

**Khulna University of Engineering & Technology**  
**Department of Industrial Engineering and Management**

B.Sc. Engineering 3<sup>rd</sup> Year 2<sup>nd</sup> Term Examination, 2015

**IPE 3205**

Product Design- II

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) A hollow short compression member of normalized cast steel (ASTM A27-58, 65 10  
 ksi) is to support a load of 1500 kips with a factor of safety of 8 based on the  
 ultimate strength. Determine the outside diameter and inside diameter, if  $D_o = 2D_i$ .
- (b) A connecting link is shown in figure 1 (b), except that there is a 1/8 in. radial hole 25  
 drilled through it at the center section. It is machined from AISI 2330, WQT  
 1000°F and it is subjected to a repeated reversed axial load whose maximum value  
 is 5 kips. For  $N = 1.5$ , determine the diameter of the link at the hole,  
 i) For indefinite life.  
 ii) For a life of  $10^5$  repetitions (no column action).  
 iii) In the link found in (i), what is the maximum tensile stress?

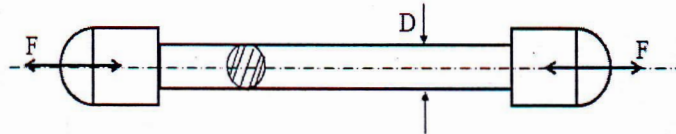


Figure 1 (b).

2. A machine part of uniform thickness  $t = \frac{b}{2.5}$  is shaped as shown in figure 2, and 35  
 machined all over from AISI C1020, as rolled. The design is limited to a life of  $10^6$   
 cycles for a load repeated from 1750 to 3500 lb. Let  $d = b$ . Determine:  
 i) For a design factor of 1.8 (soderberg) what should be the dimensions of  
 the part?  
 ii) What is the maximum tensile stress in the part as designed?

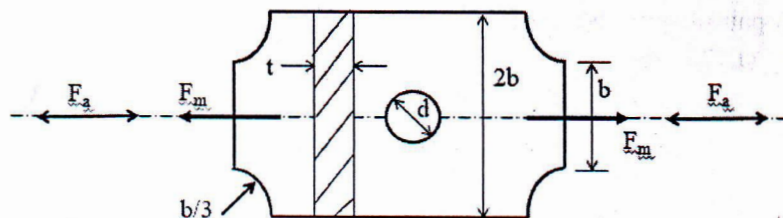


Figure 2.

3. A carbon steel spring is to be subjected to a load that varies from 500 to 1200 lb. 35  
 The outside diameter should be between 3.5 and 4 in.; the spring index between 5  
 to 10; approximate scale of 500 lb/in. Choose a steel and for design factor of 1.4 by  
 the Wahl line; find the wire diameter. Also determine the number of active coils  
 and the free length for squared and ground ends. Conform to the general condition  
 specified in the text.

4. A cold finished shaft, AISI 1141 is to transmit power that varies from 200 to 100 hp and back to 200 hp in each revolution at a speed of 600 rpm. The power is received by a 20-in. spur gear A and delivered by a 10-in. spur gear C. The tangential forces have each been converted into a force (A and C shown) and a couple (not shown). The radial component R of the tooth load is to be ignored in the initial design. Let  $N = 2$ , and considering varying stresses with the maximum shear theory, compute the shaft diameter.

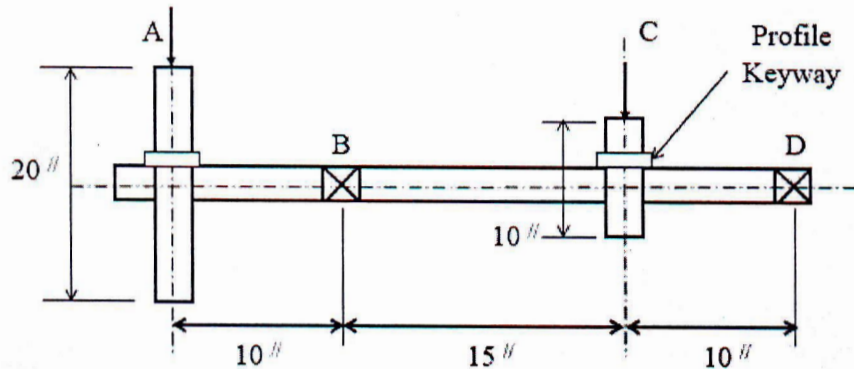


Figure 4.

**SECTION-B**

5. The pinion of a pair of steel gears transmitting 110 hp at 2300 rpm, is to have a diameter of about  $4\frac{1}{3}$  in. ;  $m_g \approx 2.3$  ;  $20^\circ$  full depth teeth; the drive is to a centrifugal pump, continuous services. 35
- Decided upon  $P_d$ ,  $b$ ,  $N_p$ ,  $N_g$  and the material to be used. Consider the strength with the load near the middle of the profile.
  - The same of (i) except that it is not expected that the maximum loading will occur for more than  $10^7$  cycles, can you justify changes in your previous answers?
6. For continuous duty in a speed reducer, two helical gears are to be rated at 7.4 hp at pinion speed of 1750 rpm;  $m_w \approx 2.75$ ; the helix angle  $15^\circ$  ;  $20^\circ$  F.D. teeth in the normal plane; let  $N_p = 21$  teeth and keep  $b < 2D_p$ . Determine the pitch, face,  $N_g$  and the material and heat treatment. Use through hardened teeth with maximum of 250 BHN (teeth are cut after heat treatment). 35
7. A pair of spiral bevel gear is used for a speed reducer, the input to the pinion is 20 hp at 1750 rpm;  $m_g \approx 1.9$ ; pinion overhang and gear straddle mounted. It is hoped not to exceed a maximum  $D_p$  of  $4\frac{3}{8}$  in., steel gears with minimum BHN = 245 on pinion and BHN = 210 on gear. The gear is motor driven, subject to miscellaneous drive involving moderate shock; indefinite life against breakage and wear with high reliability. Determine the pitch, face width and no. of teeth both for gear and pinion. 35
8. Design the teeth for two herringbone gear for a single reduction speed reducer with  $m_w \approx 4.71$ . The capacity is 23 hp at 3000 rpm of the pinion;  $\Psi = 30^\circ$ ; F.D. teeth with  $\phi_n = 20^\circ$ . Since space is at a premium, the initial design is  $N_p = 15$  teeth and carburized teeth of AISI 8620; preferably  $b < 2D_p$ . 35

**Khulna University of Engineering & Technology**  
**Department of Industrial Engineering and Management**  
 B.Sc. Engineering 3<sup>rd</sup>Year 2<sup>nd</sup> Term Examination, 2015  
**IPE 3217**  
 Operations Research

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) Write down the phases of Operations Research study. 04  
 (b) A manufacturer has two products  $p_1$  and  $p_2$ , both of which are produced in two steps by machine  $M_1$  and  $M_2$ . The process time per hundred for the products on the machines are: 13

	$M_1$	$M_2$	Contribution (per 100 units)
$P_1$	4	5	10
$P_2$	5	2	5
Available hours	100	80	

Formulate the problem as LP model and determine optimum product mix using graphical method.

- (c) Consider the following LP problem: 18  
 Maximize  $z = 10x_1 + 6x_2 + 4x_3$   
 Subject to,  
 $x_1 + x_2 + x_3 \leq 100$   
 $10x_1 + 4x_2 + 5x_3 \leq 600$   
 $2x_1 + 2x_2 + 6x_3 \leq 300$   
 $x_1, x_2, x_3 \geq 0$   
 Solve the problem using simplex method.

2. (a) Solve the following linear programming problem using two-phase method. 18  
 Maximize  $z = 3x_1 + 4x_2$   
 Subject to,  
 $2x_1 + 3x_2 \geq 90$   
 $4x_1 + 3x_2 \geq 120$   
 $x_1, x_2 \geq 0$   
 (b) A factory manufactures three products which are processed through three different production stages. The time required to manufacture one unit of each of the three products and the daily capacity of the stages are given in Table 1 and Table 2 represent the optimum tableau. 17

Stage	Product 1	product 2	product 3	Stage capacities
1	1	2	1	430
2	3	-	2	460
3	1	4	-	420
Profit/unit	3	2	5	

Basic	$X_1$	$X_2$	$X_3$	$X_4$	$X_5$	$X_6$	Solution
$z$	4	0	0	1	2	0	1350
$X_2$	-1/4	1	0	1/2	-1/4	0	100
$X_3$	3/2	0	1	0	1/2	0	230
$X_6$	2	0	0	-2	1	1	20

Where,  $x_1, x_2$  and  $x_3$  represents the unit to be produced for product 1, 2 and 3 respectively and  $x_4, x_5$  and  $x_6$  represents the slack variable for stage 1, 2 and 3 respectively.

Now the factory wants to increase the unit price of product 1 and 2 by 3 and 2 Taka respectively and decrease the price of product 3 by 2 Taka. Is this permissible when the changes are simultaneous?

3. (a) Consider the following LP:

17

$$\text{Maximize } z = 3x_1 + 2x_2 + 5x_3$$

$$\text{Subject to, } x_1 + 2x_2 + x_3 + x_4 = 430$$

$$3x_1 + 2x_3 + x_5 = 460$$

$$x_1 + 4x_2 + x_6 = 420$$

$$x_1, x_2, x_3, x_4, x_5, x_6 \geq 0$$

Compute the entire simplex tableau associated with the following basic solution.

$$\text{Basic variable} = (x_2, x_3, x_6), \text{ Inverse} = \begin{pmatrix} 1/2 & -1/4 & 0 \\ 0 & 1/2 & 0 \\ -2 & 1 & 1 \end{pmatrix}$$

- (b) A company that operates 10 hours a day manufactures three products on three sequential processes. Table 1 summarizes the data of the problem and Table 2 shows the optimal tableau where  $x_1, x_2$  and  $x_3$  represents the three products and  $x_4, x_5$  and  $x_6$  represents the slack variable of the three processes. Find out which resources are fully consumed? How much of each resource remains unused? Suppose the company propose to shift the unused capacity to process 3. How would this change impact the current optimum solution?

Table 1

Minutes per unit

Product	Process 1	Process 2	Process 3	Unit price
1	10	6	8	\$ 4.50
2	5	8	10	\$ 5.00
3	6	9	12	\$ 4.00

Table 2

Basic	$X_1$	$X_2$	$X_3$	$X_4$	$X_5$	$X_6$	Solution
$z$	0	0	2	0.08	0	0.46	325
$X_1$	1	0	0	0.17	0	-0.08	50
$X_5$	0	0	-0.6	0.07	1	-0.83	140
$X_2$	0	1	1.2	-0.13	0	0.17	20

4. (a) Solve the following transportation model to find out the optimum transportation cost.

20

Distribution center

		$D_1$	$D_2$	$D_3$	$D_4$	Supply
Factory	$F_1$	8	12	44	28	18
	$F_2$	4	0	24	4	3
	$F_3$	20	32	60	36	30
		21	15	9	6	

- (b) An Automobile dealer wishes to put four repairman to four different jobs. The dealer has estimated the number of man-hours that would be required for each job-man combination. This is given in the following matrix form.

Man \ Job	A	B	C	D
1	5	3	2	8
2	7	9	2	6
3	6	4	5	7
4	5	7	7	8

15

**SECTION-B**

5. (a) What is game? The payoff is for player A 20

	B			
A	3	2	1	-3
	2	4	3	2

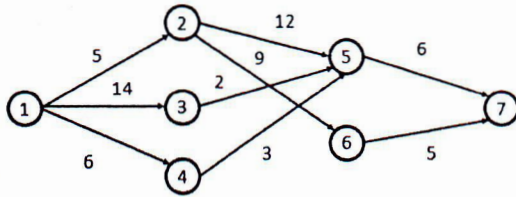
Find the strategy of A graphically.

- (b) 15

		State		
		S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>
Alternative	A <sub>1</sub>	5	10	12
	A <sub>2</sub>	3	4	16
	A <sub>3</sub>	8	9	6

Find the best alternative by Laplace, Minimax, Savage and Hurwicz method.  $\alpha = 0.4$

6. (a) What is dynamic programming? Find the shortest route. 20



- (b) A 4 ton vessel can be loaded with one or more of three items. The following table gives the unit weight,  $w_i$ , in tons and the unit revenue in thousands of dollars,  $r_i$ , for item  $i$ . How should the vessel be loaded to maximize the total return? The state  $x_i$  assumes integer values only. 15

items	$w_i$	$r_i$
1	2	31
2	3	47
3	1	14

7. (a) What is queue? Describe the necessity of studying queue. 10  
 (b) Babies are born in a state of the rate of one birth every 12 minutes. The time between birth follows exponential distribution. Find- 12  
 i) The average number of births per year.  
 ii) The probability that no birth will occur in any one day.  
 iii) The probability of issuing 50 birth certificates in 3 hours, given that no certificates were issued during the first 2 hours of the 3 hours period.

- (c) For steady state behavior, prove, 13  

$$p_n = \left( \frac{\lambda_{n-1} \lambda_{n-2} \dots \lambda_0}{M_n M_{n-1} \dots M_1} \right) p_0, n=1, 2, \dots$$

8. (a) A barbershop serves one customer at a time and provides seats for waiting customer. If the place is full, customer go elsewhere. Arrivals occur accordingly to a Poisson distribution with mean four per hour. The time to get a haircut is exponential with mean 15 minutes. Determine- 16  
 i) The steady state probabilities.  
 ii) The expected number of customer in the shop.  
 iii) The probability that customer will go elsewhere because the shop is full.

- (b) What is Markov chain? Write down its application. 07

- (c) Initial condition,  $a^{(0)} = (1,0,0)$  12  
 Transition matrix,

P =		1	2	3
	1	0.3	0.6	0.1
	2	0.1	0.6	0.3
	3	0.05	0.4	0.55

Find the condition at the step 4.

**Khulna University of Engineering & Technology**  
**Department of Industrial Engineering and Management**

B.Sc. Engineering 3<sup>rd</sup> Year 2<sup>nd</sup> Term Examination, 2015

**IPE 3219**

Production Systems Design

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 PSD. What are the factors to be considered to design a system for a product or service? 10
- (b) Design a system for a garments manufacturing industry. 13
- (c) Describe the information contained in the following graphic aids for process design:- 12
  - i) Block diagram
  - ii) process chart
  - iii) Operation sheet
  - iv) Operation chart

2. (a) Define CRP. What are the effect of poor capacity requirement planning? 10
- (b) Write down the differences between single stage and multiple- stage operations system in capacity planning. 10
- (c) Reliable parts Co. has signed a contract with a farm-equipment manufacturer for 100,000 parts to be delivered uniformly over 1 year. Each part is processed in three departments (pressing, drilling and grinding) with the following production data. The company operates 250 days/yr. 15

	Department		
	Pressing	Drilling	Grinding
Working hours per day	8 × 2	8	8
Processing time per part, minute	4	8	12
Average daily downtime, minute	20	40	30
Average daily setup time, minute	5	7	8
Defective output, %	3	9	6

- Determine,
- i) The efficiency E for each production department.
  - ii) The required daily production rate for each department if all defectives are discarded as scarp.
  - iii) The equipment requirements for each department.

3. (a) What reasons usually prompt an existing organization to seek a new location? 08
- (b) Why are energy considerations important during process design? How are pollutants classified in terms of their effects? 15
- (c) A fabrication department must supply 3000 good parts daily to another department for assembly. Processing time 2.50 min/unit and the equipment efficiency for two shifts daily is estimated at 80%. 12
  - i) What is the actual output rate of the fabrication department when defective output amount is 5%?
  - ii) What is the required equipment for the fabrication department?

**Khulna University of Engineering & Technology**  
**Department of Industrial Engineering and Management**  
 B.Sc. Engineering 3<sup>rd</sup> Year 2<sup>nd</sup> Term Examination, 2015  
**IPE 3221**  
 Quality 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) What is meant by Quality Control? How is statistical quality control (SQC) used for quality control purpose? 12
- (b) What is meant by controlled and uncontrolled variances? Discuss the various reasons for the variance in production process. 12
- (c) What are the differences between process in control and process out of control? 11
2. (a) What impact does the sample size have on control limit? Explain with examples. 10
- (b) Discuss the sensitizing rules for control chart with necessary figures. 10
- (c) Pepcico company filled its water bottle Aquafina at one liter of water. In order to test the quality filled a sample of 5 bottles were taken randomly over the last two days. The results are given in the following table. 15

Sample No.	1	2	3	4	5
1	990	985	1005	992	987
2	990	985	980	990	990
3	985	995	990	995	995
4	990	990	990	995	995
5	995	995	1000	1005	985

Construct a control chart and check whether the process in control?

3. (a) What is meant by process capability? What are the purpose of it? 10
- (b) Explain why  $C_{pk}$  value can never be greater than  $C_p$ ? 12
- (c) Rajshahi silk mill has often weaving defect in sharee. 10 sharees were taken randomly and number of defects noted in each is given below. 13

Sahree	1	2	3	4	5	6	7	8	9	10
Defects	2	6	0	8	4	7	5	0	2	3

Determine the process is in control? Set up a control chart.

4. (a) What are the differences between specification limit and control limit? 10
- (b) Discuss the physical significance of  $C_p=0.67$ . 12
- (c) When the process mean shift from target value, the value of  $C_{pk}$  decreases and once become negative-Explain with sketches. 13

**SECTION-B**

5. (a) Define Design of Experiment (DOE). Write down the basic methodology of DOE to know what parameters affect quality and in what degree? 15
- (b) Four treatments for fever blisters, including a Placebo (A), were randomly assigned to 20 patients. The data in table 5 (b) shows for each treatment, the number of days from initial appearance of the blisters until healing is complete. Test the hypothesis, at the 5 % significance level, that there is no difference between the four treatments with respect to mean time of healing. 20

Table 5 (b)

Treatments	Numbers of Days				
A	5	8	7	7	8
B	4	6	6	3	5
C	6	4	4	5	4
D	7	4	6	6	5

6. (a) What is meant by acceptance sampling? What are the disadvantages of acceptance sampling? 07
- (b) Write short note on i) AQL, ii) LTPD, iii) AOQ, and iv) AOQL. 08
- (c) Draw the primary OC curve for a double-sampling plan with  $n_1 = 50$ ,  $c_1 = 2$ ,  $n_2 = 100$ ,  $c_2 = 6$ . If the incoming lots have fraction nonconforming  $p = 0.05$ , what is the probability of acceptance on the first sample? What is the probability of final acceptance? Calculate the probability of rejection on the first sample. 20
7. (a) What is meant by reliability? Explain reliability as a function of time. 12
- (b) What are the differences between MTBF and MTTF? 05
- (c) Define ISO 9000 QMS. What are the criticisms of ISO 9000 QMS? 08
- (d) Briefly discuss the clauses ISO 9000 QMS. 10
8. (a) What is meant by TQM? How can you differentiate TQM from other quality tools? 10
- (b) Write down the necessity of PDCA cycle and quality circle. 06
- (c) What are the procedures of finding a root cause of a problem? 04
- (d) Define QFD. Construct a HOQ of the production of a new mobile phone in the existing market. 15



**Khulna University of Engineering & Technology**  
**Department of Industrial Engineering and Management**

B.Sc. Engineering 3<sup>rd</sup> Year 2<sup>nd</sup> Term Examination, 2015

**IPE 3223**

Material Handling and Maintenance Management

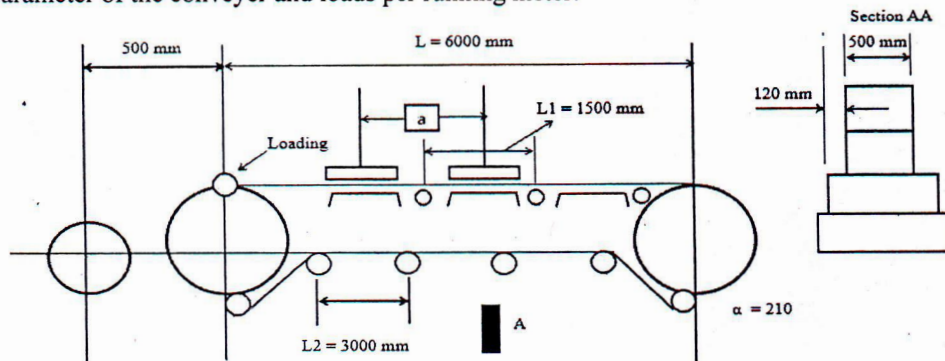
Full Marks: 210

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) What do you meant by material handling? Briefly discuss the common terminology used in material handling system design. 10  
 (b) Write down the selection criteria of conveying equipment. 10  
 (c) A conveyor is intended to move  $z = 1500$  parts per hour for a distance of  $L = 6000$  mm, 15  
 shown in the following figure, the co-efficient allowing for irregularity of feed is  $k' = 1.25$ .  
 The parts have plane dimensions of  $b = 500$  mm, a height 100 mm and a piece weight of  $G = 20$  kg. The conveyor is horizontal and ordinary cotton belting. Determine the main parameter of the conveyor and loads per running meter.



2. (a) Write short notes on- 09  
 i) Drive unit ii) Loading & discharging devices iii) Belt cleaner  
 (b) Discuss screw, pneumatic and hydraulic conveyor. 15  
 (c) Show that the value of the polar distance of bucket elevator depends only on the rpm of the pulley. 11
3. (a) What are the purposes of testing the packages? Describe the various types of procedures for package testing. 15  
 (b) Write short notes on serial, modular and closed loop conveyor system. 10  
 (c) An automated guided vehicle (AGV) system is chosen for delivering small parts from storage to five shops in a plant. Determine the number of vehicles needed, given the information in the following table. The vehicle can carry parts to and from only one shop at a time. The AGV's under normal condition can travel at a rate 250 ft per minute. 10

Shop Number	Distance from Storage (feet)	Number of Trips Per hour	Loading/ Unloading (minutes)
01	400	12	3
02	600	13	5
03	500	15	2
04	800	6	1
05	1000	8	3

4. (a) What are the storage and order picking policies used in warehouse? 08  
 (b) A manufacturing company wishes to store a unit on  $36'' \times 48'' \times 24''$  pallet having a weight of 14000 pounds and 75 dual cycles per hour. The total storage is 1800 unit loads. The height of the building is 80 ft but clearance of 2 ft from the ceiling and 6 inches for the rack support are needed. Determine: 13

- i) The number of stacks that can be accommodated with the height of the load.
  - ii) The no. of dual cranes needed.
  - iii) The no. of bays needed.
  - iv) The storage dimensions.
- (c) Four different items are to be stored in the warehouse whose initial layout is shown in figure 4 (c). Table 4 (c) shows the number of pallets received each week, average receiving trips per week and average size of each order shipped. Each of the 16 sections of the warehouse stores 100 pallets. The rectilinear distance from section to section is 15 feet. Determine the most efficient storage arrangement for the warehouse.

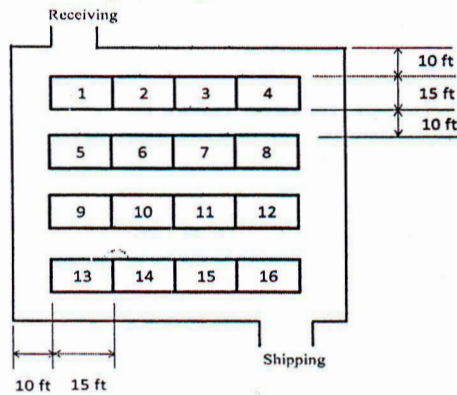


Figure 4 (c)

Table 4 (c)

Item	Pallets Received	Average receiving trips per week	Average pallets shipped per week per shipment
A	275	138	2.7
B	425	213	2
C	150	75	0.5
D	550	275	1.2

**SECTION-B**

- 5. (a) Define maintenance. Briefly enumerate the challenges of maintenance function. 10
- (b) Explain condition-based maintenance with its advantages. 15
- (c) Explain the duties & responsibilities of a maintenance engineer. 10
  
- 6. (a) Define motivation. Enumerate the training problems that are faced during performance of the maintenance functions. 10
- (b) Examine the economic aspects of incentive plans used in the maintenance functions. 12
- (c) What is Job card system? List the computer-based maintenance system which can be practiced in maintenance functions. 13
  
- 7. (a) What are the main objectives of maintenance organizational function? 10
- (b) Discuss the merits and demerits of different types of maintenance organizations. 15
- (c) Describe the methods employed for cost minimization in any maintenance organization. 10
  
- 8. (a) Given, 15
  - i) Age of machine since last replaced,  $a = 0, 1, 2, \geq 3$
  - operating cost/period  $C(a)$ , Tk 200 300 350 400
  - ii) Cost of replacement,  $C_r = \text{Tk } 225$
  - iii) Cost of matrix
 

I/J	0	1	2	3
0	$\infty$	200	$\infty$	$\infty$
1	$\infty$	425	200	$\infty$
2	$\infty$	425	$\infty$	350
3	$\infty$	425	$\infty$	400

The problem is to determine the replacement policy to be adopted if equipment in new now and there are 2 periods of time to go to complete the production plan.
- (b) Differentiate between deterministic and probabilistic replacement problems. 07
- (c) Construct a model for optimal replacement where operating cost increases with use. 13