

INDIAN STATISTICAL INSTITUTE

Mid-Semestral examination: 2013-14

Course Name: M.Tech (QR & OR) 1st YEAR (E & S Streams)

Subject: Operations Research-I

Date of Exam: 26.08.13 **Max Marks:** 75 **Duration:** 2½ hrs.

Answer all questions.

1. An indigenous mobile manufacturer produces two brands of mobiles. Long-term projections indicate an expected demand of at least 100 brand-I and 80 brand-II mobiles each day. Because of limitations on production capacity, no more than 200 brand-I and 170 brand-II mobiles can be made daily. To satisfy a contract, a total of at least 200 mobiles must be despatched each day. Each brand-I mobile sold results in a \$2 loss, but each brand-II mobile produces a \$5 profit. Formulate the optimization problem.

Show graphically how many of each brand should be made daily to maximize net profit? What is the value of expected net profit to be maximum?

[Mark all extreme points, feasible region, constraint lines and use isoprofit line (objective function) approach to find out the optimal solution.]

[10+10=20]

2. (a) Define Convex Set, Convex polyhedron and Extreme Point.
(b) If the set of all feasible solutions K of a LPP is a Convex Polyhedron, then at least one extreme point must be obtained which is optimal.
(c) Show that the set of vectors $a^1 = (2, -1, 0)$, $a^2 = (3, 5, 1)$ and $a^3 = (1, 1, 2)$ forms a basis in E_3 .

[6+10+4=20]

3. (a) What is the degeneracy of basic feasible solution (b.f.s) of a transportation problem (T.P.)? Describe the conditions for a non-degenerate b.f.s of a T.P.
- (b) Determine an initial b.f.s by Minimum Cost method and test for the optimal solution for the following T.P.

		Distrn. centres				Supply
		D1	D2	D3	D4	
Plants	P1	19	30	50	10	7
	P2	70	30	40	60	9
	P3	40	8	70	20	18
Demand		5	8	7	14	34

[5+15 = 20]

4. Prove the following results:

- If x^* is any feasible solution (f.s.) of primal and w^* is any f.s. of dual such that $c'x^* = b'w^*$, then x^* is optimal f.s. of primal and w^* is optimal f.s. of dual.
- The value of a flow in a network is the net flow across any cut of the network.
- Intersection of two convex sets is convex.

[5+5+5 = 15]

INDIAN STATISTICAL INSTITUTE

Mid-Semestral Examination: 2013-14

Course Name: M. Tech (QR&OR)

Subject Name: Statistical Methods – I

Date: 28.08.1013

Maximum Marks: 100

Duration: 3 Hours

Note: Answer all the questions

1. The following data were collected for a certain characteristic of a product. The 100 samples were selected randomly from the process over a period of 16 hours.

21	30	28	19	21	19	20	22	26	22
26	23	21	30	25	27	26	25	31	26
27	22	16	18	29	23	19	24	24	25
25	25	25	19	24	20	24	20	20	25
22	20	22	22	22	26	27	22	25	30
27	20	25	24	22	21	28	24	23	23
26	29	31	23	29	27	28	31	29	27
16	19	23	23	19	25	23	28	26	25
26	23	31	23	31	27	29	25	30	27
27	22	25	21	24	25	20	22	21	28

(a) Construct a suitable frequency distribution for the data and offer your comments on the status of the process

(b) Compute the mean, median and standard deviation for the grouped data

[(8+3) + 3x3]

The next three questions (# 2, 3 and 4) are related to the simple linear regression model

$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i$, and the notations used have usual meaning.

2. Let \hat{Y} be the estimator of $E(Y|X)$.

(a) Show that \hat{Y} can be expressed as $\frac{\hat{Y} - \bar{y}}{s_y} = r \frac{x - \bar{x}}{s_x}$, where the notations have usual meaning.

(b) Use the above expression to explain the phenomenon known as 'regression to mean' or 'regression to mediocrity'.

[8 + 5]

3. (a) Show that $\hat{\beta}_1 = S_{xy} / S_{xx}$ is an unbiased estimate of β_1 .

(b) Derive the expression for $V(\hat{y})$, where \hat{y} is the point estimate of $E(Y|x_0)$.

[10 + 15]

4. Consider the following data on salary (in Rs. thousand) vs. years of experience.

Sl. No.	Salary (Y1)	Y2 = Log(Y1)	Experience (X)	Residual of Y1	Residual of Y2
1	26	1.41	7	-0.5	0.00
2	79	1.90	28	8.9	0.00
3	66	1.82	23	6.3	0.04
4	42	1.62	18	-7.4	-0.04
5	62	1.79	19	10.6	0.10
6	41	1.61	15	-2.1	0.02
7	54	1.73	24	-7.8	-0.07
8	34	1.53	13	-5.0	-0.02
9	22	1.34	2	5.8	0.05
10	33	1.52	8	4.4	0.09
11	43	1.63	20	-10.5	-0.08
12	56	1.75	21	0.4	0.02
13	59	1.77	18	9.6	0.11
14	22	1.34	7	-4.5	-0.07
15	21	1.32	2	4.8	0.03
16	50	1.70	18	0.6	0.04
17	33	1.52	11	-1.8	0.02
18	44	1.64	21	-11.6	-0.09
19	16	1.20	4	-4.3	-0.14
20	66	1.82	24	4.2	0.02
Mean	43.45	1.60	15.15	-	-
Std. Dev.	17.74	0.196	7.92	6.69	0.066

The regression models obtained using the above data are $Y1 = 12.0 + 2.08*X$ and $Y2 = 1.24 + 0.0233*X$. The residuals of the models are given in the last two columns of the above table.

(a) Examine if there is any relationship between salary and years of experience. Constructing scatter plots are not permissible and formal statistical testing is not required.

(b) Examine the plots of residual vs. predicted values for both the regression models and use other suitable summary measures to select the better model, if any.

[8 + 14]

5. Write short notes on the following:

(a) Histogram (b) Box plot (c) Types of data (d) Linear model assumptions

[4 x 5]

INDIAN STATISTICAL INSTITUTE

Mid-Semester Examination : 2013-14(First Semester)

Course Name: M. TECH. (QROR) I Yr.

Subject Name : Electrical and Electronics Engineering

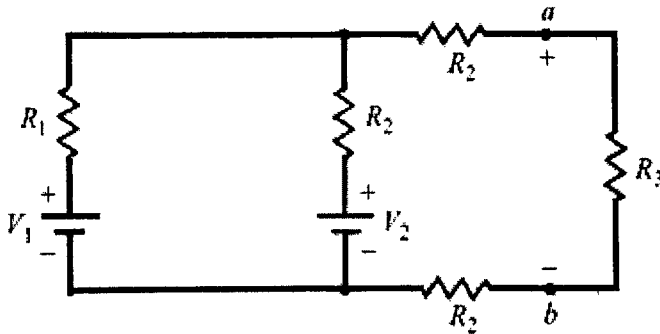
Date : 28.08.13

Maximum Marks : 50

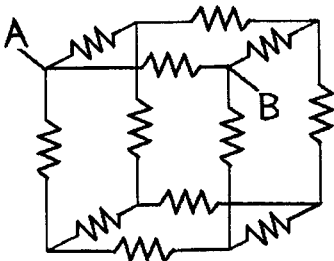
Duration : 2Hrs

GROUP A: Answer any 5 questions.

1. What is an OP-AMP? Explain the operations of an OPAMP as an adder and an integrator. [2+3+3=8]
2. For the circuit, given below, $V_1 = 8V$, $V_2 = 16V$, $R_1 = 4$ Ohms, and $R_2=6$ Ohms. Find the Thevenin equivalent for the network to the left of terminals a,b. Assume that the internal resistances of the batteries are 0. [8]



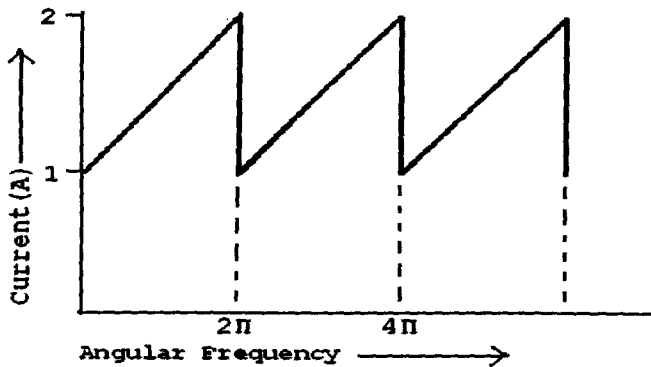
3. A cube is formed by joining equal wires, each of resistance 1 Ohm. The cube is shown in figure below. Calculate the equivalent resistance between the points A and B. [8]



4. a) If $f(t)$ is a complete response of a circuit, then define the steady state response and the transient response of that circuit. [3]

b) A series RC circuit is excited by a battery of e.m.f. E at time $t=0$. Find the steady state current and the transient current in that circuit. [5]

5. Explain with a diagram how AC voltage can be generated for a rectangular coil having N turns rotating in a uniform magnetic field with an angular velocity of ω radian/second. [8]
6. Find the series resonance frequency for a circuit having a capacitor (C), inductor (L) and a resistor (R) connected in series with an A.C. voltage $V_0 e^{j\omega t}$. [8]
7. Calculate the average and r.m.s. value of current represented in figure below. [5+3=8]



GROUP B: Answer any 1 question.

1. State and prove Thevenin's theorem. [10]
2. a) Explain the maximum power transfer theorem.
b) Suppose, three resistances R_1 , R_2 , and R_3 are connected in delta formation and the delta formation is equivalent to a star formation comprising of resistances x , y , and z . Find R_1 , R_2 , and R_3 individually in terms of x , y , and z . [5+5=10]

INDIAN STATISTICAL INSTITUTE

Mid-semester Examination: 2013 – 14

Course Name: M Tech (Q, R & OR), 1st Year

Subject Name: Quality Management

Date: 30th August, 2013

Maximum Marks: 60

Duration: 90 minutes

Notes: Answer question 3 and any one of questions 1 or 2.

1. Answer the following

- a. Explain Kano's model. Think about some word processing software like MS word. Identify three quality characteristics of this software product and classify them according to Kano's model. Do you think the suggested characteristics are directly measurable variables or are constructs? Explain your answer for each of the identified characteristics. [5 + 3 X 2 + 3 = 14]
- b. Explain how Garvin has distinguished between strategic and defensive approaches to quality. In this context explain what you mean by *strategy*. [4 + 2 = 6]
- c. Use Kano's model to explain Juran's insight that "*customer satisfaction and dissatisfaction are not opposites*". [5]

2. Answer the following

- a. What is measurement? Explain the different scales of measurement briefly. [2 + 8 = 10]
- b. What are the five major dimensions of service quality? Explain each of the dimensions briefly. [15]

3. Answer the following

- a. Give two different definitions of quality. [2 + 2 = 4]
- b. Specify three distinctive characteristics of service often not found in products. [3]
- c. Answer the following questions in the context of a university that is financed by the government. Answer the same questions in case the university is financed through fees paid by students
 - i. Identify two internal and two external customers in each case [1 X 4 = 4]
 - ii. Identify one business process and one work process in each case. Specify the outcomes of the identified processes and explain how you propose to measure the outcome through some outputs. Note that the outcomes may be directly measurable and hence it is possible that both outcomes as well as outputs may be the same. In this case explain why you think so. [8 + 8 = 16]
 - iii. Specify some special and common causes of variation for the outputs of any of the work processes identified by you. [3]
 - iv. Can you think of cases in the context of the identified processes where attempts are made to solve chronic problems at operational level for any of the identified processes? If yes, explain. If you think that for all the processes, the solutions are being attempted at the appropriate layer, explain by taking any one process as an example. [5]

INDIAN STATISTICAL INSTITUTE
M.Tech (QR & OR) 1st YEAR (E & S Streams)
Session: 2012-2014
MIDSEMESTRAL EXAMINATION

Subject: SQC1

Date of Exam: 02/09/2013

Max. Marks: 100

Time: 3 hrs.

Group – A (Control Chart)

Answer All Questions.

1. Construct a Pareto Diagram out of the following data on defects pertaining to tanks produced for aerospace application. Identify the “Vital Few” and “Trivial or Useful Many” defects.

Defect	Frequency
Parts damaged	34
Machining problems	29
Supplied parts rusted	13
Masking insufficient	17
Misaligned weld	2
Processing out of order	4
Wrong part issued	3
Unfinished fairing	3
Adhesive failure	6
Powdery alodine	1
Paint out of limits	2
Paint damaged by etching	1
Film on parts	5
Primer cans damaged	1
Voids in casting	2
Delaminated composite	2
Incorrect dimensions	36
Improper test procedure	1
Salt-spray failure	4
TOTAL	166

[20]

2. The response times in minutes of two service providers – Premier, Agarpara and Car Care, Sodpur – for providing on-road service to car owners are given in the following.

Premier, Agarpara	Car Care, Sodpur
280	211
217	241
364	231
236	200
190	220
286	192
225	216
395	205
271	207
248	205
208	222
	203

- (a) Construct Box Plots to compare the performances of the two service providers.
- (b) Which service provider is better and why is it better?
- (c) Does there remain any outlier in the distribution of service time of any of these service providers? If yes, identify the outlier.

[12+3+5=20]

3. Draw an \bar{X} -R control chart for the chloride content in soda ash, which is a lower the better quality characteristic with Upper Specification Limit (USL) set at 0.75%. The summary statistics given in the following table pertains to the 16 subgroups. Each subgroup represents a day. On each day chloride content has been measured every 4 hours resulting in 6 measurements per subgroup.
- Find the homogenized values of $\bar{\bar{X}}$ and \bar{R} .
 - Was the process under statistical control?
 - What control limits will you recommend for future control purposes for both \bar{X} and R-chart?
 - Find the estimate of process σ .
 - Assuming that the chloride content in soda ash follows normal distribution, determine the extent of non-conformance above USL.

Summary Statistics for Chloride Content in Soda Ash

Day	\bar{X}	R
1	0.720	0.24
2	0.477	0.29
3	0.543	0.17
4	0.545	0.41
5	0.517	0.35
6	0.555	0.41
7	0.563	0.17

8	0.642	0.41
9	0.478	0.17
10	0.710	0.58
11	0.573	0.23
12	0.565	0.35
13	0.557	0.17
14	0.460	0.62
15	0.605	0.70
16	0.495	0.23

[10+2+4+2+2=20]

Group-B (Acceptance Sampling)

Maximum Marks (40)

1. a) What are the purposes of introducing an acceptance sampling plan in an organization?
- b) What are the advantages and disadvantages of acceptance Sampling compared to 100% inspection?
- c) Give an overview of various types of Acceptance Sampling plans with the help of an appropriate diagram.

3 7
[7+3+10=20]
2. a) Define the following terms that are used in the explanation and development of acceptance sampling plans: AOQ, AOQL, AQL, ATI, LTPD.
- b) What is the purpose of drawing an Operating Characteristic (OC) curve in the context of Acceptance Sampling?
- c) What are the distinctions between type A and type B OC curves?
- d) How the shape of an OC curve is determined by the parameters (n and c) of a sampling plan?

[10+3+4+3=20]

INDIAN STATISTICAL INSTITUTE

M.Tech (QR-OR) 1st Year (S Stream)

Session : 2013-2014

MID-SEMISTRAL EXAMINATION

Subject : Workshop-I (Engineering Drawing)

Date of Exam: 04.09.2013.

Max. Marks : 40

Time : 1hrs 30 mins

Note: (a) Answer any two questions.

(b) Write your Name and Roll no. at one corner of the drawing sheet.

(c) Marks allotted to each question are indicated.

1. Construct a regular pentagon and a hexagon. [20]
2. Draw the projections of (i) a cylinder, base 50 mm diameter and axis 70 mm long, and (ii) a cone, base 50 mm diameter and axis 70 mm long, resting on the ground on their respective bases. [20]
3. Draw a diagonal scale of R.F. = $\frac{3}{100}$, showing metres, decimeters and centimeters and to measure up to 5 metres. Show the length of 3.69 metres on it. [20]

Indian Statistical Institute
Mid-Semestral Examination : 2013-14
M-TECH(QR&OR) -- 1st YEAR (E - STREAM)
PROBABILITY-1
{Answer all the questions}

Date: 04.09.13

Full marks: 100

Time: 2 hours

[Symbols have their usual meaning]

1. a) State and prove Bonferroni's inequality.
b) State and prove Poincare's theorem.
[10+10=20]

2. a) Define moment generating function (MGF). Find MGF of Negative binomial distribution. Hence find its mean and variance.
b) Find the mode of binomial distribution.
[12+8=20]

3. a) Consider r indistinguishable balls randomly distributed in n cells. What is the probability that exactly m cells remain empty?
b) In a test an examinee either guesses or copies or knows the answer to a multiple choice question with four choices, only one answer being correct. The probability that he makes the guess is $1/3$, the probability that he copies the answer is $1/6$. The probability that his answer is correct given that he copies it is $1/8$. Find the probability that he knew the answer to the question given that he answered it correctly.
[8+7=15]

4. a) Explain the difference between 'pairwise independent events' and "mutually independent events". Give an example to show that three events A, B, C are pairwise independent but not necessarily mutually independent.
b) Three students A, B, C can solve a problem of Mathematics with probability $1/2, 3/4$ and $1/4$ respectively. What is the probability that the problem will be solved?
[5+5=10]

5. Assignments.
[35]

INDIAN STATISTICAL INSTITUTE

Mid-Semestral Examination

Course Name: M.Tech. (QROR)

Year: 1st year

Subject Name: Programming Techniques and Data Structures

Date: 06/09/13

Maximum Marks: 50

Duration: 2.00 hrs

Answer all questions.

1. Write short notes on any two of the following: 5x2=10

- a. Scope of a variable
- b. Two dimensional array and its one dimensional representation
- c. Binary Search

2. Write the output of the following C-code segment with appropriate assumptions and proper explanation. 5x2=10

2.1

```
#include<stdio.h>
void main()
{
    int a[10];
    int *p;

    for (int i=0; i<=9; i++)
        a[i]=i+1;

    p=a;
    printf("%u, %u, %d, %d", p, &p, *p, *(p+1));
}
```

2.2

```
#include<stdio.h>
void main()
{
    int i=10;
    while (--i)
        printf("%d\t", i);

    printf("\n");
}
```

3. (a) Write a C program to compute the transpose of a 3x2 matrix, supplied by the user. Explain your program with a suitable example. 4+2

(b) Write a function to check the overflow condition of a circular queue.

4

4. Given the infix expression: $3 + 4 + 20/4$, convert it into postfix and prefix forms. Write an algorithm to compute the value of a postfix expression using stack and explain your algorithm with the previous example. $3+5+2=10$
5. Define the node structure of a singly linked list, which has one "info" part and one "link" part. Write a program to count the number of odd numbers stored in a linear linked list. What is the advantage of using doubly linked list over singly linked list. $3+5+2=10$

INDIAN STATISTICAL INSTITUTE
M.Tech (QR_OR) 1st Year (S Stream)
Session : 2013-2014
SEMISTRAL EXAMINATION
Subject : Workshop – 1 (Engg. Drawing)

Date of Exam: 07.11.13

Max. Marks : 60

Time : 3:00 hrs

Note : (a) Answer question No.1 (compulsory) and any other three questions.
(b) Write your Name and Roll no. at one corner of the drawing sheet.
(c) Marks allotted to each question are indicated in the bracket.

1. Sketch a sectional front view of a knuckle joint. Use suitable dimensions to complete the drawing. [18]
2. A square pyramid, base 40 mm side and axis 70 mm long, has its base in the V.P. One edge of the base is inclined at 30° to the ground and a corner contained by that edge is on the ground. Draw its projections. [14]
3. A cube of 35 mm long edges is resting on the ground on one of its faces with a vertical face inclined at 30° to the V.P. It is cut by a section plane, inclined at 60° to the V.P. and perpendicular to the H.P., so that the face which makes 60° angle with the V.P. is cut in two equal halves. Draw the sectional front view, top view and the true shape of the section. [14]
4. Show by means of sketch any four of the following thread forms.
a) Whitworth
b) Seller
c) Buttress
d) Knuckle
e) Square [14]
5. Construct a diagonal scale of R.F.=1/4000 to show metres and long enough to measure up to 500 metres. Show the length of 369 metres on it. [14]
6. The pictorial drawing of a machine part is given below. Draw the top view and the front view of it. Insert all the dimensions in the views. Use first angle projection method. Ref. Fig. 1. [14]

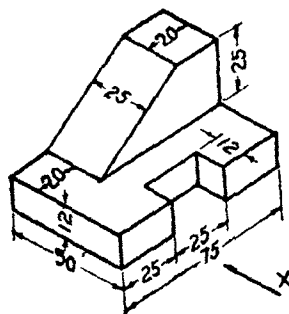


Fig. 1

Medhavi
Sharma
6.11.13.

INDIAN STATISTICAL INSTITUTE

First Semestral examination: 2013-14

Course Name: M.Tech (QR & OR) 1st YEAR (E & S Streams)

Subject: Operations Research-I

Date of Exam : 11-11-2013

Max Marks: 100

Duration: 3 hrs.

Assignment: 25 marks

Answer as many as you can. Question nos. 3,5 and 9 are compulsory.

1. Explain the implications of evaluating opportunity cost in Vogel's approximation method (VAM) for un-occupied (non-basic) cells of a T.P. while finding for an improved b.f.s. What is the significance of computing penalty (difference between two successive lowest shipping costs) in VAM?

[6+2=8]

2. If f is a flow in a flow network $G = (V, E)$ with source s and sink t , then prove that the following conditions are equivalent:
- f is a maximum flow in G .
 - The residual network G_f contains no augmenting path.
 - $|f| = c(S, T)$ for some cut (S, T) of G .

[10]

3. Consider the following financial problem:

Maximize Return on Investment (ROI) = $2X_1 + 3X_2$

Subject to $6X_1 + 9X_2 \leq 18$

$9X_1 + 3X_2 \geq 9$

$X_1, X_2 \geq 0$

- Find the optimal solution using the simplex method.
- What evidence in the tableau indicates that an alternative optimum solution exists?
- Find the alternate optimal solution.
- Solve this problem graphically as well, and illustrate the alternate optimal corner points.

[5+1+1+3=10]

OR,

Solve the following problem using dual variables:

$$\text{Maximize } 3X_1 + 2X_2$$

Subject to

$$X_1 + X_2 \geq 1$$

$$X_1 + X_2 \leq 7$$

$$X_1 + 2X_2 \leq 10$$

$$X_2 \leq 3$$

$$X_1, X_2 \geq 0$$

[10]

4. Prove that whenever the primal admits of optimal solution, the dual also admits of optimal solution. Furthermore, the respective optimal values of the primal and dual objective functions are equal.

[8]

5. Define *inventory*, *inventory system*, *reorder point*, *order level*, *safety stock*, *service level* along with different cost components of an inventory system. Mention the basic differences between (t_p, S) policy and (t, S_p) policy.

OR

What are the basic assumptions of an EOQ model? Derive optimal order quantity, ordering interval and cost of the EOQ model when several items can be procured with the same ordering cost.

[10]

6. A digital printing has an annual demand for portable hard disk of 1,400. The cost of a hard disk is Rs. 400. Carrying cost is estimated to be 20% of the unit cost, and the ordering cost is Rs. 25 per order. If the company orders in quantities of 300 or more, it can get a 5% discount on the cost of the hard disks. Should the company take the quantity discount? Assume the demand is constant.

[8]

7. Define a Markov process in terms of a stochastic process. In general, what type of Markov process a Queue model is and why? Derive steady-state solution for p_n of a Poisson queue stating all its assumptions.

[2+3+7=12]

8. An airlines organisation has one reservation clerk on duty in its local branch at any given time. The clerk handles information regarding passenger reservation and flight schedule. Assume that the no. of customers arriving for any given period is Poisson distribution with arrival rate 8/hr and the reservation clerk can service a customer in 6 minutes on an average with an exponentially distributed service time.
- What is the probability that the system is busy?
 - What is the average time that a customer spends in a system?
 - What is the average length of the queue and what is the average length of customer in the system?

[2+2+2=6]

9. Whirlpool Appliances sells and services several brands of home appliances. Past sales for a particular model of washing machine have resulted in the following probability distribution for demand:

Demand per week	0	1	2	3	4
Probability	0.2	0.4	0.2	0.15	0.05

The lead time, in weeks, is described by the following distribution:

Lead time (week)	1	2	3
Probability	0.15	0.35	0.50

Based on cost considerations as well as storage space, the company has decided to order 10 of these each time an order is placed. The carrying cost is Rs. 100 per week for each unit that is left in the inventory at the end of the week. The stock out cost is set at Rs 4,000 per stock out. The company has decided to place an order whenever there are only 2 washing m/cs. left at the end of the week. Simulate 10 weeks of operation for Whirlpool with currently 5 units in inventory. What would be the weekly stock out cost and weekly carrying cost under this situation?

[8+2+2=12]

INDIAN STATISTICAL INSTITUTE
First-Semester Examination : 2013-14
M-TECH(QR&OR) -- 1st YEAR (E-STREAM)

PROBABILITY -- 1

Note : Answer any FIVE questions

Date: 13.11.13

Full marks:100

Time: 3 hours

[Symbols have their usual meaning]

1. a) State and prove Chebyshev's lemma. State and prove Chebyshev's inequality.
b) State and prove Central Limit Theorem due to Lindeberg and Levy.
[(5+5)+10=20]

2. a) Define $F = \frac{Y_1^2/n_1}{Y_2^2/n_2}$
where Y_1^2 and Y_2^2 are independent χ^2 random variables with degree of freedom n_1 and n_2 respectively.
Find the p.d.f of F.
b) Let the joint distribution of X and Y be
$$f(x, y) = \frac{e^{-(x+y)}x^3y^4}{\Gamma(4)\Gamma(5)} \quad x, y > 0$$

Find the pdf of $U = \frac{X}{X+Y}$
[12+8=20]

3. a) Suppose X_1, X_2, \dots, X_n are iid continuous random variable with p.d.f $f(x)$ and c.d.f $F(x)$,
Let $X_{(1)} = \text{Min}(X_1, \dots, X_n)$. Derive the distribution of $X_{(1)}$.
b) Let ρ be the correlation co-efficient between two random variables X and Y. Prove that $-1 \leq \rho \leq 1$.
[8+12=20]

4. a) Let X follows Normal distribution (with parameters μ and σ) truncated to the left of $X = a$, and right of $X = b$. Find the p.d.f and expectation of X.
b) In a bolt manufacturing company the specification for the diameter of the bolt is (30-50) mm. The percentage of bolts below the lower specification is 3% and the percentage of bolts above the upper specification is 8%. Assuming the diameter distribution of the bolts is normal find the mean and variance of the distribution.
[10+10=20]

5. a) Let A_1, A_2, \dots, A_r be r events not necessarily mutually exclusive. Find the probability of occurrence of exactly m events ($m < r$).
b) Define a monotonic sequence of events. Let $\{A_n\}$ be a monotonic sequence of events. Then prove that, $\lim_{n \rightarrow \infty} P(A_n) = P(\lim_{n \rightarrow \infty} A_n)$.
[10+10=20]

6. a) If you permute the word "PARAMETER" in all possible ways what is the probability that no vowel will lie between two consonants?

- b) A person is paying Rs 50.00 for each participation of the following game:
He is drawing 2 cards from a deck. He gets Rs 20.00 if he draws 2 red kings. He gets Rs 30.00 if he draws 2 queens. He gets Rs 30 if he draws 1 red jack and another black ace. Otherwise he gets nothing. What is his expected gain?
- c) A and B play a game of tennis. The situation of the game is as follows: If one score 2 consecutive points after a dence he wins, [if loss of a point followed or preceded by win of a point, it is called dence]. The chance of a server to win a point is $\frac{2}{3}$. The game is at a dence and A is serving. What is the probability that A will win?

[6+7+7=20]

INDIAN STATISTICAL INSTITUTE
SQC & OR Unit, Kolkata
M. Tech. (QR OR) I Year
Session: 2013-2014
Semester Examination

Subject: Statistical Quality Control 1

Date: 18/11/2013

Time: 3 hours

Full Marks: 100

[All Symbols Have Usual Meaning]

Group A (Control Chart): Full Marks 50

Answer Any Two Questions

1. a) What's the role of OC curve in \bar{x} and R chart? [2]
- b) Prove that for an \bar{x} -chart if the mean shifts from the in-control value μ_0 to another value $\mu_1 = \mu_0 + \delta\sigma$, then $\beta = \Phi(k - \delta\sqrt{n}) - \Phi(-k - \delta\sqrt{n})$. [4]
- c) Prove that $ARL = \frac{1}{1-\beta}$. [4]
- d) Prove that the economic process centering of a process following normal distribution is $\mu = \frac{U+L}{2} + \frac{\sigma^2}{U-L} \ln \frac{C_1+C}{C_2+C}$, where U and L are upper and lower specification limits, C is the profit per unit for within specification production and C_1 and C_2 are losses per unit due to producing under specification and over specification respectively. [7]
- e) Define the process capability indices C_p , C_{pk} , C_{pm} , and C_{pmk} . [2×4=8]
2. a) How the disadvantage of any Shewhart control chart is overcome by CUSUM chart? [4]
- b) How will you define the CUSUM quantity for a sample average against a target value μ_0 ? [3]
- c) State the estimate of the mean for a sustained pattern with constant slope running from observation j to observation i. [4]
- d) What are the disadvantages of the CUSUM control chart? [5]
- e) Describe the procedure for constructing the tabular form of the CUSUM control chart. [9]

3. a) What is the purpose of using an Exponentially Weighted Moving Average (EWMA) control chart? [2]
- b) How is the statistic for EWMA control chart defined? [3]
- c) Show that the statistic Z_i in the EWMA chart is a weighted average of all previous sample means [5]
- d) Show that the weights of the EWMA decrease geometrically with the age of the sample mean and the weights sum to unity [2+4=6]
- e) If the observations X_i are independent random variables with variance σ^2 , find the expression for the variance of the EWMA statistic Z_i [5]
- f) Determine the centerline and control limits for the EWMA control chart with sample size one. What will be the steady state values of the corresponding control limits? [2+2=4]

Group B (Acceptance Sampling): Full Marks 50
Answer All Questions

4. a) Describe with the help of a Flow Chart the general procedure for double sampling plans.
- b) What are the relative merits and demerits of implementing a double sampling plan in an organization?
- c) Consider a double-sampling plan with lot size $N = 2000$ and parameters $n_1 = 30$, $c_1 = 1$, $n_2 = 60$, $c_2 = 3$. Assuming that the lot fraction nonconforming is 0.05 and the underlying distribution as Binomial, determine the Average Sample Number (ASN). [7+5+8 = 20]
5. Determine a single-sampling rectifying inspection plan that has an AOQL of 0.03, lot size of 4000 items and that minimizes the Average Total Inspection (ATI) for $p = 0.015$. Assume Poisson approximation to Binomial for evaluating the necessary probabilities. The values of $y = P_a p_M n$ are given in the following for different values of c .

Values of $y = P_a p_M n$

c	y
0	0.3679
1	0.8408
2	1.3720

3	1.9460
4	2.5440
5	3.1720
6	3.8100

P_a = Probability of acceptance

P_M = p value at which the AOQL is reached

n = Sample size

c = Acceptance number

[20]

6. Assignment

[10]

INDIAN STATISTICAL INSTITUTE

First Semester Examination: 2013-14

Course Name: M. Tech. (QR&OR)

Subject Name: Quality Management Systems

Date: 20/11/2013

Maximum Marks: 100

Duration: 3 hours

Group-A, Maximum Marks: 60

Note: Answer any three questions.

Answer the following

- (a) Explain the five different views of quality suggested by Garvin, with brief explanation for each view.
- (b) What are the five absolutes of quality as suggested by Crosby?
- (c) Use Kano's model to explain Juran's insight that "*customer satisfaction and dissatisfaction are not opposites*".

(10+5+5) = [20]

Answer the following

- (a) Explain Deming's system of profound knowledge.
- (b) What is Maslow's hierarchy of needs? Explain how Maslow's need hierarchy is related to one or more principles suggested by Deming.
- (c) What is Juran's trilogy? Explain briefly.

(8+(5+4)+3) = [20]

Answer the following

- (a) What do you think are the main barriers to introducing quality in an organization? Explain each of the barriers briefly.
- (b) Explain the concept of scientific management as proposed by Frederick Taylor.

(14+6) = [20]

Answer the following

- (a) What are the different components of cost of quality? Explain briefly.
- (b) What do you mean by business case in the context of six-sigma?
- (c) Do you envisage any difficulties that a traditional functionally defined organization (SILO form) may face while attempting to implement six-sigma? Explain.

(8+4+4) = [20]

Group-B, Maximum Marks: 40

Note: Answer all the questions from this group. Answer Group-B in separate sheet.

1. You are working in an educational institution, which decides to implement ISO 14001: 2004. List down any two of its activities and mention different environmental aspects and associated impacts. Suggest a suitable scheme to identify significant environmental aspects.
(6+6) = [12]

2. Write short note explaining the following terms. (any three)
 - (a) Accuracy and Bias
 - (b) Process Map
 - (c) Internal Audit
 - (d) Environmental Objective(s) and Programme(s)
 - (e) Emergency Preparedness(4 x 3) = [12]

3. Following are the objective evidences of an internal audit conducted according to both ISO 9001: 2008 QMS and ISO 14001: 2004 EMS. For each of the objective evidence, identify whether the observation is related to QMS or EMS. Then provide your explanation and justification whether it is a nonconformance or not. (any four)
 - (a) Data on disposition of hazardous waste, which is a legal requirement, is not available.
 - (b) The foreman in the Machine Shop was referring to revision 03 of drawing BFQ1677/53, but was not sure whether that is the latest one.
 - (c) An auditor was interviewed and asked whether she is qualified for internal auditing. The auditor replied she had attended a two-day training programme on internal audit followed by an examination and then started auditing.
 - (d) Customer complaints are replied promptly and records are kept. Record shows similar complaints are recurring every month. When asked, the concerned manager explains that his responsibility is confined only to reply the complaints promptly.
 - (e) XYZ is a hazardous raw material, which is handled occasionally by the Stores. It has been found that Stores Incharge is not aware of any MSDS of the material XYZ.
(4 x 4) = [16]

INDIAN STATISTICAL INSTITUTE

Semestral Examination

Course Name: M.Tech. (QROR)

Year: 1st year

Subject Name: Programming Techniques and Data Structures

Date: 22.11.13 Maximum Marks: 100

Duration: 3.00 hrs

Answer all questions.

1. Write short notes on any two of the following: 5x2=10
- IEEE 754 Single precision floating point representation
 - Quick sort
 - AVL Tree

2. Answer any two of the following with proper explanations: 3x2=6

2.1 How many times the word 'print' shall be printed by the following program segment?

```
for (i=1; i<2; i++)  
  
    for (j=1; j<2; j++)  
  
        for(k=1; k<2; k++)  
  
            printf("print\n");
```

2.2 With proper explanation state what the following function does:

```
int x, y;  
  
x = x+y;  
y = x-y;  
x = x-y;
```

2.3 Write the output of the program:

```
#include<stdio.h>  
  
void main()  
{  
    float a=3.15529;  
    printf("%2.1f\n", a);  
}
```

3. Differentiate with example (any two):

5x2=10

- i) Call by Value and Call by Reference
- ii) Iterative Vs Recursive Function
- iii) 1's Complement Vs 2's Complement Representation of Binary Numbers

4. Write a C program for sorting a set of numbers in ascending order using a bubble sort algorithm. Derive its time complexity. 6+4=10

5. What are linear and non-linear data structures? Name a non-linear data structure that uses pointers. Write an algorithm for inserting an element 'x' after element 'y' in a given singly-linked list. (2+2)+6=10

6. Let a binary tree T have n_2 number of nodes of degree 2, n_1 numbers of nodes of degree 1 and n_0 number of nodes of degree 0. Then prove that $n_0=n_2+1$. 10

7. Define BST. Write the node structure of a BST. What is the advantage of using threaded binary tree? Explain with an example. 2+4+6=12

8. Write a non recursive algorithm for pre-order traversal of a binary tree. Explain with an example. 8+4=12

9. Construct the binary tree from the following traversals: 10

Inorder: 16, 33, 45, 62, 80, 92

Postorder: 16, 45, 80, 92, 62, 33

Draw the construction step-wise.

10. Hash the numbers 12, 34, 56, 14, 19, 10, 89 using the hash function $h(x)=x \bmod 10$, where the hash table size is 10. Use linear probing method as the collision resolution technique.

10

INDIAN STATISTICAL INSTITUTE

First-Semester Examination : 2013-14

Course Name: M. TECH. (QROR) I Yr.

Subject Name : Electrical and Electronics Engineering

Date : 25.11.13

Maximum Marks : 96

Duration : 3Hrs

Answer any 6 questions.

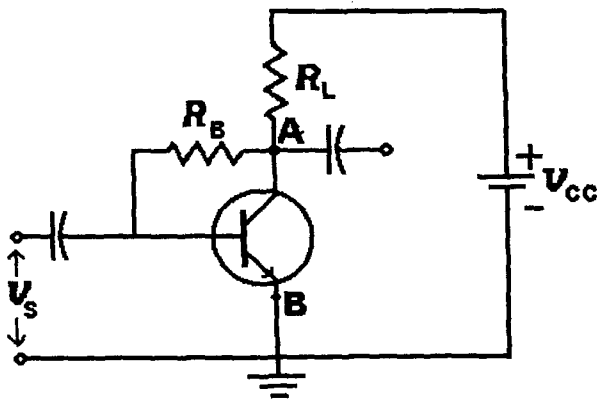
1. a) Show that, for an AC voltage the angular frequency $\omega = 2\pi/T$ where, T is the time period of one complete cycle.
b) An inductor (L) is connected in series with a resistance (R) and a capacitor (C) is connected in parallel with the series LR. If an AC voltage $V_0 e^{j\omega t}$ is now applied across this circuit, then determine the condition for resonance and the angular frequency at resonance. [3+13=16]
2. a) Draw the block diagram of an automatic control system and define control lag, load variable, manipulated variable, process lag, and dead time.
b) Derive the output of a PID (proportional plus integral plus derivative) control action for a step type error signal. Explain with a figure that how the output changes with error signal and time. [(2+6)+(5+3)=16]
3. What is a transformer? Draw the equivalent circuit of a transformer and show that in ideal situation the ratio of the primary to the secondary voltage is equal to the primary-to-secondary turns ratio.

Show that the mutual inductance M between primary coil (inductance L_1) and secondary coil (inductance L_2) of a transformer is $\sqrt{L_1 L_2}$. [12+4=16]
4. a) A DC voltage E is applied across a series RL circuit. Find the steady state current and the transient current in the circuit and draw the respective curves of current w.r.t. time.
b) After the attainment of steady state for the same RL circuit, the DC voltage is now replaced with a short circuit. Find the decay of current w.r.t time in R and L respectively. [8+8=16]
5. Explain the operational principles of an OP-AMP to be used as a noninverting amplifier, differential amplifier, adder, and differentiator. [4+4+4+4=16]

6. Draw the circuit diagrams of amplifiers using a p-n-p transistor in common-base, common-emitter and common collector modes of operation, respectively.

Find the relation between the parameters α and β of a transistor.

An n-p-n transistor, shown in the Fig. below, is used in common-emitter amplifier mode with $\beta=49$, $V_{CC}=10V$, and $R_L=2k$ Ohms. If a $100k$ Ohms resistor, R_B , is connected between the collector and the base of the transistor, then calculate the quiescent collector current and the collector to emitter voltage drop between points A and B. [6+4+6=16]



7. a) Draw the basic circuit and AC equivalent circuit (using hybrid parameters) of a tuned collector oscillator. [3]
 b) Analyze the circuit and determine the relationship among hybrid parameters for oscillations to sustain. [4+9=13]
8. Draw the hybrid-parameter equivalent circuit of a transistor in common base mode and calculate the current gain, input resistance and voltage gain in terms of the hybrid parameters. [4+4+4+4=16]
9. Explain the operation of a full adder with circuit diagram and truth table. Show that a 3 bit addition can be realized with adders. [12+4=16]
10. a) Derive the binary equivalent of 65.375
 b) Subtract 01110 from 10011 using 1's complement method and verify the result by doing the same subtraction using 2's complement method.
 c) Show how an AND gate can be realized using diodes and resistances.
 d) Construct an OR gate with AND and NOT gates only. [2+5+5+4=16]

INDIAN STATISTICAL INSTITUTE

Semester Examination: 2013-14

M. Tech. (QR & OR), 1st Year, 1st Semester, E Stream

Subject: Statistical Methods I

Date: 25.11.2013

Duration: 3 hours

Note: This paper carries a total of 112 marks. Answer as many questions as you can. But the maximum you can score is 100.

1. Identify the nature of the following characteristics (Continuous/Discrete/Ordinal/Nominal)

(a) Student identification number (e.g. roll number), (b) Date of birth, (c) Percentage rejection of parts and (d) Number of defects per square meter of cloth

[1x4=4]

2. Comment on the following (wear a statistician's hat)

(a) The mean weight of one-year old boys is 22.5 pounds. So the parents of one-year old boys weighing 20 pounds should be concerned about their child's development

(b) Two students take an IQ test. Student A scores 98 and student B scores 101. Since the mean IQ score is defined to be 100, student A is of below average intelligence and student B is above average.

[2x2=4]

3. Suppose the starting monthly salary (in Rs. thousand) offered to the ten M. Tech. (QROR) students of the 2011-12 batch were as follows: 34, 34.5, 34, 36, 39, 32, 35.5, 106.5, 36.5, and 33. What should we report as the typical monthly salary?

[2]

4. Identify the sources of bias, if any, in the following cases

(a) A political poll is conducted by calling numbers picked at random from the telephone directory.

(b) Tests to determine the incidence of hepatitis is conducted on a random sample of people attending a blood donation centre.

(c) In order to make a Pareto Analysis of different types of defects, a random sample is taken from the final inspection report for a given period. The parts are subjected to 100% inspection for the purpose of segregation good parts from the bad ones.

[3x3=9]

5. A politician hires a pollster to estimate his support in the forthcoming election. A poll of 1000 people indicates that he has the support of 52% of the people with a margin of error of 3% (i.e. the

95% confidence interval is $\pm 3\%$). He is not satisfied with the large error and desires a more accurate estimate. How many people would need to be polled in order to reduce the margin of error to 1%?

[3]

6. The following table shows (fictional) data for travel by bus and by taxi between two points. The "Pass." columns show the mean number of passengers per day travelling between the two points and the "Time" columns show the mean travel time in minutes.

Day	Bus		Taxi		Overall	
	Pass.	Time	Pass.	Time	Pass.	Time
Sunday	1524	38	231	23	1755	?
Monday	246	41	386	27	632	?

Calculate the overall mean travel time for Sunday and for Monday. Is the correlation between overall mean travel time and total number of passengers travelled spurious? Explain. [Hint: Simpson's paradox]

[3+1+5=9]

7. Suppose psychologists have found empirical evidence of the following: Students having strong belief in superstition (e.g. black cats and Friday the 13th) are more likely to have psychological disorders. Clearly, we cannot take the findings on its face value and conclude that belief in superstition causes psychological disorder. What can be a possible explanation for the observed correlation? If we want to test the causal effect of belief in superstition then how should we plan for data collection? State whether the proposed plan will be practically feasible?

[3+4+1=8]

8. Why is mean so extensively used as a measure of centre despite its disadvantages?

[2]

9. The least square estimates of the two parameters of a simple linear regression model are obtained based on 50 pairs of data on (X, Y) . This gives $Y = 2 + 3 \cdot X$ as the fitted model. The same data is used to obtain the least square estimates of the following transformed models:

(a) $Y = a_1 + b_1 \cdot X'$ and (b) $Y' = a_2 + b_2 \cdot X'$

Where $Y' = Y - \text{mean of the 50 observations on } Y$ and $X' = X - \text{mean of the 50 observations on } X$. Find the values of (a_1, b_1) and (a_2, b_2) . [Assume that the mean of the 50 observations on Y is 8]

[2+2=4]

10. The following model is found to be adequate in predicting the weight (in kg.) of 5-15 years old boys: $\text{Weight} = 15 + 1.5 \cdot \text{Age}$. Interpret the coefficients of the model. Suggest an alternative linear model that will allow a better interpretation of the coefficients.

[2+3=5]

11. In classical linear regression situations, the independent variables are assumed to be fixed and we make a standard set of linear model assumptions. If the independent variables are also assumed to be stochastic, then an additional assumption is made. What is that assumption? How do we check

the validity of that assumption? Explain the consequence of violating the assumption? [Hint: Evaluate $E(\hat{\beta})$]

[2+3+4=9]

12. While developing a simple linear regression model, the histogram of the standardized residuals is found to be bimodal. Give an example (scatter diagram) of a situation in which we will have such a histogram. Suggest an appropriate remedial measure for modelling the data.

[3+4=7]

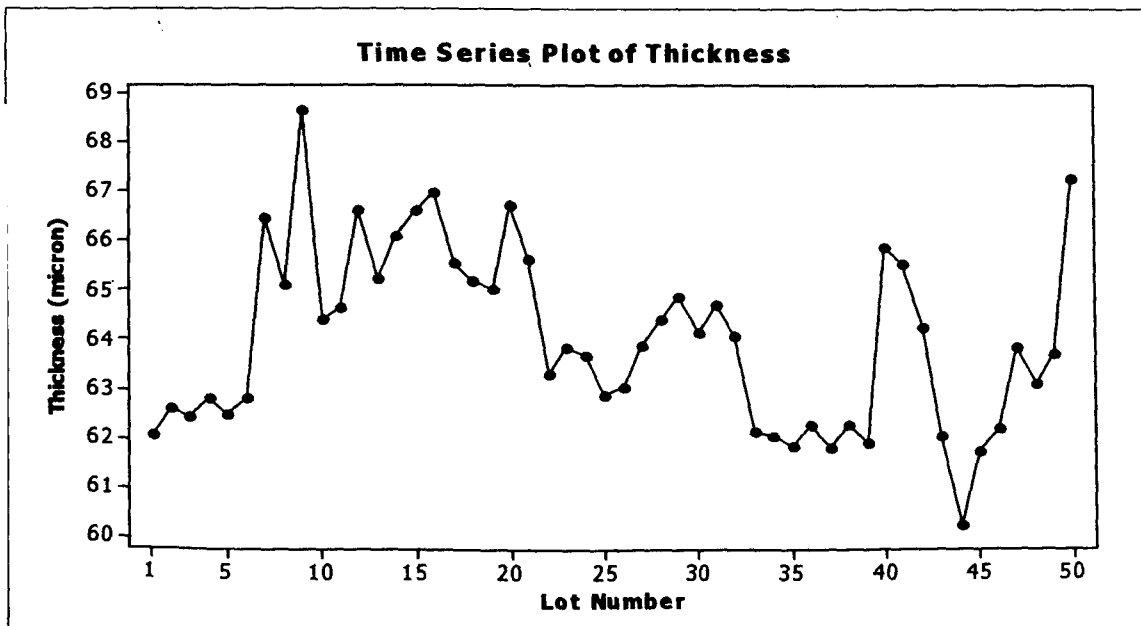
13. Prove that the sample mean and variance of observations drawn from a Normal distribution are independent. [Hint: Use the results that for Normal distributions, no correlation implies independence and that functions of independent random variables are independent]

[8]

14. The thickness (in μm) of cigarette paper is measured for 50 consecutive rolls. The data obtained are as follows:

Lot No.	Thickness	Lot No.	Thickness	Lot No.	Thickness	Lot No.	Thickness	Lot No.	Thickness
1	62.08	11	64.64	21	65.63	31	64.70	41	65.55
2	62.60	12	66.64	22	63.30	32	64.08	42	64.23
3	62.45	13	65.23	23	63.83	33	62.15	43	62.06
4	62.80	14	66.10	24	63.68	34	62.03	44	60.25
5	62.48	15	66.65	25	62.88	35	61.83	45	61.73
6	62.80	16	67.00	26	63.05	36	62.29	46	62.21
7	66.46	17	65.56	27	63.87	37	61.80	47	63.86
8	65.10	18	65.20	28	64.41	38	62.28	48	63.10
9	68.67	19	65.04	29	64.87	39	61.90	49	63.70
10	64.40	20	66.73	30	64.16	40	65.88	50	67.28

The line chart of the data is given below.



(a) Classify the data into four suitable strata

(b) The total sample size is 8. Select the sample size for each stratum suitably. Offer qualitative justification for your choice.

(c) Use the uniform random number generator given below to obtain a simple random sample of size 8 from the fifty lots and a stratified random sample of the same size and as defined by you in (b) above. Use different seeds for the simple and stratified random samples. Mention the seeds used.

UNIFORM RANDOM NUMBER GENERATOR

R FOLLOWS $U(0, 1)$

$X_i = 5X_{i-1} + 3 \pmod{16}$

$R_i = X_i/16$

(d) Estimate the population mean using the samples as obtained in (c) above for both the cases. Compare the estimates obtained with the known population mean of 64.024 and offer your comments.

(e) If the population mean is estimated repeatedly following the above stratified random sampling procedure for a large number of times then what should we expect as the variance of these estimates?

[3+5+8+ (5+3) +5=29]

15. Write short notes on the following:

(a) Systematic sampling

(b) 't' distribution

(c) R^2 statistic

[3x3=9]

INDIAN STATISTICAL INSTITUTE

Mid-Semester Examination: 2013-14 (Second Semester)

Course Name: M. TECH. (QROR) I Yr.

Subject Name: Instrumentation and Computer Engineering

Date: 28.08.14 Maximum Marks: 60 Duration: 2 Hrs 20 min

Answer any 5 questions.

1. Explain the operation of a full adder with circuit diagram and truth table. Show that a 3 bit addition can be realized with adders. [9+3=12]
2. Design a 4 bit R-2R ladder digital to analog (D/A) convertor. [12]
3. Derive the expression of the output voltage for a 6 bit weighted register digital-to-analog (D/A) convertor. The output of the D/A convertor is now connected with inverting terminal of an OP-AMP through a resistance $2R$. Derive the expression of the output analog voltage of the OPAMP for a feedback resistance of $4R$. [8+4=12]
4. What is an encoder? Explain the operation of an encoder with circuit diagram and truth table to encode the decimal numbers from 0 to 10. [2+10=12]
5. Design a shift register that can store a binary number 1010. Show the output of the register after each clock pulse for the same binary number. [12]
6. Design a 3 bit synchronous counter such that, the binary equivalent of the series 3, 4, 2, 1, 0, 6, 5, 7 and 3 can be realized at the output. [12]
7. What is a T type Flip flop? Show the working procedure of a 4 bit DOWN counter with circuit and timing diagram. [2+10=12]
8. Explain the operation of a J-K flip flop with truth table. What is race around condition? [9+3=12]

INDIAN STATISTICAL INSTITUTE

Second Mid-Semester Examination (2013 – 2014)

Course Name : M.Tech (QR & OR)
Subject : Industrial Engineering and Management
Date : 26/02/2014
Maximum Marks : 50
Duration : 120 minutes

Question Paper

Answer all questions

Marks: (2 X 5 + 10X 4 = 50)

1. For multiple choice questions, record your answer in your answer sheet indicating clearly the question number. [2 × 5]
- A. A good layout requires determining
- a. material handling requirements
 - b. capacity and space requirements
 - c. environment and aesthetics
 - d. cost of moving between various work areas
 - e. all of the above
- B. The main issue in designing process-oriented layout concerns the relative positioning of _____ to minimize cost of material handling.
- a. work stations
 - b. departments
 - c. raw materials
 - d. entrances, loading docks, etc.
- C. The following are true about stopwatch time except:
- a. Several repetitions are usually timed
 - b. A performance rating are usually necessary
 - c. There is no record of the method used by the worker
 - d. It is well studied for repetitive jobs
 - e. Jobs that have varying task requirements can pose some difficulty

D. Which of the following must be true in every case

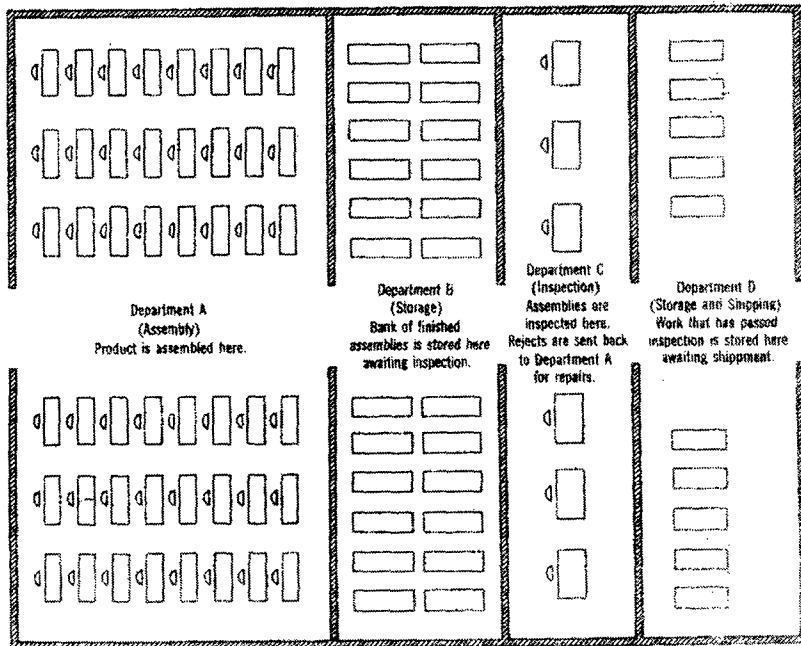
- a. the standard time > the normal time
- b. the normal time > the observed time
- c. the observed time < the mean time
- d. the mean time > the measured time of one performance of the operation
- e. the standard time < the normal time

E. The Dulac Box plant produces 500 cypress packing boxes in two 10-hour shifts. What is the productivity of the plant?

- a. 25 boxes/hr
 - b. 50 boxes/hr
 - c. 5000 boxes/hr
 - d. none of the above
 - e. not enough data to determine productivity
2. (a) Technology Innovation improves the productivity. Comment and justify with example.
(b) What is the scope of motion and time study? [5+5]
3. (a) State the major differences between the motion and time study practices.
(b) Construct a process chart and flow diagram for making coffee in an electric coffee maker. [5+5]
4. Crash the following network. [10]

Activity	Normal Time (Weeks)	Crash Time (Weeks)	Normal Cost	Crash Cost
1-2	12	7	3000	5000
2-3	8	5	2000	3500
2-4	4	3	4000	7000
3-4	0	0	0	0
4-5	4	1	500	1100
4-6	12	9	50,000	71,000
5-6	4	1	500	1100
6-7	4	3	15,000	22,000

5. (a) In one plant, as shown in following figure, small assemblies were made on semiautomatic machines in Department A. They were stored in Department B, inspected in Department C, and packed for shipment in Department D.
- State the problem in existing production line. Suggest the possible improvements.



- (b) The owner of a supermarket wants to change the existing conventional check-out operation to an electronic system. Suggest step-wise procedures to solve the above-mentioned problem.

[5+5]

INDIAN STATISTICAL INSTITUTE

M. Tech. (QR OR), I Year
Session: 2013-14, Semester II
Mid-Semestral Examination

Subject : Probability II

Date : 25.02.2014

Time : 2 hours

Maximum Marks : 60

Notes:

- (1) Unless Stated Otherwise, "M.C." will mean a discrete time parameter Markov Chain with stationary transition probabilities.
- (2) The symbols have their usual meanings.
- (3) Answer all the questions.

(1) Define the following:

- (a) Markov Chain
- (b) Transition probabilities
- (c) Stationarity of the transition probabilities

(3 × 5)=[15]

(2) Suppose $\{X_n | n = 0, 1, 2, \dots\}$ is a Markov Chain with state space $I = \{0, 1, 2, \dots\}$, transition probability matrix

$P = \left((p_{ij}) \right)_{i,j \in I}$ and initial distribution $\pi = (\pi(i))_{i \in I}$. Find an expression for:

$$P(X_0 = i_0, X_1 = i_1, \dots, X_n = i_n).$$

in terms of the initial distribution and the transition probability matrix.

[15]

(3) State and prove the Chapman – Kolmogorov equation

[15]

(4) A meter measuring a sequence of electric impulses records the highest voltage that has passed through it up to any given time. Suppose that the impulse passing through the meter at the n^{th} moment is Y_n . Assume that the probability distribution of Y_n is :

$$P(Y_n = k) = \frac{1}{M+1} \text{ for } k = 0, 1, \dots, M$$

(where M is a given positive integer)

Let X_n denote the meter reading at the n^{th} moment.

- (a) Show that $\{X_n | n = 0, 1, 2, \dots\}$ is a Markov Chain.
- (b) Find the state space and transition matrix of the Markov Chain

(5 + 10) = [15]

INDIAN STATISTICAL INSTITUTE

Mid-Semester Examination: 2013-14

Course Name : M. Tech. (QROR)

Subject Name: SQC II

Date: 24.02.14 Maximum Marks: 100

Duration: 2 hrs. 30 min.

Note: You can obtain maximum 80 marks from part I and 20 marks from part II

Part I: Answer any four questions

1. (a) A machine has four heads. Samples of $n = 3$ units are selected from each head, and the \bar{x} and R values for an important quality characteristic are computed. The data are shown here. Set up a group control chart for this process and interpret it.

Sample number	Head 1		Head 2		Head 3		Head 4	
	\bar{x}	R	\bar{x}	R	\bar{x}	R	\bar{x}	R
1	53	2	54	6	52	2	55	3
2	51	1	55	2	54	4	54	4
3	54	2	52	5	53	3	55	2
4	55	3	54	3	52	1	51	5
5	54	7	52	2	51	2	53	4
6	53	2	51	1	54	2	52	2
7	51	1	53	2	53	5	54	3
8	52	2	54	4	51	2	55	2
9	51	2	52	3	52	3	51	3
10	51	3	55	3	53	3	53	5
11	52	3	55	2	52	4	55	6
12	51	2	55	4	54	2	54	5
13	54	4	54	2	51	5	53	1
14	53	5	54	4	51	3	54	2
15	55	2	52	3	54	2	52	6
16	54	4	51	1	53	2	53	5

- (b) If $r = 4$ is the number of consecutive times that a particular stream is the largest (or smallest) value, then what will be the one-sided in-control average run length (ARL) for the above process?

[17+3 = 20]

2. (a) Consider a simple situation involving a process in which feedback adjustment is appropriate and highly effective. Suppose, the process output characteristic of interest at time period $t = y_t$ and the target value for the output variable = T . We wish to keep y_t as close as possible to the target T . This process has a manipulatable variable x and a change in x will produce all of its effect on y within one period, i.e. $y_{t+1} - T = gx_t$, where g is a constant usually called the process gain. Assume that disturbance can be predicted adequately using an EWMA and $0 < \lambda \leq 1$ is the weighting factor for the EWMA. Determine

- (i) the actual adjustment to the manipulatable variable made at time t and
(ii) the actual setpoint for the manipulatable variable at the end of period t

- (b) Explain the need for combining SPC and EPC for the monitoring of a process? Describe an approach for combining SPC and EPC.

[12 + 8 = 20]

3. (a) What do you mean by 'Economic Design of \bar{x} Chart'?

- (b) A \bar{x} chart is used to maintain current control of a process. The cost parameters are as follows: the fixed cost of sampling and testing is Rs 0.50 and the variable cost of sampling and testing is Rs 0.10 per unit, cost of finding and elimination of an assignable cause is Rs 25.00, cost of investigating a false alarm is Rs 50.00 and penalty cost per hour of production in out-of-control state is Rs. 100.00. Only a single assignable cause of magnitude $\delta = 2\sigma$ can occurs at random in the process according to a Poisson process with an intensity of 0.01 per hour. Sampling and testing require 0.05 hour., and it takes 2 hours to locate the assignable cause. Assume that Duncan's model for estimation of $E(L)$ is appropriate. Evaluate the cost of the arbitrary control chart design $n = 5, k = 3$ and $h = 0.5$.

[3 + 17 = 20]

4. (a) Describe a graphical approach and an analytical approach for detection of autocorrelation in process data.
- (b) The data shown here come from a production process with two observable quality characteristics, x_1 and x_2 . The data are sample means of each quality characteristic, based on samples of size $n = 25$. Assume that mean values of the quality characteristics and the covariance matrix were computed from 50 preliminary samples. These are:

$$\bar{\bar{\mathbf{x}}} = \begin{bmatrix} 55 \\ 30 \end{bmatrix} \text{ and } \mathbf{S} = \begin{bmatrix} 200 & 130 \\ 130 & 120 \end{bmatrix}$$

Construct a T^2 control chart using these data. Give phase-II limits. Assume $F_{0.001,2,239} = 7.10$

Sample no.	\bar{x}_1	\bar{x}_2
1	58	32
2	60	33
3	50	27
4	54	31
5	63	38
6	53	30
7	42	20
8	55	31
9	46	25
10	50	29

(6 + 14 = 20)

5. (a) Define the appropriate process capability indices (C_p , C_{pl} , C_{pu} and C_{pk}) for those process measurements which do not follow normal distribution.
- (b) State three commonly used approaches for fitting a distribution to the sample non-normal data.

- (c) Define a short run process. Can a run of 50000 toothpicks produced in a toothpick manufacturing organization be called a short run? Explain your answer. What is the simplest technique for monitoring the short run process?
- (d) State the following four models that may be used for modeling autocorrelated process data, x_t :
- (i) first-order autoregressive model
 - (ii) first-order moving average model
 - (iii) first-order mixed model
 - (iv) first-order integrated moving average model

[4+3 + 5 +8 = 20]

Part II: Assignments

[20]

INDIAN STATISTICAL INSTITUTE

Mid-Semester Examination : Semester II (2014-15)

M. TECH. (QR & OR) I Year

Reliability I

Date: 03.03.2013

Maximum marks: 70

Time: 2.30 hours

(Calculator is allowed. Answer as many as you can. Total mark is 75.)

1. (a) The systems $\phi_1(x_1, x_2, x_3, x_4)$ and $\phi_2(x_1, x_2, x_3, x_4)$ are defined by the following table, where '1' represents functioning and '0' represents non-functioning.

x_1	x_2	x_3	x_4	ϕ_1	ϕ_2
0	0	0	0	0	0
0	0	0	1	0	0
0	0	1	0	1	1
0	0	1	1	1	1
0	1	0	0	0	0
0	1	0	1	1	1
0	1	1	0	1	1
0	1	1	1	1	1
1	0	0	0	0	0
1	0	0	1	1	0
1	0	1	0	0	1
1	0	1	1	1	1
1	1	0	0	0	0
1	1	0	1	1	1
1	1	1	0	1	1
1	1	1	1	1	1

Is either ϕ_1 or ϕ_2 a coherent system? Explain.

- (b) Prove that, for a coherent system ϕ ,

$$\phi(\tilde{x} \amalg \tilde{y}) = \phi(\tilde{x}) \amalg \phi(\tilde{y}), \text{ for all } \tilde{x} \text{ and } \tilde{y}$$

if and only if the structure is parallel.

- (c) Let P_1, \dots, P_p denote the min path sets of a coherent system (C, ϕ) . Prove that $\cup_{j=1}^p P_j = C$.
- (d) Prove that the dual of a module of a coherent system ϕ is also a module of the dual ϕ^D .
- (e) Two bridge structures are arranged in parallel. Find structural importance of each component.

[4+5+5+5+6=25]

2. (a) Consider a coherent structure $\phi(\tilde{X})$ with $\tilde{X} = (X_1, \dots, X_n)$ denoting the vector of binary operational status of the components. Suppose the reliability of the i^{th} component is $p_i = P[X_i = 1] = E[X_i]$, $i = 1, \dots, n$. Explain the difference between

the notations $E[\phi(X)]$ and $h(\underline{p})$, where $\underline{p} = (p_1, \dots, p_n)$, specifying when and why these can be used to denote system reliability.

- (b) In a coherent system with independent components, $I_h(i)$ denotes the reliability importance of the i th component. This system is connected
- i. in series with another independent component first and then in parallel with another independent one.
 - ii. in parallel with another independent component first and then in series with another independent one.

In the bigger system (i) and (ii) above, will the reliability importance of the i th component be any different from $I_h(i)$? If so, how?

- (c) Consider a bridge structure with independent components having component reliabilities as $p_3 = 0.8$ and $p_j = 0.6$ for $j \neq 3$. Compute the tightest possible bounds for the system reliability.
- (d) Construct an example to show that, if $0 << \underline{p} << 1$ is violated, system reliability $h(\underline{p})$ may not be a strictly increasing function in all the p_i 's.
- (e) Let ϕ be a coherent structure of n associated components. Prove that

$$\text{cov}(\phi(\underline{X}), \sum_i^n X_i) \geq \text{var}(\phi(X))$$

[3+(2+2)+6+6+6=25]

3. (a) Write down the density of the lifetime of a k-out-of-n system using the results on order statistics when the component life time have i.i.d. exponential(λ) distribution.
- (b) Write down the joint p.d.f. of $(X_{(r)}, X_{(s)})$, where $r < s$, from a random sample of size n , where $X_i \sim F$.
- (c) For a stereo system with independent *exponential*(λ_i) component life times, for $i = 1, \dots, 5$, derive the system reliability.
- (d) Let F be the life distribution of a parallel system of two independent components having respective life distributions $F_1(t) = 1 - e^{-\lambda_1 t}$ and $F_2(t) = 1 - e^{-\lambda_2 t}$. Show that the F is IFR if and only if $\lambda_1 = \lambda_2$.
- (e) Let T have a Gamma distribution with pdf

$$f_T(t) = \frac{\lambda e^{-\lambda t} (\lambda t)^{\alpha-1}}{\Gamma(\alpha)}, \text{ for } t \geq 0; \alpha, \lambda > 0.$$

Prove if it is IFR or DFR and under what condition.

[6+3+4+7+5=25]

INDIAN STATISTICAL INSTITUTE
Mid- Semestral Examination: 2013-14

Course Name : M. TECH (QR-OR)-I
Subject Name : MECHANICAL ENGINEERING
Date: - 04.03.14
Note, if any :

Maximum Marks: 40

Duration: 2 hours

Answer *question no. 1* and *two* from the rest.

1. a) Give a block diagram of manufacturing process. Also show the inputs and output.
b) Sketch to show two mechanisms.
c) How is taper expressed? 3 + 3 + 4

2. a) What is tool life? When operating with roughing cuts on mild steel at 20 m/min, a certain tool gave a tool life of 160 minute between regrinds. Estimate the life of this tool on similar cuts at a speed of 28 m/min. Take the exponent of tool life as 0.125.
b) Discuss the different modes of tool failure. Write the essential properties of an ideal tool material. 8 + 7

3. a) Five holes are to be drilled on an ms plate of thickness 15 mm with 10 mm hss twist drill. The feed is 0.5 mm/rev. Assuming a suitable cutting speed, estimate the machining time.
b) Write the specification of a grinding wheel and explain it.
c) Sketch the following operations indicating the motions required:
i) Shaping a flat surface
ii) Turning operation in a lathe. 5 + 6 + 4

4. a) What is meant by machining operation?
b) Define a machine and a machine tool.
c) What is meant by volume removal rate in metal cutting operation? Derive an expression of the same in terms of the chief elements of metal cutting.
d) For cutting a 16 tpi thread on lathe having 4 tpi-lead screw, determine the change gears. 2 + 4 + 6 + 3

INDIAN STATISTICAL INSTITUTE
Mid - Semester Examination: 2013 – 14
M. Tech (QROR), E-Stream, Semester II
Statistical Methods – II

Date: 05.03.14

Maximum Marks: 60

Duration: 2 Hrs.

Note: Answer any three questions.

1. a) Define and explain the following
 - i) Point estimation and Interval estimation,
 - ii) Minimum variance bound estimator.
b) Suppose x_1, x_2, \dots, x_n be a random sample from normal distribution with mean μ and variance σ^2 with known μ . Show that $s^2 = \frac{1}{n} \sum_{i=1}^n (x_i - \mu)^2$ is a minimum variance bound estimator of σ^2 .

[5+3+12=20]

2. a) Let X be normally distributed with mean μ and variance σ^2 , where both μ and σ^2 are unknown. Find the maximum likelihood estimators of μ and σ^2 , based on a random sample of size n .

b) A research engineer for tyre manufacturer is investigating tyre life for a new rubber compound and has built 16 tyres of the same compound and tested them to end-of-life in a road test. The sample mean and standard deviation of the data thus obtained are 60139.70 and 3645.94 kilometers. Find a 95% confidence interval on mean tyre life.

[15+5=20]

3. a) Define and explain
 - i) Simple hypothesis and Composite hypothesis,
 - ii) Uniformly most powerful test.

b) The breaking strength of a certain type of fiber used in manufacturing of cloth is required to be greater than 160 psi. Past experience has indicated that the standard deviation of breaking strength is 3 psi. A random sample of four specimens is tested and average breaking strength is obtained as 158 psi.

- i) Should the fiber be judged acceptable at 5% level of significance?
- ii) What is the P-value for this test?

[6+4+7+3=20]

4. a) Two machines are used to fill plastic bottles with dishwashing detergent. The standard deviations of fill volume for the two machines are known to be $\sigma_1 = 0.15$ fluid ounces and $\sigma_2 = 0.12$ fluid ounces respectively. Two random samples of 12 bottles from machine 1 and 10 bottles from machine 2 are selected and the sample mean fill volumes are found as 30.87 fluid ounces and 30.86 fluid ounces respectively. Test the hypothesis that both machines fill to the same volume. Use $\alpha = 0.10$.

b) Consider the following frequency table of observations on the random variable X

Values	0	1	2	3	4
Frequency	5	20	10	13	2

Based on these 50 observations, is a binomial distribution with $n = 6$ and $p = 0.25$ an appropriate model? Perform a goodness-of-fit procedure with $\alpha = 0.05$.

[10+10=20]

INDIAN STATISTICAL INSTITUTE
M. Tech. (QR & OR), I Year, E-Stream
Session : 2013 – 2014, Semester II
Semestral Examination

Subject : Probability II

Date : 30.04.2014

Time : 3 hours

Max. Marks : 100

Notes :

- (1) Unless stated otherwise, "M.C." will mean a discrete time parameter Markov Chain with stationary transition probabilities.
- (2) The symbols have their usual meanings.
- (3) Answer all the questions.

Questions

(1) Define the following with respect to M.C. :

- (a) Class property, (b) Essential and Inessential states, (c) Recurrent and Transient states, (d) Recurrence time distribution of a Recurrent state, (e) Irreducible Markov Chain.

(5 × 3) = [15]

(2) Derive the relationship between the generating functions of the sequences $\{p_{ij}^{(n)}\}_{n=0}^{\infty}$ and $\{f_{ij}^{(n)}\}_{n=0}^{\infty}$.

[10]

(3) Suppose $i \in I$. Define

N_i = Total number of visits to state i at positive time points $n \in \{1, 2, \dots\}$.

(a) Show that $E(N_j | X_0 = i) = \sum_{n=0}^{\infty} p_{ij}^{(n)} - \delta_{ij}$ where $\delta_{ij} = \begin{cases} 1 & \text{if } i = j \\ 0 & \text{if } i \neq j \end{cases}$

(b) Show that for all $i, j \in I$

$$P(N_j = m | X_0 = i) = \begin{cases} 1 - f_{ij}^* & \text{if } m = 0 \\ f_{ij}^* (f_{jj}^*)^{m-1} (1 - f_{jj}^*) & \text{if } m = 1, 2, \dots \\ g_{ij} & \text{if } m = \infty \end{cases}$$

[Note : Prove all results that you use.]

(5 + 20) = [25]

(4) Consider a M.C. with state space $I = \{1,2,3,4,5,6\}$ and transition matrix

$$P = \begin{bmatrix} 1/2 & 1/2 & 0 & 0 & 0 & 0 \\ 3/4 & 1/4 & 0 & 0 & 0 & 0 \\ 1/8 & 0 & 0 & 0 & 7/8 & 0 \\ 1/3 & 1/3 & 0 & 0 & 0 & 1/3 \\ 7/8 & 0 & 0 & 0 & 1/8 & 0 \\ 0 & 0 & 1/2 & 0 & 1/4 & 1/4 \end{bmatrix}$$

- Find the return states and momentary states.
- Find the various classes of this chain.
- Find the recurrent and transient states.

Hint : For example, $f_{11}^* = \sum_{n=1}^{\infty} f_{11}^{(n)}$. Now,

$$\begin{aligned} f_{11}^{(1)} &= p_{11} = 1/2 \\ f_{11}^{(2)} &= P(1 \rightarrow 2 \rightarrow 1) \\ f_{11}^{(3)} &= P(1 \rightarrow 2 \rightarrow 2 \rightarrow 1) \text{ etc.} \end{aligned}$$

Also, use the fact that a recurrent state is necessarily essential.

(2 + 5 + 8) = [15]

(5) Show that the one-dimensional simple random walk on the integers $I = \{\dots, -2, -1, 0, 1, 2, \dots\}$ with transition probabilities

$$p_{ij} = \begin{cases} p & \text{if } j = i + 1 \\ q & \text{if } j = i - 1 \\ 0 & \text{otherwise} \end{cases}$$

(where $0 < p, q < 1$ and $p + q = 1$)

Is recurrent if and only if $p = q = \frac{1}{2}$.

[15]

(6) (a) Show that the sum of two independent Poisson processes is also a Poisson process.

(b) Suppose $\{N(t) | t \geq 0\}$ is a Poisson process with parameter $\lambda > 0$. Show that for $0 < s < t$,

$$P(N(s) = k | N(t) = n) = \binom{n}{k} \left(\frac{s}{t}\right)^k \left(1 - \frac{s}{t}\right)^{n-k} \text{ for } k \in \{0, 1, \dots, n\}.$$

(8 + 12) = [20]

INDIAN STATISTICAL INSTITUTE
Semester Examination : Semester II (2013-14)
M. TECH. (QR & OR) I Year

Reliability I

Date: 28.04.2014

Maximum marks: 100

Time: 3 hours

(Calculator and RMM Table needed. Answer as many as you can. Total mark is 103.)

1. State if the following statements are true or false giving suitable reasons.
 - (a) For a 3-out-of-7 system with identical but associated components each having reliability p , the system reliability is greater than p^4 .
 - (b) Consider a discrete lifetime random variable with finite number of mass points. The sum of its hazard can not be less than 1.
 - (c) It is possible to simulate life time of a series system with two independent components each having exponential (λ) life distribution, using only one random number u from $\mathcal{U}[0, 1]$.
 - (d) Consider a device with random strength X following exponential (λ) distribution. The stresses acting on it at n different cycles are *iid* random variables following exponential (α) distributions. The device fails during a cycle if the stress in that cycle exceeds the strength. If stress distributions are independent of strength distribution then the reliability of the component at n th cycle is $\frac{\lambda}{\lambda+\alpha}$.
 - (e) Consider Type II censored data from $\exp(\lambda)$ life distribution. The maximum likelihood estimator of the expected lifetime is biased.

[3+3+3+3+3=15]

2.
 - (a) Prove that the min path sets of a coherent system are the min cut sets of its dual.
 - (b) The minimal path sets of a coherent structure are $\{1, 2, 4\}$, $\{1, 3, 5\}$ and $\{5, 6\}$. What are the minimal cut sets of the structure?
 - (c) Consider a coherent system with iid components each having reliability p and the system reliability is $h(p)$. Let N be the random variable denoting the number of minimal cut sets having all of its components failed.
 - i. Write $h(p)$ in terms of the probability distribution of N .
 - ii. Show that $P(N > 0) \geq \frac{E^2(N)}{E(N^2)}$.
 - iii. Hence, prove that $h(p) \leq \frac{\text{Var}[N]}{E[N^2]}$.

[4+6+(2+6+2)=20]

3.
 - (a) Write down the density of a guaranteed Weibull life distribution, clearly specifying the support of the random variable and the parameter space.
 - (b) Suppose T follows a Weibull distribution. Construct discrete variable T_d as $T_d = [T]$, the integer part of T . Derive the hazard rates of T_d and hence comment on its IFR or DFR property.

P.T.O

- (c) If the distribution F is a continuous IFR with mean μ , then show that $\log \bar{F}(t)$ is convex in t .

[3+(3+2)+4=12]

4. (a) Consider an three-unit passive redundant system with failure rates of all the three units are λ , a constant. If the switch is imperfect and having a constant failure rate λ_s , find the reliability function of the system.
- (b) Compute the expected system lifetime of a 3-out-of-4 system when the first two components lifetimes are uniform on $(0, 1)$ and the second two are uniform on $(0, 2)$.
- (c) Consider a device with random strength X following exponential (α) distribution. This device is subjected to two independent shocks arriving at prefixed times t_1 and t_2 ($t_1 < t_2$) causing random and independent amount of damages Y_1 and Y_2 , respectively, to the device. These two damages are also independent of the strength X and each follows exponential (λ) distribution. The device fails when the cumulative damage at any time is greater than its strength. Find the reliability of the device at time t .
5. (a) Describe hybrid censoring. Derive the distribution of the number of observations in the hybrid censored data when lifetime distribution is F .
- (b) Consider the following data on seconds to breakdown of 12 items with + indicating right censoring.

50, 134, 187, 882, 1450, 1470, 2290, 2930, 4180, 15800, 15800+, 15800 + .

Identify the censoring scheme that generated this data. Check validity of exponential distribution of the corresponding lifetime variable. Assuming exponential(λ) life distribution, obtain exact and appropriate 95% confidence interval for λ .

[(2+4)+(1+10+2+2)=21]

6. Consider randomly censored life time data on products from two different brands, the i th brand having n_i products under consideration, for $i = 1, 2$. The life time T_i of a product of i th brand has a Weibull distribution with parameters λ_i and α (independent of i). The interest is to test for homogeneity of the two brands. Formulate the null hypothesis. Develop an asymptotic test giving details of the method.

[2+8=10]

INDIAN STATISTICAL INSTITUTE

Second-Semester Examination: 2013-14

Course Name: M. TECH. (QROR) I Yr.

Subject Name: Instrumentation and Computer Engineering

Date: 02.05.14

Maximum Marks: 96

Duration: 3 Hrs

Answer any 6 questions.

1. Show the classification of input type and passive type transducers with examples. Discuss about the operational procedure of an electromagnetic transducer and rectilinear type capacitor.
[(4+4)+(5+3)=16]
2. a) What are the advantages of automatic control system? Draw the block diagram of an automatic control system and describe its components.
b) Explain the operational procedure of a PD controller with related equations for any one type of error signal. What are the advantages of a PD controller over a P controller?
[(3+5)+(5+3)=16]
3. Draw the circuit diagram of a 4 bit dual-slope analog-to-digital (A/D) convertor and explain its operational procedure. [16]
4. a) Derive the expression of the output voltage for an n bit weighted register digital-to-analog (D/A) convertor.
b) The output of the D/A convertor is now connected with the inverting terminal of an OP-AMP through a resistance $2R$. The non-inverting terminal of the OP-AMP is connected to a 4 volt source. Derive the expression of the output analog voltage of the OPAMP for a feedback resistance of $4R$.
[10+6=16]
5. Explain the operation of a master slave JK flip flop with truth table for all possible combinations of input bits. Why master slave JK flip flop is more advantageous than JK flip flop? [12+4=16]
6. What are the advantages of a content addressable memory (CAM)? Explain the operation of a CAM, for finding a matched word, with block diagram and circuit diagram. [3+13=16]

7. a) Negate 7 using 32-bit signed binary representation and then negate it again to check the result.
- b) Define normalized scientific notation with example.
- c) Give an example of exponent overflow by adding two numbers using IEEE 754 binary representation and 32 bit precision.
- d) Show the IEEE 754 binary representation of the number -0.75 in 32 bit precision. [4+3+4+5=16]
8. a) Why registers are included in the CPU? Explain the procedure of transferring data from registers to ALU and then ALU to registers, within a CPU.

b) The binary OPR selects (codes) for performing various micro-operations in ALU are as follows:

OPR Select	Operation	Symbol
00000	Transfer A	TSFA
00001	Increment A	INCA
00010	Add A + B	ADD
00101	Subtract A - B	SUB
00110	Decrement A	DECA
01000	AND A and B	AND
01010	OR A and B	OR
01100	XOR A and B	XOR
01110	Complement A	COMA
10000	Shift right A	SHRA
11000	Shift left A	SHLA

Find the 14 bit control words for performing the following operations and storing the results using 7 CPU registers

- Register2 ← input +1
- Register4 ← input -1
- Register5 ← (Register2 Content) XOR (Register4 Content)
[(2+7)+(2+2+3)=16]

9. a) Show the sequence of micro-operations for performing PUSH and POP operation in a 64 word register stack.

b) Find the reverse polish notation for the expression $(2 \times 6) + (3 \times 3)$ and show the related stack operations with diagrams. [(5+5)+(2+4)=16]

INDIAN STATISTICAL INSTITUTE
Second Semestral Examination: 2013-14

Course Name : M. TECH (QROR)-I
Subject Name : MECHANICAL ENGINEERING
Date: 05.05.2014 Maximum Marks: 100 Duration: 3 hours
Note, if any :

*Answer any five questions.
Assume suitable data if necessary.*

1. a) Define tolerance. What are unilateral and bilateral tolerances? State and explain the different types of fit in hole basis system. Give necessary sketches.
b) Explain the different terms of assembly 40 H8/g6.
c) What is meant by form error in machining? Discuss the different causes of machining errors. 8 + 4 + 8
2. a) With the help of neat sketch, discuss the working principle of Talysurf.
b) What is meant by R_a value of surface roughness? Calculate the R_a value of surface roughness for which the sampling length is 0.8 mm. The graph has been drawn with a vertical magnification of 10000 and a horizontal magnification of 100, and the areas above and below the datum line are
- | | | | | | |
|--------|-----|----|-----|-----|---------------|
| Above: | 180 | 90 | 155 | 55 | mm^2 |
| Below: | 70 | 90 | 170 | 155 | mm^2 |
- Why is the vertical magnification so high in comparison to the horizontal magnification?
c) What are effects of surface roughness on the performance of a machined component? 8 + 6 + 6
3. a) Draw the stress-strain diagram of ductile material and show the important points on it.
b) Discuss about the Tresca's and von Mises' criteria in connection with metal forming operation.

OR

Show the variation of net interatomic force with interatomic distance and explain it. Also discuss about the mechanics of slip in perfect crystal. 10 + 10

4. a) What are forward and backward extrusion processes? Explain them with necessary sketches.
b) What is meant by High-Energy-Rate-Forming process? With suitable examples explain its necessity.
c) Distinguish between hot forming and cold forming processes. 8 + 6 + 6

5. a) Explain why the non conventional machining processes are used.
- b) With help of neat sketch(es), explain the abrasive jet machining process. Show the variation of material removal rate in abrasive jet machining process with the mixing ratio, abrasive mass flow rate and nozzle tip distance.
- c) Briefly discuss the process of electrochemical machining. 4 + 10 + 6
6. a) State the quantities on which the depth to which the melting temperature of the material depends in case of electron beam welding process and hence, through dimensional analysis establish the necessary relation.
- b) During drilling a hole in a tungsten work piece by electron beam welding process, the accelerating voltage of 150 kV is used. If the density of tungsten is 7.6×10^{-6} kg/mm³, determine the electron range. 16 + 4
7. a) What is meant by productivity in metal cutting? Find out the expression for the same in terms of chief elements of metal cutting.
- b) Define cutting speed in metal cutting. State the factors on which it depends.
- c) A grinding wheel is specified as
A-36-L-8-V.
- Explain all the terms of it.
- d) Give sketches indicating the motions for the following operations:
 i) facing operation in lathe ii) milling a flat surface. 5 + 5 + 5 + 5
8. a) What is tool life? When operating with roughing cuts on mild steel at 18 m/min, a certain tool gave a tool life of 3 hours between regrinds. Estimate the life of this tool on similar cuts at a speed of 24 m/min. Take the exponent of tool life as 1/8.
- b) Discuss the different modes of tool failure in metal cutting operation.
- c) A single point turning tool is used to turn a cast iron job of diameter 40 mm. The length of the job is 125 mm and the feed is 0.5 mm/rev. If the permissible cutting speed for the operation is 18 m/min, find out the machining time for 4 passes.
- d) What is a NC machine tool? 7 + 5 + 5 + 3

INDIAN STATISTICAL INSTITUTE
Semester Examination: 2013 – 14
M. Tech (QROR), E-Stream, Semester II
Statistical Methods – II

Date: 05.05.2014

Maximum Marks: 100

Duration: 3 Hrs.

Note: Answer any five (5) questions.

1. a) Let x_1, x_2, \dots, x_n be random sample from a normal distribution with known variance σ^2 and unknown mean μ . Use likelihood ratio test to define the critical region for testing the following hypothesis:

$$H_0 : \mu = \mu_0$$

$$H_1 : \mu \neq \mu_0$$

- b) A company operates four machines in three shifts each day. From production records, the following data on the number of machine breakdowns are collected.

Shift	Machines			
	A	B	C	D
1	41	20	12	16
2	31	11	9	14
3	15	17	16	10

Test the hypothesis (using $\alpha = 0.05$) that breakdowns are independent of the shift.

[10+10 = 20]

2. a) Consider a two factor factorial experiment, where both the factors A and B are assumed to be fixed factors. The response variable is modeled as follows:

$$y_{ijk} = \mu + \tau_i + \beta_j + (\tau\beta)_{ij} + \varepsilon_{ijk} \begin{cases} i = 1, 2, \dots, a \\ j = 1, 2, \dots, b \\ k = 1, 2, \dots, n \end{cases}$$

where μ is the overall mean effect, τ_i is the effect of the i th level of factor A , β_j is the effect of the j th level of factor B , $(\tau\beta)_{ij}$ is the interaction effect between A and B and ε_{ijk} is the random error component following $N(0, \sigma^2)$.

Write down the hypotheses that need to be tested for such a model and show that under the corresponding null hypothesis mean square A (MS_A) is an unbiased estimate of σ^2 .

b) The response time in milliseconds was determined for three different types of circuits in an electronic calculator. The results recorded are as under.

Circuit Type	Response Time (in ms)				
	1	16	15	18	26
2	19	22	20	18	25
3	20	21	33	27	40

Does the circuit type affect the mean response time? Use $\alpha = 0.05$.

[12+8 = 20]

3. A mechanical engineer is studying the thrust force developed by a drill press. He suspects that the drilling speed and the feed rate of the material are the two important factors. He selects four feed rates and uses a high and a low drill speed to represent the extreme operating conditions. He obtains the following experimental results.

Drill Speed	Feed Rate			
	0.015	0.030	0.045	0.060
Low	2.70	2.45	2.60	2.75
	2.78	2.49	2.72	2.86
High	2.83	2.85	2.86	2.94
	2.86	2.80	2.87	2.88

- State the hypotheses of interest in this experiment.
- Suitably analyze the data and draw your conclusion using analysis of variance with $\alpha = 0.05$.
- Use Fisher's least significant difference method to compare the average thrust force developed at each level of 'Feed Rate'. Use $\alpha = 0.05$.

[3+10+7=20]

4. Linear regression methods were used to analyze the data from a study investigating the relationship between compressive strength (x) and intrinsic permeability (y) of various concrete mixes and cures. Summary quantities are given in the following page:

$$n = 14, \sum y_i = 572, \sum y_i^2 = 23,530, \sum x_i = 43,$$

$$\sum x_i^2 = 157.42 \text{ and } \sum x_i y_i = 1697.80.$$

- a) Calculate the least square estimates of the slope and intercept.
 - b) Test the significance of regression using analysis of variance. Use $\alpha = 0.05$.
 - c) Find 95% confidence interval for the intercept.
 - d) Find 95% prediction interval on permeability when the compressive strength is 2.5.
- [4+5+5+6=20]

5. a) The diameter of a ball bearing was measured by 12 inspectors, each using two different kind of calipers. The results were as follows:

Inspector	Caliper 1	Caliper 2
1	0.265	0.264
2	0.265	0.266
3	0.266	0.264
4	0.267	0.266
5	0.267	0.267
6	0.265	0.268
7	0.267	0.264
8	0.267	0.265
9	0.265	0.265
10	0.268	0.267
11	0.265	0.269
12	0.266	0.268

Is there a significant difference between the medians of the populations of measurements represented by two samples? Use Wilcoxon signed rank test with $\alpha = 0.05$.

b) A random sample of size 10 gives following observations: 0.621, 0.503, 0.203, 0.477, 0.710, 0.581, 0.329, 0.480, 0.554, and 0.382. Can it be assumed that above data comes from a standard uniform distribution, $U(0,1)$? Use one sample Kolmogorov Smirnov test with $\alpha = 0.05$.

[10+10=20]

6. a) An experiment was performed to investigate the effect of three different conditioning methods on breaking strength of cement briquettes. The data are shown in the following table. Is there any indication that conditioning method affects breaking strength? Use Kruskal Wallis test with $\alpha = 0.05$.

Conditioning Method	Breaking Strength (lb/in ²)				
	1	550	568	541	537
2	599	579	545	540	535
3	530	528	510	571	520

- b) Assuming $A = \frac{1-\beta}{\alpha}$ and $B = \frac{\beta}{1-\alpha}$, obtain the expression for the sequential testing procedure for testing the hypothesis

$$H_0 : \mu = \mu_0$$

$$H_1 : \mu = \mu_1$$

where the random variable X follows normal distribution with known variance σ^2 . Explain the test procedure thus obtained. [α , β are the probability of type I and type II error respectively]

[10+10=20]

INDIAN STATISTICAL INSTITUTE

Second Semestral Examination: 2013-14

Course Name : M. Tech. (QROR)

Subject Name : SQC II

Date : 07.05.2014 Maximum Marks: 100 Duration: 3 hours

Note : Symbols are having their usual meaning

Answer any five questions

1. (a) A product has two quality characteristics, x_1 and x_2 . The nominal values of these quality characteristics and their sample covariance matrix have been determined from the analysis of 30 preliminary samples of size 10 as follows:

$$\bar{\bar{\mathbf{x}}} = \begin{bmatrix} 3.0 \\ 3.5 \end{bmatrix} \text{ and } \mathbf{S} = \begin{bmatrix} 1.40 & 1.02 \\ 1.02 & 1.35 \end{bmatrix}$$

At a time point t , the values of x_1 and x_2 are found to be 3.1 and 3.7 respectively.

- (i) Compute the T^2 value at time point t .
- (ii) State Phase-II control limits of the T^2 control chart that may be used for joint monitoring of the means of the two quality characteristics.
- (b) Describe the principles of model-based approach and model-free approach for monitoring autocorrelated process data.

[(5+3) + 12 = 20]

2. (a) State the definition of 'quality' given by G. Taguchi. Mention two internal noise factors and two external noise factors that are usually responsible for functional variation of a product.
- (b) Let m be the ideal value for the length of a component part. The specification of the component part is $m \pm \Delta$ and the loss sustained at the specification terminal points is 'A'. Determine the average loss per product due to variation.

(c) The quality of a product is defined by two characteristics: Brinell hardness number (BHN) and circular diameter. The specifications of these characteristics are:

Hardness in BHN: 250 ± 5

Diameter : 1.0000 ± 0.002 inch

The following BHN measurements were taken:

248	250	249	252	253
249	247	249	250	251
250	249	248	250	251
249	245	246	249	254

The following measurements of the diameter were also taken:

1.0010	1.0020	1.0015	1.0009	1.0019
0.9998	0.9999	1.0020	1.0011	0.9997
0.9980	1.0010	1.0009	0.9996	0.9990
1.0000	1.0013	1.0009	1.0009	1.0009

The loss caused by unacceptable BHN is ₹ 20 and the loss caused by unacceptable diameter size is ₹ 30. What is the total expected loss caused by deviations from target values?

$$[(2 + 2) + 6 + 10 = 20]$$

3. (a) Let us consider a quality control system where the process is diagnosed on every 'n' production units by checking a product. If the process is found abnormal, then it is recovered to the normal condition. On the other hand, if the process is found to be normal, the production is continued without any recovering operation. Suppose, loss due to producing one unit of product under abnormal production process is A , cost of a diagnosis is B , adjustment cost is C , average trouble occurrence interval is \bar{u} and the time lag of diagnosis is l . Determine the optimal diagnosis interval for this quality control system.
- (b) A \bar{x} chart is used for monitoring of a quality characteristic. Only a single assignable cause can occur at random in the process according to a Poisson process with an intensity of λ occurrences per hour. Samples are taken at

intervals of h hours. The probability of getting a false alarm is α . Derive the expected number of false alarms within a production cycle?

[12 + 8 = 20]

4. (a) At a production process of ring hollowing of automobile part two types of defectives occur where one type is reworkable defective and is 20% of all defectives and the other type is non-reworkable defective and is 80% of all defectives. The loss due to producing one reworkable defective item is ₹ 60/- and the loss due to producing one non-reworkable defective item is ₹ 500/-. Diagnosis cost is ₹ 15/- and adjustment cost is ₹ 9800/-. During last one month, 2 machine-troubles occurred while the total production was 8500 items. Time lag is 4 items. The tool cost within the adjustment cost is ₹ 2500/-. Now, tool with longer life than the present one has come into market with unit cost of ₹ 12000/-. Find how many times the expected life of this new tool has to be of the present one such that it is profitable to use this new tool instead of the present one. Assume when machine trouble occurs, the adjustment is done by changing the tool.
- (b) A ChSP-1 plan has $n = 4$, $c = 0$ and $i = 3$. Estimate the probability of acceptance when the process average $p = 0.10$.

[12+8 = 20]

5. (a) The target value of a quality characteristic of a chemical process is y_0 . The quality characteristic is measureable and adjustable. After an interval of Δ , the value of the quality characteristic is measured (predicted) and instead of adjusting the whole gap between the measured and the target values, β times the gap is adjusted (β is nonnegative). Determine the optimal value of β .
- (b) State two advantages and two disadvantages in the approach for estimation of process capability indices by transforming non-normal data into a normal data.
- (c) Discuss about the sensitivity of the following errors on the economic design of \bar{x} chart:
- i) Errors in the estimates of cost coefficients and

ii) Error in the estimate of the magnitude of shift (δ).

[12+4+4 = 20]

6. (a) State the main characteristic of a 'short run' process.

(b) Use the following data to set up appropriate short-run \bar{x} and R charts, assuming that the standard deviations of the measured characteristic for each part type are not the same. The nominal dimensions for each part are $T_A = 100$, $T_B = 200$ and $T_C = 300$.

Sample no.	Part type	Measurements			
		M1	M2	M3	M4
1	A	120	95	100	110
2	A	115	123	99	102
3	A	116	105	114	108
4	A	120	116	100	96
5	A	112	100	98	107
6	A	98	110	116	105
7	B	230	210	190	216
8	B	225	198	236	190
9	B	218	230	199	195
10	B	210	225	200	215
11	B	190	218	212	225
12	C	450	530	200	225
13	C	500	416	300	250
14	C	200	300	415	290
15	C	268	550	460	400
16	C	800	525	775	690
17	C	300	200	530	260
18	C	260	280	400	450
19	C	620	450	200	240
20	C	460	250	350	425

[2 + 18 = 20]

7. (a) Describe the procedure of continuous sampling plan CSP-1 using flow diagram.

(b) A press process has the following parameters: $A = ₹ 300/-$, $B = ₹ 50/-$ and $l = 1$ product. The loss due to interrupting this process by one minute is ₹ 200/-. There

exist two types of troubles of which one involves a reset of press pattern and the other involves a repair of press pattern. Their elements are shown below:

Type of adjustment required	Average interruption time (t)	Direct adjustment cost (C_d)	Number of units between adjustments	Total adjustment cost ($C = C_r \times t + C_d$)
1) Reset of pattern	5 min	₹ 300/-	$\bar{u}_1 = 250$	$C_1 = 200 \times 5 + 300$ $= ₹1300/-$
2) Repair of pattern	8 hrs	₹ 50000/-	$\bar{u}_2 = 20,000$	$C_2 = 200 \times 480 + 50000$ $= ₹146000/-$

It is decided to introduce a spare press m/c which can be used for replacement of the regular press m/c. whenever the regular press m/c has a trouble so that the production process can be continued. It takes only 5 minutes for the replacement. However, the process has to be interrupted for that 5 min. The cost of the spare m/c is ₹ 5000000 and the annual interest rate is 15%. The loss for having such a machine is only the interest and the cost due to its occupancy space. The cost due to occupied space is ₹ 150000/-. Assume that the annual production is 3000000 units. What is the effect of introducing the spare machine?

[5 + 15 = 20]

INDIAN STATISTICAL INSTITUTE

Second End-Semester Examination (2013 – 2014)

Course Name : M.Tech (QR & OR)
Subject : Industrial Engineering and Management
Date : 09.05.2014
Maximum Marks : 50
Duration : 120 Minutes

Question Paper

Direction: Question 6 is compulsory. Attempt Any four questions from rest. All questions carry equal marks.

1. (a) What do you mean by 'financial management'? State main objectives of financial management.
(b) Produce a typical balance sheet and explain its major important components. [5+5]

2. (a) Explain 'Time Value for Money'.
(b) Given the following four projects and their cash flows, calculate the discounted payback period with a 5% discount rate, 10% discount rate, and 20% discount rate.
What do you notice about the payback period as the discount rate rises? Explain this relationship.

Projects	A	B	C	D
Cost	Rs.10,000	Rs.25,000	Rs.45,000	Rs.100,000
Cash Flow Year One	Rs.4,000	Rs.2,000	Rs.10,000	Rs.40,000
Cash Flow Year Two	Rs.4,000	Rs.8,000	Rs.15,000	Rs.30,000
Cash Flow Year Three	Rs.4,000	Rs.14,000	Rs.20,000	Rs.20,000
Cash Flow Year Four	Rs.4,000	Rs.20,000	Rs.20,000	Rs.10,000
Cash Flow year Five	Rs.4,000	Rs.26,000	Rs.15,000	Rs.10,000
Cash Flow Year Six	Rs.4,000	Rs.32,000	Rs.10,000	Rs.0

[3+7]

3. (a) What is ROCE? Explain its advantages and disadvantages.

(b) As the Chief Financial Officer of the Orient Express, you are offered the following two mutually exclusive projects.

Year	Cash Flows (Rs.)	
	Project A	Project B
0	-5,000	-100,000
1	3,500	65,000
2	3,500	65,000

(i) What are the IRRs of these two projects?

(ii) If you are told only the IRRs of the projects, which would you choose?

(iii) According to the NPV rule, which of these two projects should be pursued?

Again, assume a 15% discount rate.

[3+7]

4. A firm has decided to acquire a new machine to neutralise the toxic waste produced by its refining plant. The machine would cost Rs 6.4 million and would have an economic life of five years.

Capital allowances (CAs) of 25% per annum on a reducing balance basis are available for the investment.

Taxation of 30% is payable on operating cash flows, one year in arrears.

The firm intends to finance the new plant by means of a five year fixed interest loan at a pre-tax cost of 11.4% per annum, principal repayable in five years' time.

As an alternative a leasing company has proposed a finance lease over five years at Rs 1.42 million per annum payable in advance.

Scrap value of the machine under each financing alternative will be zero.

Evaluate the two options for acquiring the machine and advise the company on the best alternative.

[10]

5. (a) Explain the strategic business plan of manufacturing planning and control.

(b) What is MRP II?

[5+5]

6. Assignment (to be submitted on the day of examination).

[10]