

Khulna University of Engineering & Technology
Department of Industrial Engineering and Management
B.Sc. Engineering 3rd Year 1st Term Examination, 2016
IPE 3103
Engineering Metallurgy

Full Marks: 210

Time: 3 hrs

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 missing any.

SECTION-A

1. (a) What is the importance of the knowledge of “Materials and Metallurgy” to an industrial engineer? 08
- (b) What is meant by crystallization? Differentiate between a crystal, a dendrite and a grain. 10
- (c) Lead melts at 620⁰ F and Tin melts at 450⁰ F. They form a eutectic containing 62 percent tin at 360⁰ F. The maximum solid solubility of tin in lead at this temperature is 19 percent; of lead in tin is 3 percent. Assume the solubility of each at room temperature is 1 percent. 17
 - i) Draw the equilibrium diagram to scale on a piece of graph paper labeling all points, lines and areas.
 - ii) Give the chemical compositions and relative amounts of two phases present for an alloy containing 90 percent tin.
 - iii) Draw the cooling curve for the above alloy.
2. (a) Describe completely the changes that take place during the slow cooling of a 0.5 percent carbon steel from the austenite range. 12
- (b) Describe delta region of the iron-iron carbide diagram with suitable figure. 10
- (c) Show that volume of the H.C.P unit cell is $\frac{3}{2}\sqrt{3} a^2c$, where the symbols have their usual meanings. 13
3. (a) Which diagram is called the bible of metallurgy? And why? 05
- (b) Briefly explain the mechanism of heat removal during quenching. 10
- (c) Briefly explain the following microstructures: (i) Ferrite (ii) Austenite (iii) Pearlite. 12
- (d) Write down the properties of Martensitic transformation. 08
4. (a) Which microstructure in eutectoid steel has maximum hardness? Give reason. 07
- (b) If a piece of steel having 0.8% carbon has martensitic structure, can it be converted to fully pearlite structure by holding it at 700⁰ C? 05
- (c) Define critical cooling rate. How TT diagram is formed? Explain with net sketches. 13
- (d) Sketch the microstructures of 0.2% C steel. Calculate % pearlite, % cementite, % pro-eutectoid ferrite and % total ferrite using lever rule. 10

SECTION-B

5. (a) Define heat treatment process of metal. Briefly explain the carburizing, flame hardening and nitriding process. 13
- (b) What is I-T diagram? How an I-T diagram is determine experimentally? Briefly explain. 14
- (c) Distinguish between normalizing and annealing process. 08
6. (a) What is meant by powder metallurgy? Discuss the characteristics of metal powder. 13
- (b) Briefly discuss the various finishing operations used in powder metallurgy. 10
- (c) Briefly describe three methods by which powders suitable for powder metallurgy can be produced. 12
7. (a) Write down the basic properties that tool materials must possess. Write down the properties of different elements used in cutting tool materials. 15

- (b) What is meant by NDT? Briefly discuss the following NDT method with net sketches 15
 - (i) Magnetic particle inspection
 - (ii) Eddy current.
- (c) Write down some common application of NDT method. 05
- 8. (a) What is ferrous materials? Briefly describe the raw materials used in production of iron and steel. 11
- (b) What are the effects of following elements on the mechanical properties of steel; (i) Nickel 12
 - (ii) Silicon (iii) Cobalt (iv) Sulphur
- (c) What is Babbitt metals and White metals? Write down their compositions, properties and uses. 12

Khulna University of Engineering & Technology
Department of Industrial Engineering and Management
B.Sc. Engineering 3rd Year 1st Term Examination, 2016
IPE 3105
Product Design-I

Full Marks: 210

Time: 3 hrs

N.B: i) Answer any *THREE* questions from each section in separate scripts.
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iii) Assume reasonable data if missing any.

SECTION-A

1. (a) What is meant by product development? Clarify central functions of a product development projects. 12
(b) “Without the concept of trade-off, product development will never be optimum”. Justify with an appropriate example. 12
(c) What is Organization? Write down the characteristics of different organizational structure. 11
2. (a) Define market segmentation. Why sporting goods should be considered as market-pull products? 07
(b) Mention the comparative advantages and disadvantages of “Derivatives of existing product platforms” over new product platforms. 08
(c) Discuss about the significance of gross margin on mission statement with a suitable example. 10
(d) Why super groups are needed to be created to organize the needs into a hierarchy? Explain with an example. 10
3. (a) What is meant by product specification? How you can collect competitive benchmarking information of a product? 08
(b) List a set of metrics corresponding to the need that a pen write smoothly. Why are some customer needs difficult to map to a single metric? 12
(c) Could you apply the five-step method of concept generation to an everyday problem like choosing the food for a picnic? Explain. 15
4. (a) Propose a set of selection criteria for the choice of a battery technology for use in a portable computer. 10
(b) Define scale compression. Why scale compression has less influence on concept scoring than concept screening? Explain with suitable example. 12
(c) Why measuring customer response is as much important as testing a concept idea? Explain the method of customer response measurement with an example. 13

SECTION-B

5. (a) Define product architecture with respect to chunks. In what point sectional and slot modular architecture are parallel? Briefly discuss the reasons for a modular architecture. 10
(b) Describe the architecture of a Swiss army knife. What advantages and disadvantages does this architecture provide? 13
(c) Can a firm achieve high product variety without a modular architecture? How or why not? 12
6. (a) Define industrial design. How important is industrial design to a product? 10
(b) What is meant by intellectual property? Write down the names of various intellectual properties with their distinguished characteristics. 12
(c) What is meant by DFMA? Among all the overviews of DFM, which three of them are essential? Describe logically. 13
7. (a) How standardize components help to reduce the cost of component? Also write down the benefits of part integration. 10
(b) How can you define the term “Prototype”? Classify prototypes and describe each type with example. 15

- (c) Why comprehensive-analytical prototypes are not generally feasible? Discuss. Also differentiate between alpha and beta prototypes. 10

- 8. (a) What is value Engineering? Write down the steps of value Engineering. 11
- (b) What are the key elements of a Kano model? Write down the steps involved in a Kano model process. Also mention the applications of Kano model. 12
- (c) Define the term “Concurrent Engineering”. How can it differ from traditional Engineering? Also write down the objectives of concurrent engineering. 12

Khulna University of Engineering & Technology
Department of Industrial Engineering and Management
 B.Sc. Engineering 3rd Year 1st Term Examination, 2016
IPE 3115
 Engineering Economy

Full Marks: 210

Time: 3 hrs

N.B: i) Answer any *THREE* questions from each section in separate scripts.
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 iii) Assume reasonable data if missing any.

SECTION-A

1. (a) Define engineering economy. List the four essential elements involved in decision making in engineering economic analysis. 10
- (b) What is meant by i) Time value of money ii) Cash flow diagram iii) Limited capital funds iv) Sensitivity analysis? 10
- (c) Find the net future worth and equivalent annual series for the entire cash flow sequence in figure 1(c). Given that $i=7\%$; all amounts are given in Tk. 15

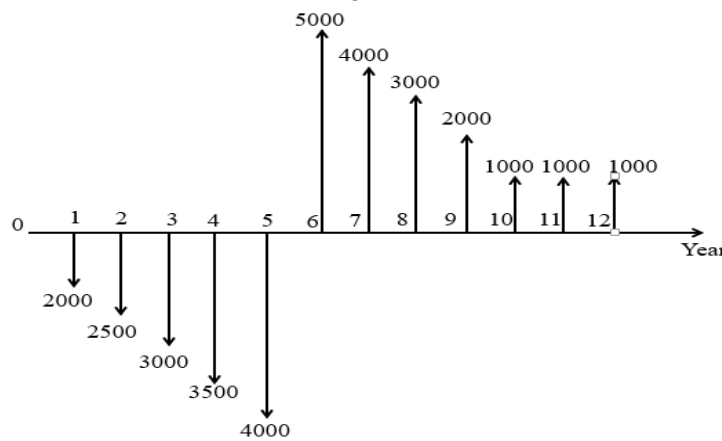


Figure 1 (c).

2. (a) Define i) Capital recovery factor ii) Sinking fund factor iii) Arithmetic gradient iv) Geometric gradient. 10
- (b) Chemical engineers at a Coleman industries plant in the Midwest have determined that a small amount of a newly available chemical additive will increase the water repellency of Coleman's tent fabric by 20%. The plant superintendent has arranged to purchase the additive through a 5-years contract at \$ 7000 per year, starting 1 year from now. He expects the annual price to increase by 12 % per year thereafter for the next 8 years. Additionally, an initial investment of \$ 35000 was made. Now to prepare a site suitable for the contractor to deliver the additive. Use $i = 15\%$ per year to determine the equivalent total present worth for all these cash flows. 12
- (c) Austin Utilities is planning to install solar panels to provide some of the electricity for its ground water desalting plant The project would be done in two phases. The first phase will cost \$ 4 million in year 1 and \$ 5 million in year 2. This investment will result in energy savings (phase 2) of \$ 540,000 in year 3, \$546,000 in year 4, and amounts increasing by \$6000 each year through year 10. Let $I = 10\%$ per year. 13
 - i) What is the future worth of the savings?
 - ii) Is the cost of the solar project justified by the savings?
3. (a) What is the difference between mutually exclusive alternatives and independent projects? What two approaches can be used to satisfy the equal service requirement? 06
- (b) For the cash flow shown, use an annual worth comparison and an interest rate of 10% per year. 15

	X	Y	Z
First Cost, \$	-90,000	-400,000	-650,000
Annual operating cost, per year, \$	-40,000	-20,000	-13,000
Overhaul every 10 years, \$	-	-	80,000
Salvage value, \$	7,000	25,000	200,000
Life, years	3	10	∞

- i) Determine the alternative that is economically best.
 - ii) Determine the first cost required for each of the two alternatives not selected (i) so that all alternatives are equally acceptable.
- (c) A chemical processing corporation is considering three methods to dispose of a non-hazardous chemical sludge land application, fluidized-bed incineration, and private disposal contract. The estimates for each method are shown. Determine which has the least cost on the basis of a present worth comparison at 10% per year for the following scenarios: 14
- i) The estimates as shown.
 - ii) The contract award cost increase by 20% every 2-year renewal.

	Land application	Incineration	Contract
First Cost, \$	-130,000	-900,000	0
Annual operating cost, per year, \$	-95,000	-60,000	-120,000
Salvage value, \$	25,000	300,000	0
Life, years	3	6	2

4. (a) Two sites are currently under consideration for a bridge over a big river. The north site requires a suspension bridge. The south site has a much shorter span, allowing for a truss bridge, but it would require new road construction. The suspension bridge will cost \$600 million with annual inspection and maintenance cost of \$250,000. In addition, the concrete deck would have to be resurfaced every 11 years at a cost of \$ 1,000,000. The truss bridge and approach roads are expected to cost \$250 million and have annual maintenance costs of \$200,000 for first 5 years and \$205,000 in the subsequent year. This bridge would have to be painted every 3 years at a cost of \$400,000. In addition, the bridge would have to be sandblasted every 10 years at a cost of \$1,900,000. The cost of purchasing right-of-way is expected to be \$20 million for the suspension bridge and \$150 million for the truss bridge. Compare the alternatives on the basis of their capitalized cost if the interest rate is 6 % per year. 18
- (b) A city planning commission is considering two proposals for a new civic enter. Proposal F requires an initial investment of \$10 million now and an expansion cost of \$4 million 10 years from now. The annual operating cost is expected to be \$ 250,000 per year. Income from conventions, shows, etc., is expected to be \$190,000 the first year and to increase by \$20,000 per year for 4 year more years and then remain constant until year 10. In year 11 and thereafter income is expected to be \$350,000 per year. Proposal G requires an initial investment of \$18 million now and an annual operating cost of \$ 300,000 per year. However, income is expected to be \$260,000 the first year and increase by \$30,000 per year to year 7. Thereafter, income will remain at \$400,000 per year. Determine which proposal should be selected on the basis of capitalized cost if the interest rate is 6% per year, 17

SECTION-B

5. (a) Define Rate of Return (ROR). Why incremental analysis is necessary for ROR calculation? 08
- (b) In a manufacturer company, over a 5 years period, the costs associated with one product line were as follows: first cost of Tk 25,000 and annual cost of Tk 18,000. Annual revenue was Tk 27,000. What rate of return did the company make on this product? 12
- (c) The costs of the machines are estimated below and all machines have a 10-years life. If the MARR is 25% per year, determine the one machine that should be selected on the basis of a rate of return analysis. 15

Machine	First cost, Tk	Annual operating cost, Tk
1	-28,000	-20,000
2	-51,000	-12,500
3	-32,000	-19,000
4	-33,000	-18,000
5	-46,000	-14,000

6. (a) Define modified Benefit/Cost ratio. An Engineering company wants to construct a dam on a river. The estimated cost and benefits are listed below. (i) If a 6% per year rate applies and dam life is infinite for analysis purpose, select the one best location using the B/C method. If no site is acceptable, other sites will be determined later. (ii) If more than one dam site can be selected, which sites are acceptable, using B/C method? 15

Site	A	B	C	D	E	F
Construction cost, \$ millions	6	8	3	10	5	11
Annual benefits, \$	350,000	420,000	125,000	400,000	350,000	700,000

- (b) Differentiate between sunk cost and marginal cost. A pulp paper company is evaluating whether it should retain the current bleaching process or replace it with oxypure process. The relevant information for each process is shown. Use 15% per year interest rate to perform the replacement study. 20

	Current process	Oxypure process
Original cost 6 years ago, \$	-450,000	-
Investment cost now, \$	-	-700,000
Current market value, \$	25,000	-
Annual operating cost, \$/year	-180,000	-70,000
Salvage value, \$	0	50,000
Remaining life, years	5	10

7. (a) Why incremental analysis is necessary? 05
 (b) For the alternatives shown, determine the sum of the incremental cash flows for Q-P. 15

	Alternatives P	Alternatives Q
First Cost, \$	-50,000	-85,000
Annual operating cost, \$, per year	-8,600	-2,000
Annual revenue, \$, per year	22,000	45,000
Salvage value, \$	3,000	8,000
Life, years	3	6

- (c) Metroklean LLC, a hazardous waste soil cleaning company, borrowed \$2.5 million for 5 years to finance start-up costs for anew project involving site reclamation, The company expects to earn a real rate of return of 20% per year. The average inflation rate is 5 % per year. 15
- Determine the capital recovery required each year with inflation considered.
 - Determine the capital recovery if the company is satisfied with accumulating \$2.5 million at the end of the 5 years with inflation considered.

8. (a) What is basic difference among SL, DB and DDB depreciation? A structure costs Tk 600,000 to construct. It has 25-years life with an estimated resale value of 75% of the construction cost. However, the building will be depreciated to zero over a recovery period of 30 years. Calculate the annual depreciation charge and plot book value for years 4, 10 and 25 using (i) SL and DDB depreciation (ii) What is implied salvage value for DDB? 15

- (b) Define Book value and Salvage value. Why sensitivity analysis is performed? An engineer collected average cost and revenue data for FC1 hand held financial calculator. 20

Fixed cost = \$300,000 per year

Cost per unit = \$ 40

Revenue per unit = \$70

- What is range in breakeven quantity if there is possible variation in the fixed cost from \$200,000 to \$400,000 per year? (Use \$50,000 increments)
- What is the incremental change in the breakeven quantity for each \$50,000 change in fixed cost?

Khulna University of Engineering & Technology
Department of Industrial Engineering and Management
 B.Sc. Engineering 3rd Year 1st Term Examination, 2016
IPE 3119
 Operations Management

Full Marks: 210

Time: 3 hrs

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 missing any.

SECTION-A

1. (a) Define operation management. How can you differentiate manufacturing organization from service organization? 06
- (b) What are meant by production and productivity? What factors affect productivity? 12
- (c) Can you think of a business that doesn't have operations management? 07
- (d) What are trade-offs? Why careful consideration of trade-offs is important in decision making? 10

2. (a) Define forecasting. Contrast the use of MAD and MSE in evaluating forecasts. 05
- (b) Which type of forecasting approach qualitative or quantitative is better? Explain. 03
- (c) Choose the type of forecasting technique (survey, Delphi, averaging, seasonal naïve, trend, or associative) that would be most appropriate for predicting. 05
 - i) Demand for mother's day greeting cards.
 - ii) Popularity of a new television series.
 - iii) Demand for vacation on the moon.
 - iv) The impact a price increase of 10 percent would have on sales of orange marmalade
 - v) Demand for toothpaste in a particular super market.
- (d) A text book publishing company has compiled data on total annual sales of its business texts for the preceding nine years:

Years:	1	2	3	4	5	6	7	8	9
Sales (000):	40.2	44.5	48.0	52.3	55.8	57.1	62.4	69.0	73.7

 - i) Using an appropriate model, forecast textbook sales for each of the next five years.
 - ii) Prepare a control chart for the forecast using the original data. Use 2s limits.
 - iii) Suppose actual sales for the next five years turn out as follows:

Years:	10	11	12	13	14
Sales (000):	77.2	82.1	87.8	90.6	98.9

 Is the forecast performing adequately? Explain.
- (e) An electrical contractor's records during the last five weeks indicate the number of job requests:

Week:	1	2	3	4	5
Requests:	20	22	18	21	22

 Predict the number of requests for week 5, using smoothing constant, $\alpha=0.30$ and 20 for week 2 forecast. 07

3. (a) What is disaggregation? Why is it done? 05
- (b) Prepare a schedule for the following situation. The forecast is 80 units for each of the first two periods and 60 units for each of the next three periods. The starting inventory is 20 units. The company uses change strategy for determining the production lot size, except there is an upper limit on the lot size 70 units. Also the desired safety stock is 10 units. Note: The ATP quantities are based on maximum allowable production and do not include safety stock. Committed orders are: 10

Period	Customer orders
1	82
2	80
3	60
4	40
5	20

- (c) Michigan Manufacturing produces a product that has a 6-month demand cycle. Each unit requires 10 worker-hours to produce, at a labor cost of \$6 per hour regular rate (or \$9 per hour over time). The total cost per unit is estimated at \$200, units can be subcontracted at a cost of \$208 per unit. There are currently 20 workers employed in the subject department, and hiring and training costs for additional workers are \$300 per person, where layoff costs are \$400 per person. Company policy is to retain a safety stock equal to 20 percent of the monthly forecast, and each month's safety stock becomes the beginning inventory for the next month. There are currently 50 units in stock carried at a cost of \$2 per unit-month. Unit shortage, or stock outs has been assigned a cost of \$20 per unit month. 20

	January	February	March	April	May	June
Forecast demand	330	550	400	100	200	300
Workdays	22	19	21	21	22	20
Work hrs. at 8 per day	176	152	168	168	176	160

Three aggregate plans are proposed.

Plan 1: Vary work force size to accommodate demand.

Plan 2: Maintain constant workforce of 20, and use over time and idle time to meet demand.

Plan 3: Maintain constant workforce of 20, and build inventory or incur stock out cost.

The firm must begin January with the 50-unit inventory on hand. Compare the costs of the three plans in table form.

4. (a) What are the main decision areas of job-shop scheduling? Why are priority rules needed? 10
 (b) Consider the following 3 machines and 5 jobs flow shop problem. Check whether Johnson's rule can be extended to this problem. If so, what is the schedule and the corresponding makespan? 10

Job	Machine 1	Machine 2	Machine 3
1	11	10	12
2	13	8	20
3	15	6	15
4	12	7	19
5	20	9	7

- (c) The following table contains order-dependent setup times for four-jobs. For safety reasons, Job C cannot follow job A, nor can job A follow job C. Determine the processing sequence that will minimize the total setup time. 15

	Setup Time (hrs.)	Following job's Setup time (hrs.)				
		A	B	C	D	
Proceeding job	A	2	-	5	x	4
	B	1	7	-	3	2
	C	3	x	2	-	2
	D	2	4	3	6	-

SECTION-B

5. (a) Why purchasing cost is not considered in EOQ model? Explain. 08
 (b) Explain briefly how a higher carrying cost can result in a decrease in inventory. 07
 (c) A manager just received a new price list from a supplier. It will now cost \$1.00 a box for order quantities of 801 or more boxes, \$ 1.10 a box for 200 to 800 boxes, \$1.20 a box for smaller quantities. Ordering cost is \$80 per order and carrying costs are \$10 per box a year. The firm uses 3,600 boxes a year. The manager has suggested a "round number" order size of 800 boxes. The manager's rationale is that with a U-shaped cost curve that is fairly flat at its minimum, the difference in total annual cost between 800 and 801 units would be small anyway. How would you reply to the manager's suggestion? What order size would you recommend? 15
 (d) What is safety stock and what is its purpose? 05

6. (a) Contrast independent and dependent demand. When is MRP appropriate? 09
 (b) How does the purpose of ERP differ from the purpose of MRPII? 06
 (c) Eighty units of end item E are needed at the beginning of week 6. Three cases (30 units per case) of J have been ordered and one case is scheduled to arrive in week 3, one in week 4 and one in week 5. J must be ordered by the cases and B must be produced in multiples of 120 units. There are 60 units of B and 20 units of J now on hand. Lead times are two weeks each for E and B and one week for J. Prepare a MRP for component J.

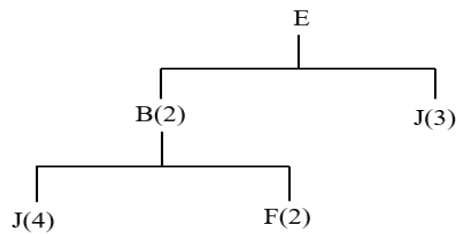
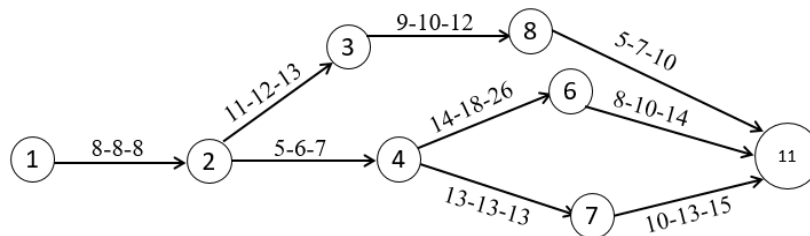


Fig. 6 (c)

7. (a) Define project management. What is a breakdown structure and how is it useful for project planning? 08
 (b) List the main advantages of PERT. List the main limitations. 07
 (c) The following precedence diagram reflects three time estimates for each activity. Determine;
 i) The expected completion time for each path and its variance.
 ii) The probability that the project can be completed in 46 weeks or less.



8. (a) What is the ultimate goal of JIT system? What are the supporting goals? 10
 (b) Briefly describe the benefits of effective supply chain management. 10
 (c) Differentiate push and pull methods of moving goods and materials through production systems. 10
 (d) Explain the kanban system. 05

Khulna University of Engineering & Technology
Department of Industrial Engineering and Management
 B.Sc. Engineering 3rd Year 1st Term Examination, 2016
ME 3111
 Fluid Mechanics and Machinery

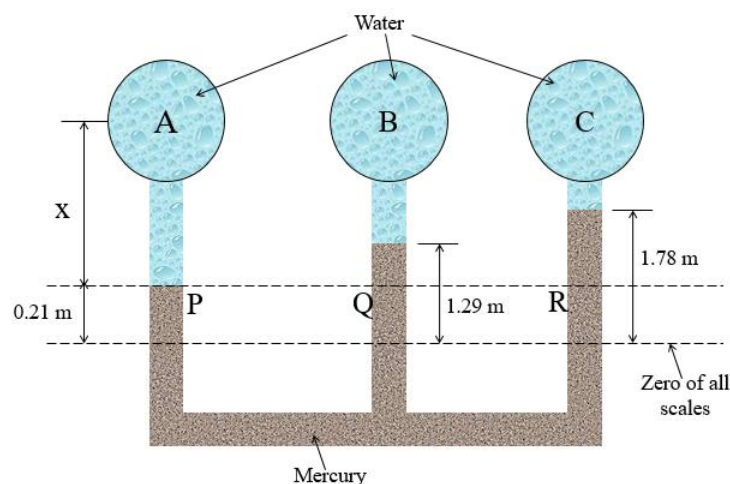
Full Marks: 210

Time: 3 hrs

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SECTION-A

1. (a) Why fluid is called so continuum? 05
- (b) Define surface tension and capillarity. 06
- (c) Prove that variation of pressure in a static mass of fluid is only in one direction. 12
- (d) For the multiple differential manometer shown in the sketch, if point A, B and C are at the same elevation, what is the difference in pressure heads in terms of water column between A and B, between A and C and between B and C? 12



2. (a) Differentiate between simple and differential type of manometers. 05
- (b) Derive expression for total pressure and a center of pressure on a vertical plane surface. 15
- (c) A circular plate 2.5 m diameter is immersed in water, its greatest and list depth below the free surface being 3 m and 1m respectively. Find 15
 - i) The total pressure on one face of the plate.
 - ii) The position of the center of pressure. Determine in SI unit and metric units
3. (a) Derive an equation for the measurement of fluid flow by venturimeter. 13
- (b) Derive an equation for time of emptying a tank through an orifice of its bottom. 10
- (c) Water flows through a rectangular channel 1 m wide and 0.5 m deep and then over a sharp crested cipolletti weir of crest length 0.6 m. If the water level in the channel is 0.225 m above the weir crest, calculate the discharge over the weir. Take $C_d = 0.6$ and make correction for velocity of approach. 12
4. (a) What do you meant by dimensional homogeneity? Write short notes on- 10
 - i) Renolds Number ii) Nusselt Number iii) Froude Number
- (b) What are the assumptions for Euler's equation for motion? Prove the Bernoulli's equation from the Euler's equation for motion. 15
- (c) A closed tank partially filled with water discharge through an orifice of 12.5 mm diameter and has a coefficient of discharge of 0.65. If air is pumped into the upper part of the tank, determine the pressure required to produce a discharge of 36.6 10

liters/minute when the water surface is 1 m above the outlet.

SECTION-B

5. (a) What is priming? Why priming is so important? 08
(b) Why is the efficiency of a volute casing of a centrifugal pump as an energy conversion device low? How is a whirlpool or vortex chamber superior in performance? 15
(c) A pump impeller is 375 mm diameter and it discharges water with component velocities of 2 and 12 m/s in the radial and tangential directions respectively. The impeller is surrounded by a concentric cylindrical chamber with parallel sides the outer diameter being 450 mm. If the flow in this chamber is a free spiral vortex, find the component velocities of water on leaving and increase in pressure if there is no loss. 12
6. (a) Draw operating characteristics curve for reciprocating pump. 08
(b) What is meant by governing of turbines? Discuss the governing mechanism for pelton turbine. 12
(c) A single acting reciprocating pump has a plunger of 80 mm diameter and a stroke of length 150 mm. It takes its supply of water from a sump 3 m below the pump through a pipe 4.5 m long and 30 mm diameter. It delivers water to a tank 12 m above the pump through a pipe 25 mm diameter and 15 m long. If separation occurs at 78.48 kN/m^2 below atmospheric pressure, find the maximum speed at which the pump may be operated without separation. Assume the plunger to have simple harmonic motion. 15
7. (a) What are the differences between Reaction and Impulse turbine? 08
(b) Shows losses of energy in hydroelectric installation for reaction turbine. 12
(c) Describe different types of losses and efficiencies of turbine. 15
8. (a) Shows the effect of acceleration in delivery pipe on indicator diagram. 10
(b) Briefly describe the working principle of compressor. 10
(c) Prove that the head loss due to friction is $h_f = \frac{flv^2}{2gd}$, where symbols have their usual meanings. 15