280	0.9928	2.4075
1.3	0.7860	1.8050	1.5157	1.1909	0.9794	2.7136
1.4	0.7397	2.1200	1.6897	1.2547	0.9582	3.0492
1.5	0.7011	2.4583	1.8621	1.3202	0.9298	3.4133
1.6	0.6684	2.8200	2.0317	1.3880	0.8952	3.8050
1.7	0.6405	3.2050	2.1977	1.4583	0.8557	4.2238
1.8	0.6165	3.6133	2.3592	1.5316	0.8127	4.6695
1.9	0.5956	4.0450	2.5157	1.6079	0.7674	5.1418
2.0	0.5774	4.5000	2.6667	1.6875	0.7209	5.6404
2.1	0.5613	4.9783	2.8119	1.7705	0.6742	6.1654
2.2	0.5471	5.4800	2.9512	1.8569	0.6281	6.7165
2.3	0.5344	6.0050	3.0845	1.9468	0.5833	7.2937
2.4	0.5231	6.5533	3.2119	2.0403	0.5401	7.8969
2.5	0.5130	7.1250	3.3333	2.1375	0.4990	8.5261
2.6	0.5039	7.7200	3.4490	2.2383	0.4601	9.1813
2.7	0.4956	8.3383	3.5590	2.3429	0.4236	9.8624
2.8	0.4882	8.9800	3.6636	2.4512	0.3895	10.5694
2.9	0.4814	9.6450	3.7629	2.5632	0.3577	11.3022
3.0	0.4752	10.3333	3.8571	2.6790	0.3283	12.0610
4.0	0.4350	18.5000	4.5714	4.0469	0.1388	21.0681
5.0	0.4152	29.000	5.0000	5.8000	0.0617	32.6335
∞	0.3780	∞	6.0000	∞	0	∞

Department of Mechanical Engineering
Chittagong University of Engineering and Technology (C U E T)
Level 4, Term II Examination 2020

Course No: MI: 421	Full Marks: 210	Time: 03 hours
Course Title: Fluid Machinery	Date: 20 / 03 / 2022	

The figures in the right margin indicate full marks. The questions are of equal value. There are 04 questions in each section. Answer any 03 questions from each section. Use separate script for each section.

Section: A

			Marks
1.	a)	Define Boyle's law, Charles's law and Gay-Lussac law with their empirical relation.	10
	b)	Define specific hear and write the total heat equation in terms of specific heat and temperature difference,x	10
	c)	A certain quantity of air has a volume of 0.4 m^3 at a pressure of 500 kPa and a temperature of 80°C. It is expanded (i) Isothermally (ii) Isentropically and (iii) Polytropically (n = 1.5). Determine the work done by the air during expansion for each case.	15
2.	a)	Define Compressibility and Bulk modulus of elasticity.	05
	b)	Derive the equation for pressure-height relationship for compressible fluid.	10

$$2.3\log\left(\frac{P_2}{P_1}\right) = \frac{h_1 - h_2}{RT}$$

	c)	A supersonic nozzle is to be designed for air flow with M = 3 at the exit section which is 200mm diameter. The pressure and temperature of air at the nozzle exit are to be 7.85 kN/m^2 and 200 K respectively. Determine the reservoir pressure and temperature and throat area. (Take γ = 1.4)	20
3.	a)	Explain the influence of impeller blade shape on the performance of centrifugal compressor.	10
	b)	What is surging in axial flow compressor? How do you control a compressor surge?	07
	c)	A three stage compressor delivers air at 70 bar from an atmospheric pressure of 1 bar and 30 °C. Assuming the intercooling complete, estimate the amount of minimum work required to deal with 1 kg of air. Also find the amount of heat rejected in each intercooler. The index of compression is 1.2 throughout. Take c_p for air = 1.005 kJ/kg-K.	18
4.	a)	Discuss briefly with neat sketches Overshot water wheel and Poncelet water wheel.	15
	b)	A breast wheel of 8m diameter and 2m width is working under a head of 5m. The depth of shroud is 400 mm and the bucket move with a velocity of 1.5 m/s with ½ full. Calculate the power of the wheel, if its efficiency is 50%.	20

Section: B

5.	a)	Prove that the hydraulic efficiency of a Pelton wheel turbine is maximum when the jet velocity striking the runner is twice the tangential velocity of the runner.	15
	b)	A Pelton wheel is to be designed for a head of 60 m when running at 200 rpm. The Pelton wheel develops 95.647 kW shaft power. The velocity of the buckets is 0.45 times the velocity of the jet. Overall efficiency is 0.85 and coefficient of velocity is 0.98.	20
6.	a)	What is governing of turbine? Explain with neat sketch, the governing of impulse turbine.	17
	b)	A turbine is operating under a head of 25 m at 200 rpm. The discharge is 9 m^3/s. If the efficiency is 90%, determine (i) Power generated (ii) Specific speed of the turbine, and (iii) Type of turbine.	18
7.	a)	Discuss the basic working principle of hydraulic press with neat sketches. A hydraulic press has a ram of 500 mm and a plunger of 50 mm diameter. What force is required on the handle to lift a load of 20 kN, if the leverage is 1:10?	15
	b)	It is required to deliver 0.048 m^3/s of water to a height of 24m through a 150 mm diameter pipe and 120 m long, by a centrifugal pump. If the overall efficiency of the pump is 75% and coefficient of friction, f = 0.01 for the pipe line, find the power required to drive the pump.	20
8.	a)	Show from first principle that worked saved against friction in the delivery pipe of a double-acting reciprocating pump, by fitting air vessel is 39.2%.	12
	b)	A single acting reciprocating pump, running at 50 rpm delivers 0.01 m^3/s of water. The diameter of the piston is 200 mm and stroke length 400 mm. Determine: (i) The theoretical discharge of the pump. (ii) Co-efficient of discharge. (iii) Slip and percentage slip of the pump.	15
	c)	What is the difference between a hydraulic coupling and a hydraulic torque converter?	8

**********END OF QUESTION**********

Department of Mechanical Engineering
Chittagong University of Engineering & Technology (CUET)
Level 4, TermII Examination 2018

Course No:ME 421	Full Marks: 210	Time: 03 hours
Course Title:Fluid Machinery	Date: 27/06/2019	

The figures in the right margin indicate full marks. The questions are of equal value. There are 04 questions in each section. Answer any 03 questions from each section. Use separate script for each section.

Marks

Section: A

1. a) Define compressible fluid and incompressible fluid. Also define three laws of perfect gas with mathematical relationship. 15

   b) One liter of nitrogen gas at 100^0C is suddenly expanded to 2 liters according to the law $Pv^{1.35} = C$. Find the change in temperature of the gas and work done. (R=0.29 KJ/kg^{0}K). 20

2. a) What is Mach number? Considering the variation of velocity with area in case of compressible fluid flow, show that $\frac{dA}{dV} = \frac{A}{V}(M_a^2 - 1)$. 17

   b) A supersonic nozzle is to be designed for air flow with Mach number 3 at the exit section which is 20 cm in diameter. The pressure and temperature of air at the nozzle exit are to be 7.85 kN/m^2 and 200K respectively. Determine the reservoir pressure and temperature and the throat area. Take k=1.4. 18

3. a) State the effect of variation of back pressure of compressible flow in a convergent-divergent nozzle with the help of a diagram. 15

   b) At a certain section of a duct in which air is flowing at a temperature of 32^0C and pressure of 79.95 kN/m^2 with a velocity of 365 m/s. Assuming isentropic flow (reversible adiabatic) determine: i) the velocity and temperature at a section where the pressure is 122.63 kN/m^2 and ii) the Mach number at the both the suctions. Take R =287 Nm/kg ^{0}K and k for air =1.4. 20

4. a) Differentiate among fan, blower and compressor in respect of specific ration and pressure rise. 09

   b) Derive the formula of wokdone by reciprocating air compressor with clearance volume and polytropic process. 08

   c) Estimate the minimum work required to compress 1kg of air from 1 bar 27^0C to 16 bar in two stages, if the law of compression is $Pv^{1.25} = Constant$ and the intercooling is perfect. Take R=287 J/kg ^{0}K. 18

Section: B

5. a) Describe the working principle of undershot water wheel with net sketch and constructional details. 15

   b) A breast water wheel of 8 m diameter and 2m width is working under a head of 5m. The depth of shroud is 400mm and the buckets move with a velocity of 1.5 m/s with 5/8 full. Calculate the discharge and power of the wheel, if its efficiency is 60%. 20

6. a) Derive the equation of hydraulic efficiency of an impulse turbine and hence prove that for maximum efficiency wheel velocity should be the half of the jet velocity. 17

   b) A Pelton wheel having semi-circular buckets and working under a head of 140meters, is running at 600 rpm. The discharge through the nozzle is 500 litres/sec and diameter of the wheel is 600 mm. Find i) Power available at the nozzle, and ii) Hydraulic efficiency of the wheel, if coefficient of velocity is 0.98. Assume k=1. 18

7. a) What is the specific speed of a centrifugal pump? Prove that the specific speed is $N_S = \frac{N\sqrt{Q}}{H^{3/4}}$. 17

   b) A double acting reciprocating pump has a stroke of 300 mm and a piston of diameter 150 mm. The delivery and suction heads are 26m and 4m respectively including friction heads. If the pump is working at 60 rpm, find the actual power required to drive the pump with 80% efficiency. 18

8. a) How surge tank or shaft works in a typical hydroelectric scheme, discuss with net sketch. 14

   b) Write short notes on (any **three**): 21
   i) Hydraulic press ii) Hydraulic crane iii) Effect of friction in the suction and delivery pipes on the indicator diagram of reciprocating pump iv) Draft tube.

**********THE END**********

Department of Mechanical Engineering
Chittagong University of Engineering & Technology (C U E T)
Level 4 Term 2 Examination 2017

Course No: ME 421	Full Marks: 210	Time: 03 hours
Course Title: Fluid Machinery	Date: 05/08/ 2018	

The figures in the right margin indicate full marks. The questions are of equal value. There are 04 questions in each section. Answer any 03 questions from each section. Use separate script for each section.

Section: A

			Marks
1.	a)	Define isothermal, adiabatic, and isentropic process of compressible flow.	10
	b)	Derive the energy equation of a compressible flow in terms of temperature and velocity.	10
	c)	A helicopter is travelling at a height of 1500 m, above the ground. Find the pressure of air on it, if the pressure at the ground level is 100 kPa at 20 ^{0}C. Take R = 0.287 kJ/kg.K.	15
2.	a)	Define with relationship the controlling parameters in compressible flow.	10
	b)	With neat sketch describe the propagation of elastic pressure wave by an object moving in a compressible fluid.	10
	c)	A normal shock is formed while the air is flowing at 450 m/s in a diverging section and the supersonic flow changes to subsonic abruptly. Ambient pressure is 1.03 bar, temperature 27 ^{0}C, γ = 1.4, R = 0.287 kJ/kg.K. Determine (i) the Mach number upstream and downstream of the shock, (ii) the pressure rise across the shock, and (iii) the velocity and temperature after the shock.	15
3.	a)	Define fan, compressor, and blower in respect of specific ratio and rise in system pressure.	08
	b)	Classify the air compressor according to working, action and number of stages.	07
	c)	A centrifugal blower running at 8000 rpm, compresses 5 m^3/s of air from 1 bar and 15 ^{0}C to 2 bar. The index of compression n = 1.3. The velocity of flow is 70 m/s and is constant throughout the impeller. The impeller diameter at inlet and outlet are 0.3 m and 0.6 m respectively. Determine (i) the impeller blade angles at inlet and outlet, and (ii) the impeller width at inlet and outlet.	20
4.	a)	Describe the working principle an axial flow multistage drum type compressor with neat sketch.	10
	b)	Write short notes on hydraulic tork converter with neat sketch.	10
	c)	What is surge in open channel flow? Describe the working principle of surge tank in hydro-electric power plant with neat sketch.	15

Section: B

5.	a)	Describe the constructional details of overshot water wheel.	10
	b)	Describe the working principle of undershot water wheel with neat sketch.	10
	c)	An overshot water wheel has approaching canal 1.5 m wide. The water flows in the canal with a velocity of 1.5 m/s and 200 mm deep. Determine the power available from the water wheel if the water fall is 20 m and the efficiency of the wheel is 75%.	15
6.	a)	How air vessel in reciprocating pump works to maintain a uniform discharge from the pump. Discuss with neat sketch.	15
	b)	A double acting reciprocating pump has a stroke of 300 mm and a piston of diameter 150 mm. The delivery and suction heads are 26 m and 4 m respectively including friction heads. If the pump is working at 60 rpm, find power required to drive the pump with 80% efficiency.	20
7.	a)	What is meant by turbomachinery? Derive Euler turbomachinery equation.	17
	b)	A pelton wheel is required to generate 4000 kW under an effective head of 400 m. Determine (i) total flow in m^3/s and (ii) size of jet. Assume generator efficiency 95%, overall efficiency 85% and coefficient of velocity 0.98 and speed ratio 0.46.	18
8.	a)	How the speed of a reaction turbine governed by servomotor, discuss with neat sketch.	15
	b)	A Kaplan turbine operating under a net head of 20 m develops 100 kW power with an overall efficiency of 85%. The speed ratio is 2 and flow ratio is 0.6. The hub diameter of the wheel is 0.35 times the outside diameter of the wheel. Determine (i) the diameter and (ii) speed of the turbine.	20

********** THE END **********