KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 4th Year Backlog Examination, 2022

ME 4113

(Fluid Machinery)

Time: 3 Hours | Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION-A

1(a) What is negative slip? Why does it occur? 07

1(b) Deduce an expression of acceleration head and show the effect of acceleration on velocity and pressure in a reciprocating pump. 14

1(c) A single acting reciprocating pump runs at 65 rpm. The diameter of the plunger is 0.2 m and crank radius is 0.18 m. The suction pipe is 10 cm in diameter and 7.5 m long. Calculate the maximum permissible value of suction lift, if the separation takes place at 2.7 m of water absolute. 14

2(a) Explain the followings for centrifugal pump: 12
(i) Static head (ii) Manometric head (iii) Mechanical efficiency
(iv) Hydraulic efficiency.

2(b) What are the causes of pumping water in a centrifugal pump? 06

2(c) The impeller of a centrifugal pump is 0.5 m in diameter and rotates at 1400 rpm. Blades are curved back to an angle of 40^{o} to the tangent at outlet tip. If the measured velocity of flow at outlet is 5 m/sec, find the work input per kg of water per second. Also determine the theoretical maximum lift to which the water can be raised if the pump is provided with whirlpool chamber which reduces the velocity of water by 40%. 17

3(a) Distinguish between impulse turbine and reaction turbine. 08

3(b) Describe the working principle of governing system for a reaction turbine. 12

3(c) Derive an expression of pressure regained by fitting a draft tube. 15

4(a) Deduce an expression of efficiency of a reaction turbine. 18

4(b) Design a Pelton wheel to produce 2016 kW power at a head of 300 m with a speed 550 rpm. Ratio of jet diameter to wheel diameter is 1/10. Overall efficiency is 82%. Calculate- 17
(i) The number of jet
(ii) The diameter of the jet
(iii) The diameter of the wheel
(iv) The quantity of water required

SECTION-B

5(a) What is circulation? Show that circulation around a contour is equal to the product of the vortical within the area of the contour. 12

5(b) Deduce an expression of Cauchy-Reiman equation in cylindrical polar coordinates. 13

5(c) The velocity potential for a given two-dimensional flow field is: $\phi = (5/3)x^3 - 5xy^2$ 10
Show that the continuity equation is satisfied and determine the corresponding stream function.

6(a)	Derive an expression of stream function and velocity potential for a doublet.	15
6(b)	What is meant by Magnus effect?	05
6(c)	Prove that the lift force depends on the velocity, the density and the circulation of fluids.	15
7(a)	Prove that for a given specific energy, the discharge in a given channel section is maximum when the flow is in the critical state.	18
7(b)	A rectangular channel of unit width discharges fluid at a rate of 2.75 m^3/sec. If the loss of energy in the hydraulic jump is found to be 2.5 m, determine the depth of conjugate depths.	17
8(a)	Derive an expression of energy dissipation due to hydraulic jump in terms of the Froude number.	18
8(b)	During a hydraulic jump in a wide channel, the flow depth increases from 0.6 to 3 m. Determine the velocities and Froude numbers before and after the jump and energy dissipation ratio.	17

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 4th Year Backlog Examination, 2022

ME 4017

(Refrigeration and Air Conditioning)

Time: 3 Hours | Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION-A

1(a) Explain the importance of refrigeration in ensuring food security. 08

1(b) Describe the working principle of vapour compression refrigeration system with schematic diagram. 12

1(c) A simple vapour compression produces 10 ton of refrigeration when R-12 is used as refrigerant. The condensing and evaporating temperatures are 45°C and -15°C, respectively. Calculate (i) refrigeration effect per kg, (ii) circulation of refrigerant per second, and (iii) COP. 15

2(a) What is the function of back pressure valve? Explain with example. 08

2(b) Explain the working principle of Electrolux refrigeration system. Also, mention its advantages and disadvantages. 12

2(c) A single compressor using R-12 as refrigerant has three evaporators of capacity 20 TR, 30 TR and 20 TR. The temperatures in the three evaporators are to be maintained at -10°C, 0°C and 5°C, respectively. The condenser pressure is 9.609 bar. The liquid refrigerant leaving the condenser is subcooled to 30°C. The vapors leaving the evaporators are dry and saturated. Assuming isentropic compression, find (i) the mass of refrigerant flowing through each evaporator, and (ii) COP of the system. 15

3(a) How can the performance of a vapour absorption refrigeration system be improved? Explain. 12

3(b) How is helium gas liquefied? Explain. 08

3(c) Why is cooling necessary for an aircraft? Describe the Boot-Strap system of air cycle refrigeration. 10

3(d) What is cryogenics? 05

4(a) What is meant by refrigerant? What are the characteristics of a good refrigerant? 10

4(b) Find the refrigerant number for the following refrigerants: 09
C_2H_5Cl, SO_2, C_3H_6.

4(c) What is meant by capacity control of a refrigerant compressor? Describe the methods that commonly used for capacity control of a refrigerant compressor. 08

4(d) What is frosting evaporator? Explain the working principle of flooded evaporator. 08

SECTION-B

5(a) Define the followings: 10
(i) Relative humidity, (ii) Dew point temperature, (iii) Degree of saturation, (iv) Wet bulb temperature, and (v) Apparatus dew point temperature.

5(b) Describe indirection evaporative cooling system with a schematic diagram. 10

5(c) Moist air enters a room at 7°C DBT and 4°C WBT at the rate of 80 cmm. The barometric pressure is 1.01325 bar. While passing through the room, the air picks up sensible heat at the rate of 45 kW and 35 kg/hr of saturated steam at 120°C. Calculate the dry and wet bulb temperatures of the leaving air. Use enthalpy of saturated steam at 120°C as 2500 kJ/kg. 15

6(a) What is meant by human comfort? Explain the factors which influence human comfort. 10

6(b) Describe the winter air-conditioning system with a neat sketch. 12

6(c) Distinguish between ventilation and infiltration. 05

6(d) Explain the ASHRAE comfort chart. 08

7(a) What is cooling load? List the various component of cooling load. 10

7(b) An air-conditioning system is to be designed for a restaurant with the following data: 25

Outside design conditions	: 40°C DBT, 28°C WBT
Inside design conditions	: 25°C DBT, 50% RH
Solar heat gain through walls, roof and floor	: 6 kW
Solar heat gain through glass	: 7 kW
Occupants	: 30
Sensible heat gain per person	: 58 W
Latent heat gain per person	: 58 W
Internal lighting load	: 15 lamps at 50 W
Sensible heat gain from other sources	: 12 kW
Infiltrated air	: 20 m^3/min

If 25% fresh air and 75% recirculated air is mixed and passes through the conditioner coil, calculate the capacity of the conditioning plant. Assume the by-pass factor equals to 0.2.

8(a) What are the factors that should be considered while selecting the location of supply air outlet? 10

8(b) What is dynamic loss? Derive the expression of frictional pressure drop. 10

8(c) Why is rectangular duct used in central air conditioning system? 05

8(d) Explain the equal friction method of duct design. 10