KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
*Department of Mechanical Engineering*
B. Sc. Engineering 4th Year 1st Term Examination, 2017
ME 4213 (Old))
(Fluid Mechanics III)

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 the purpose of fitting air vessel in a reciprocating pump? How an air vessel minimize the effect of acceleration on velocity?   17

1(b)  A single acting reciprocating pump runs at 70 rpm. The diameter of the plunger is 0.2 m and crank radius is 0.19 m. The suction pipe is 10 cm in diameter and 7.0 m long. Calculate the maximum permissible value of suction lift, if the separation takes place at 2.6 m of water absolute.   18

2(a)  Explain the followings for centrifugal pump:   10
    (i) Static head         (ii) Manometric head
    (iii) Manometric efficiency and (iv) Volumetric efficiency.

2(b)  What are the causes of failure of pumping water in a centrifugal pump?   08

2(c)  Determine the power required to drive a centrifugal pump which delivers 36 litres of water per second to a height of 20 m through a 130 mm diameter and 105 m long pipeline. The overall efficiency of the pump is 70% and Daucy's $f = 0.04$ for the pipe line.   17

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

3(b)  Define specific speed of a turbine. What are the characteristics curves of hydraulic turbine? How are they useful to engineers in practice?   12

3(c)  Describe the working principle of governing system for an Impulse turbine.   15

4(a)  Show that in a pelton wheel maximum efficiency is possible, if the jet velocity is twice the bucket velocity.   15

4(b)  A pelton wheel develops 5520 kW under a head of 240 m at an overall efficiency of 80% when revolving at a speed of 200 rpm. Find the unit discharge, unit power and unit speed. If the head on the same turbine fall during the summer season to 150 m, find the discharge, power and speed for this head.   20

# SECTION-B

5(a)  What are the conditions that required to form a doublet? Deduce the expressions for stream function and velocity potential for a doublet.   18

5(b)  Show that for irrotational flow vorticity is zero.   07

5(c)  Deduce the Cauchy-Reiman relations in Cartesian coordinate.   10

6(a)   What is the physical significance of flow net?                                          08

6(b)   Deduce the expressions of drag force for flow past a cylinder with circulation in        12
       an ideal fluid flow field.

6(c)   Show that lift force depends on density of fluid, velocity of rectilinear flow and        15
       the recirculation of flow.

7(a)   Prove that for a given specific energy, the discharge in a given channel section is       18
       maximum when the flow is in the critical state.

7(b)   A trapezoidal channel having bottom width 5.0 m and side slopes 1:1 carries a            17
       discharge of 12.0 $m^3$/sec. Compute the critical depth and the critical velocity. If
       Manning's $n = 0.2$, determine the bottom slope required to maintain the critical
       depth.

8(a)   Derive the expression of energy loss due to hydraulic jump.                              18

8(b)   A rectangular channel carries of 2.1 $m^3$/sec per meter of width. A hydraulic jump       17
       occurs and if the loss due to jump is 2.8m, calculate the conjugate depths.

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4$^{th}$ year 1$^{st}$ Term Examination, 2017
ME 4051
(Operations Research)
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 linear program? Write down the characteristics of a linear program.          05

1(b)   A manufacturer produces three models (I, II, and III) of a certain product. He uses two          30
types of raw materials (A and B) of which 4000 and 6000 units are available respectively.
The raw material requirements per unit of the three models are given below:

| Raw material | Requirements per unit of given model | | |
|---|---|---|---|
| | I | II | III |
| A | 2 | 3 | 5 |
| B | 4 | 2 | 7 |

The labour time for each unit of model I is twice that of model II and three times that of
model III. The entire labour force of the factory can produce the equivalent of 1500 units
of model I. A market survey indicates that the minimum demand for the three models is
200, 200 and 150 units respectively. However, the ratios of the number of units produced
must be equal to 3:2:2.5. Assume that the profit per unit of models I, II and III is $30, $20
and $50 respectively. Formulate the problem as a linear programming model to determine
the number of units of each product that will maximize profit. Can this problem be solved
by graphical method? Justify your answer.

2(a)   Write the following LP model in the standard form:   Minimize $z = 2x_1 + 3x_2$          10
Subject to       $x_1 + x_2 = 10$

$-2x_1 + 3x_2 \leq -5$
$7x_1 - 4x_2 \leq 6$
$x_1$ unrestricted in sign
$x_2 \geq 0$

2(b)   Consider the following LP problem:   Maximize $Z = 3x_1 + 2x_2$          25
Subject to –   $4x_1 + 3x_2 \leq 12$          resource-I
$4x_1 + x_2 \leq 8$          resource-II
$4x_1 - x_2 \leq 8$          resource-III
$x_1, x_2 \geq 0$

(i)    Solve the problem by Simplex method.
(ii)   Identify the status of each resource.
(iii)  What are the dual prices of each resource?
(iv)   If you have the opportunity to expand the production which resource should be
given priority?
(v)    Determine the range of change in resource-I's availability that will keep the present
*solution optimal.*
(vi)   Determine the range of marginal profit of resource-I, that will keep the present
solution optimal.

3(a)   Prove that the dual of dual is a primal. When you will solve a primal/dual? Justify your          10
answer.

3(b) Write down the dual of the problem: Maximize $Z = 5x_1 + 6x_2$

Subject to – $x_1 + 2x_2 = 5$

$-x_1 + 5x_2 \geq 3$

$x_1$ unrestricted

$x_2 \geq 0$

10

3(c) Solve the following problem using dual-Simplex method (Show only one iteration).

Maximize $Z = 2x_2 - 5x_3$

Subject to – $x_1 + x_3 \geq 2$

$2x_1 + x_2 + 6x_3 \leq 6$

$x_1 - x_2 + 3x_3 = 0$

$x_1, x_2, x_3 \geq 0$

15

4(a) What is meant by balanced and unbalanced transportation model? How can you convert an unbalanced transportation problem into a balanced one? Explain with example.

05

4(b) Prove that assignment problem is a special case of transportation problem.

05

4(c) Find out the initial basic feasible solution of the following transportation problem by any one method. Also, find the optimum solution of the problem.

25

| Source | Destinations | | | Supply |
|--------|--------------|---|---|--------|
| | A | B | C | |
| I | 2 | 7 | 4 | 5 |
| II | 3 | 3 | 1 | 8 |
| III | 5 | 4 | 7 | 7 |
| IV | 1 | 6 | 2 | 14 |
| Demand | 7 | 9 | 18 | |

## SECTION – B

5(a) Define dynamic programming. Write down the name of the basic elements of dynamic programming.

05

5(b) Write down the characteristics of dynamic programming.

05

5(c) Three research teams are independently working on the same project. The project is successful if any team does so. Find the distribution of 2 scientists to maximize the probability of success of the project.

25

| New Scientists | Probability of failure | | |
|----------------|------------------------|--------|--------|
| | Team 1 | Team 2 | Team 3 |
| 0 | 0.4 | 0.6 | 0.8 |
| 1 | 0.2 | 0.4 | 0.5 |
| 2 | 0.11 | 0.2 | 0.3 |

6(a) Explain the following terms:
(i) decision under risk   (ii) decision under uncertainty

05

6(b) What is the problem with minimax criterion? How does savage minimax regret criterion overcome it? Explain with example.

10

6(c) A person has two independent investments A and B available to him, but he can undertake only one at a time due to certain constraints. He can choose 'A' first and then stop or if 'A' successful then take 'B' or vise versa. The probability of success of 'A' is 0.6 while for 'B' it is 0.4. Both investment require an initial capital outlay of Tk. 10,000/- and both return nothing if the venture is unsuccessful. Successful completion of 'A' will

20

return Tk. 20,000/- (over cost) and successful completion of 'B' will return Tk. 24,000/- (over cost).

(i) Draw and properly label the decision tree;
(ii) Evaluate the decision tree;
(iii) Determine the optimum policy.

7(a) What is game? Write down the characteristics of a game.   05

7(b) What is saddle point? Explain with example.   05

7(c) Solve the following game graphically.   25

|  | B1 | B2 | B3 | B4 |
|---|---|---|---|---|
| A1 | 8 | 5 | -7 | 9 |
| A2 | -6 | 6 | 4 | -2 |

8(a) What is queue? What are the different types of queue? Write down the elements of a queuing system.   10

8(b) Show that the exponential distribution has memoryless property.   05

8(c) Cars arrive at a toll gate on a freeway according to a Poisson distribution with mean 90 per hour. Average time for passing through the gate is 38 seconds. Drivers complain of the long waiting time. Authorities are willing to decrease the passing time through the gate to 30 seconds by introducing new automatic devices. This can be justified only if under the old system the number of waiting cars exceeds 5. In addition, the percentage of the gate's idle time under the new system should not exceed 10%. Can the new device be justified?   20

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
*Department of Mechanical Engineering*
B. Sc. Engineering 4th Year 1st Term Examination, 2017
ME 4113
(Fluid Mechinary)

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 meant by negative slip? Deduce the expression of acceleration head and show the effect of acceleration on velocity and pressure at crank position 210° in a reciprocating pump.                                                                18

1(b)  A reciprocating pump draws water from a sump 3 m below its axis through a 15 cm diameter and 12 m long suction pipe at a rpm of 260. The cylinder diameter is 22 cm, stroke 35 cm and the length of the connecting rod 1.8 m. If the motion is simple harmonic, determine the pressure in the cylinder at the beginning of the stroke                                                                17
        (i) when no air vessel is fitted;
        (ii) when an air vessel is fitted at the cylinder level at a distance 1.4 m from it;
        (iii) power required to run the pump.

2(a)  What is priming? Why priming is necessary in a centrifugal pump?                   07

2(b)  Deduce the expression of limiting value of suction lift.                           10

2(c)  A centrifugal pump lifts water against a static head of 28 m, where suction lift is 4.8 m. The suction and delivery pipes are both 75 mm diameter; the head loss in suction and delivery pipes are 2.6 m and 7.2 m respectively. The impeller is 380 mm diameter and 20 mm wide at the mouth; it revolves at 1400 rpm and its effective vane angle at exit is 28°. Assuming $\eta_{mano}$ = 0.81 and $\eta_o$ =0.74, determine:                                                                       18
        (i) the discharge of the pump;
        (ii) the power required to run the pump;
        (iii) the pressure at the outlet of the pump casing.

3(a)  Distinguish between an impulse turbine and a reaction turbine.                     10

3(b)  What is specific speed of a turbine?                                              07

3(c)  A pelton wheel has to be designed for the following data:                          18
      Power to be developed = 6000 kW; net head available = 300 m; speed = 550 rpm; ratio of jet diameter to wheel diameter = 1/10; and the overall efficiency = 85%. Find the number of jets, diameter of the jet, diameter of the wheel, and the quantity of water required.

4(a)  What are the purposes of draft tube to use in a turbine? Derive the expression of pressure regained by lifting a draft tube.                                         18

4(b)  Describe with neat sketch the working principle of governing system for an impulse turbine.                                                                       17

## SECTION-B

5(a)  Show that circulation around a contour is equal to the product of the vorticities within area of the contour.  10

5(b)  Deduce the expression of Cauchy-Reiman equation in cylindrical polar coordinate.  12

5(c)  Show that for irrotational flow vorticity is zero.  13

6(a)  Derive the expression of stream function and velocity potential for a flow about a cylinder with circulation and also show it graphically.  20

6(b)  A circular cylinder of 350 mm diameter is rotate about it axis in a uniform stream of water having velocity of 4.5 m/sec. Determine:  15
  (i)  the rotational speed at which both the stagnation points coincide,
  (ii)  the lift and drag force experienced by the cylinder. $\rho_{water}$ = 1000 kg/m$^3$.

7(a)  State the conditions under which the rectangular section of an open channel will be most economical. Derive these conditions.  18

7(b)  A trapezoidal channel having bottom width 5 m and side slope 1:1 carries a discharge of 12.0 m$^3$/sec. Compute the critical depth and the critical velocity. If Manning's n = 0.2, determine the bottom slope required to maintain the critical depth.  17

8(a)  What is meant by hydraulic jump? Show that the head loss in a hydraulic jump formed in a rectangular channel may be expressed as:  17

$$\Delta E = \frac{\left(y_2 - y_1\right)^3}{4y_1 y_2}.$$

Where the symbols have their usual meanings.

8(b)  A rectangular channel carries a discharge of 2.2 m$^3$/sec per meter of width. A hydraulic jump occurs and if the loss due to jump is 2.9 m, determine the conjugate depths.  18

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
*Department of Mechanical Engineering*
B. Sc. Engineering 4th Year 1st Term Examination, 2017
**ME 4127**
(Operations Management)

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) Define production process and production system. Also describe the input output model of a production system.     15

1(b) Describe the functions of an operations manager.     10

1(c) Describe different types of production system.     10

2(a) Define depreciation. Describe the declining balance method for calculating depreciation cost.     10

2(b) What is meant by time value of money? Describe break even analysis with its assumptions.     10

2(c) KUET authority wants to purchase a lathe machine and advertizes in a newspaper. Two companies bid for the proposal and these are as follows:     15

|                      | Company X   | Company Y  |
|----------------------|-------------|------------|
| Initial cost         | TK 100,000  | TK 95,000  |
| Operative costs year 1 | TK 8,500  | TK 9,000   |
| Operative costs year 2 | TK 7,500  | TK 7,700   |
| Salvage value        | TK 20,000   | TK 18,000  |

Determine the best alternative if the rate of interest 12%.

3(a) What is meant by THERBLIG? How many are they? Mention five of them with their symbols.     10

3(b) Define work study. What are the objectives of work study? Also write down the advantages of work study.     15

3(c) Write short notes on:     10
(i) Process block diagram and (ii) Process flow diagram.

4(a) Define project? Write down the characteristics of a project.     07

4(b) What are the key success factors of a project?     05

4(c) Describe the responsibility of a project manager.     08

4(d) For the following table, find the redundant activities and draw the network.     15

| Job | Immediate Predecessor |
|-----|-----------------------|
| A   | –                     |
| B   | A                     |
| C   | A                     |
| D   | B, C                  |
| E   | B, D                  |
| F   | C, D                  |
| G   | B, D, E, F            |

## SECTION-B

5(a) What is meant by plant layout? Write down the objectives of plant layout.     07

5(b) Discuss the characteristics of different types of layout.     08

5(c) A phermaceuticals has found three alternative locations with better facilities. They are 20
savar, Narayangonj and Manikgonj.
Annual costs for the above mentioned sites are 9 lac BDT, 12 lac BDT and 10 lac BDT
respectively. Subjective factors summery are given in the following table.

| Factor | Site rating $R_{ij}$ | | | Relative important |
|--------|-------|-----------|-----------|--------------------|
| j | Savar | Narayangonj | Manikgonj | $\omega$ factor |
| Political stability | 0.35 | 0.15 | 0.50 | 0.30 |
| Community service | 0.40 | 0.25 | 0.35 | 0.40 |
| Weather condition | 0.33 | 0.40 | 0.27 | 0.30 |

If the subjective factor is half important as objective factor, find the best possible location
for the pharmaceuticals.

6(a) What is meant by forecasting? Enumerate the factors to be considered for selecting a    07
forecasting method.

6(b) Number of Ford car sold quarterly in Khulna city is as shown below.    28

| | Quarters | | | |
|------|-------|-------|-------|-------|
| Year | $Q_1$ | $Q_2$ | $Q_3$ | $Q_4$ |
| 2013 | 30 | 42 | 35 | 51 |
| 2014 | 32 | 52 | 42 | 57 |
| 2015 | 37 | 40 | 30 | 43 |
| 2016 | 48 | 58 | 62 | 41 |

(i) Find a least square trend line and calculate the standard error of the estimate.
(ii) Using the regression line obtained above, find the forecast for the year 2017 and
specify a 95% confidence level.
(iii) From past years, the typical seasonal index values have been estimated as
$$SQ_1 = 1.02 \qquad SQ_2 = 0.97 \qquad SQ_3 = 0.95 \qquad SQ_4 = 0.92$$
Using these seasonal index determine the forecast for each quarter of 2017.

7(a) What is meant by inventory? What are the different types of cost in inventory? Discuss    15
them in details.

7(b) The WALTON Hi-tech industries received the following price schedule for an engine    20
valve from its supplier.
$$\text{Pr} ice / valve \quad b = \begin{cases} 120 \ TK & if \ Q < 400 \\ 90 \ TK & if \ Q \ge 400 \end{cases}$$
Annual demand of engine valve is 2000 and ordering cost is 600 TK per order and holding
cost is 20% of the unit cost. What is the best purchase quantity?

8(a) Weekly demand for fresh delux cake of a bakery is given below.    15

| Demand y | 0 | 1 | 2 | 3 | 4 | 5 |
|----------|------|------|------|------|------|------|
| Probability P(y) | 0.06 | 0.12 | 0.18 | 0.23 | 0.17 | 0.15 |

The owner sells the cakes for 80 BDT each and they cost 50 BDT to prepare. If any fresh
cakes are left over, after the weekend, they are put on special sale at 30 BDT each. Find the
optimum quantity of cake to be prepared.

8(b) A manufacturer of a skate board requires the parts as shown in the accompanying product    20
tree.

Skate board

Board (1)      Axles (2)      Wheels (4)
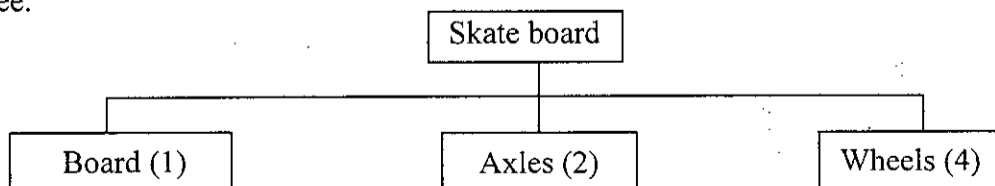
The master production schedule for the next 10 weeks call for 300 in week-3, 330 in
week-6, 250 in week-8, and 310 in week-10. The lot size, lead times and initial inventory
are as shown below:

| Part Name | Lot size | Lead Time, week | Initial Inventory |
|-----------|----------|-----------------|-------------------|
| Board | 700 | 1 | 60 |
| Axles | 800 | 1 | 100 |
| Wheels | 3000 | 2 | 200 |

Determine the material requirements planning schedules for the part.