

Mid-Semester Examination : 2011-12

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

Subject Name : Electrical and Electronics Engineering

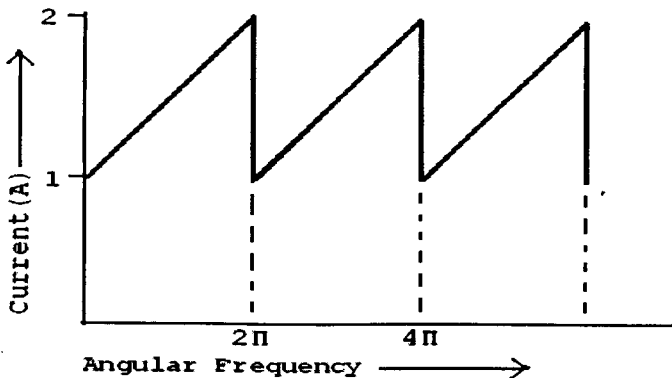
Date : 2.9.11

Maximum Marks : 50

Duration : 2Hrs

Answer any 5 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) 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. [2+8=10]
2. 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 $V_0 e^{j\omega t}$. [10]
3. a) Mention True or False
 - i) In a circuit, maximum power is absorbed by the load resistance when the load resistance is equal to the Norton equivalent resistance.
 - ii) Kirchhoff's voltage law states that the algebraic sum of the voltage drops flowing to a point must be zero.
 - iii) The average value of an AC current is zero.
 b) Calculate the average and r.m.s. value of current represented in figure below. [3+7=10]



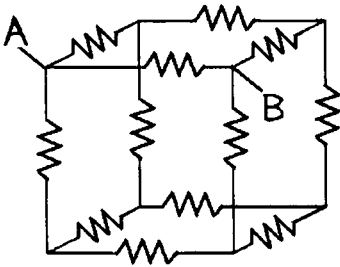
4. a) Explain the maximum power transfer theorem.

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]

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

b) A series RL 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. [3+7=10]

6. 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. [10]



7. a) Derive the octal equivalent of the decimal number 75.25

b) Show that an OR gate can be realized with diodes, batteries and resistances.

d) Construct an OR gate with AND and NOT gates. [2+5+3=10]

INDIAN STATISTICAL INSTITUTE

Mid-Semestral Examination : 2011 – 12

M.TECH. (QROR) I Year, E-Stream

Statistical Methods – I

Date : 02/09/2011

Maximum Marks :100

Duration : 3 hours

Note: *The paper carries 118 marks. Answer as much as you can but the maximum you can score is 100. You can answer any part from any question.*

- (a) What are raw and grouped data? What are the considerations in constructing a frequency distribution for a continuous characteristic?
(b) Illustrate, with an example, the method of drawing a histogram for a frequency distribution when the class intervals are of unequal width? Which is the modal class in your example?
(c) Compute the median for the example considered in part (b). [State the general formula, used for such computations, clearly.]

$$(2 + 4) + (5 + 1) + 5 = [17]$$

- Let \bar{x}_{wt} be the weighted arithmetic mean of x_i 's with positive weights $w_i, i = 1, 2, \dots, n$. Show that

$$\left(\sum_{i=1}^n w_i \right) \left(\sum_{i=1}^n w_i (x_i - \bar{x}_{wt})^2 \right) = \sum_{i=1}^{n-1} \sum_{j>i}^n w_i w_j (x_i - x_j)^2$$

[10]

- A man invested a certain amount of money for a period of 30 days. For the first 13 days his fund grew at the rate of 2% per day, for the next 8 days the fund grew by 3% per day and for the last 9 days it grew at the rate of 1% per day. What was the average rate of daily growth of the investment over these 30 days? What was the value of the fund at the end of 15th day for an initial investment of ₹100,000/-?

$$(5+2) = [7]$$

- Define mean absolute deviation and mean square deviation about A . What values of A will minimize these two deviations? Prove both of your claims.

$$(1\frac{1}{2} \times 2) + (1 \times 2) + (8+4) = [17]$$

- What is dispersion? What are common measures of dispersion? What is meant by relative dispersion? Give a measure of relative dispersion. How this measure of yours is affected by a change of scale and/or origin?

$$(2+4+2+1+4) = [13]$$

- The first of the two samples has 100 units with mean 15 and standard deviation 3. If the whole group formed by pulling both the sample has 250 units with a mean of 15.6 and standard deviation $\sqrt{13.44}$, find the standard deviation of the second sample. Which of the two samples has larger variability with respect to the individual values? Justify.

$$(5 + 2) = [7]$$

- Express the 4th sample raw moment m_4' (i.e. 4th moment about origin zero) in terms of sample raw moment m_1' (about origin zero) and central moments m_2, m_3, m_4 (about origin arithmetic mean).

[5]

8. (a) What is the meaning of skewness? Propose three measures of skewness of which at least one should involve only moments. Distinguish between positive and negative skewness, by drawing figures. What is the relation between the arithmetic mean, median and mode for a negatively skewed distribution?

(b) Prove that $b_2 - b_1^2 - 1 \geq 0$, where $b_1 = \frac{m_3}{m_2^{3/2}}$ and $b_2 = \frac{m_4}{m_2^2}$.

$$(2 + 3 \times 2 + 3 + 1) + 9 = [21]$$

9. The following table 1 gives the bivariate frequency distribution of annual income (x) and expenditure on entertainment (y) in a year for 100 families. Compute the correlation coefficient between x and y . Interpret this value of the correlation coefficient obtained by you.

Table 1: Bivariate Frequency Distribution of Annual Family Income ('00 Rs.) and Annual Family Expenditure on Entertainment ('00 Rs.)

Expenditure on Entertainment (y)	Annual income (x)									
	25 – 80	80 – 135	135 – 190	190 – 245	245 – 300	300 – 355	355 – 410	410 – 465	465 – 520	520 – 575
45 – 50										1
40 – 45									3	2
35 – 40							2	3	2	
30 – 35						1	4	6	2	
25 – 30					1	4	4	5	1	
20 – 25					3	5	7	12		
15 – 20				3	4	8	1			
10 – 15		1	1	4	1					
5 – 10		1	4							
0 – 5	4									

$$(18+3) = [21]$$

INDIAN STATISTICAL INSTITUTE
M.Tech (QR & OR) 1st YEAR (E & S Streams)
Session: 2011-2013
MIDSEMESTRAL EXAMINATION

Subject: Operations Research-I

Date of Exam : 05.09.11

Total Marks: 100

Time : 3 hrs.

Assignment: 30 marks

Answer as many questions as you can. The maximum you can score is 70.

1. What are the different OR techniques you have heard about? Cite two performance measures usually being considered for optimization [5+2=7]
2. What is the difference between deterministic models and probabilistic models? Can you give a real-life example? [2½+2½=5]
3. A fuel manufacturing company wants to mix two fuels (*A* and *B*) for its trucks to minimize cost. It needs no fewer than 3,000 litre to run its trucks during the next month. It has a maximum fuel storage capacity of 4,000 litre. There are 2,000 litre of fuel *A* and 4,000 litre of fuel *B* available. The mixed fuel must have an octane rating of no less than 80. The octane rating is the weighted average of the individual octanes, weighted in proportion to their respective volumes. Fuel *A* has an octane of 90 and costs Rs. 80 per litre. Fuel *B* has an octane of 75 and costs Rs. 60 per litre. Formulate this product mix problem as a LPP. [8]
4. Write down the general formulation of a LP problem. Explain the basic assumptions in solving an LP problem. [3+7=10]
5. Define linear dependence and independence of vectors. Show that the set of vectors $\mathbf{a}^1 = (2,1,4)$, $\mathbf{a}^2 = (1,-1,2)$ and $\mathbf{a}^3 = (3,1,-2)$ forms a basis in E_3 . [4+6=10]

6. Define Extreme points of a Convex set. Prove that if the set of all feasible solutions K of a LPP is a Convex Polyhedron, then at least one extreme point must be obtained.

[4+6=10]

7. Show that the following system of linear equations has two degenerate b.f.s. and the non-degenerate basic solution is not feasible. [8]

$$3x_1 + x_2 - x_3 = 3$$

$$2x_1 + x_2 + x_3 = 2$$

8. Develop your own set of constraint equations to illustrate graphically the cases of redundancy and degeneracy while solving an LP problem. [8]
9. Explain how a change in a technological coefficient can affect a problem's optimal solution. How can a change in resource availability affect a solution? [3+3=6]
10. What is the role of an artificial variable in Simplex algorithm? When and how an improved b.f.s is constructed from a current b.f.s? Under what conditions infeasibility and degeneracy are observed in simplex tableau? [2+5+3=10]
11. Solve the following LP problem using Simplex algorithm. Explain the path of traversal of corner point solutions (b.f.s) graphically with the results of simplex tables achieved sequentially. [8+4=12]

$$\text{Maximize profit} = 50X_1 + 20X_2$$

$$\text{Subject to} \quad 2X_1 + 4X_2 \leq 400$$

$$100 X_1 + 50X_2 \leq 8000$$

$$X_1, X_2 \geq 0$$

12. Write down the alternative conditions that hold for Primal-Dual problems. Prove that If x^* is any 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. [4+4=8]

Mid-Semestral Examination (2011 – 2012)

M Tech (Q, R & OR) – 1st Year

Quality Management and Systems – Group A

Time: Three hours (Group A and group B together)

07.09.11

Maximum Marks: 100

Instructions: Notes and books are allowed

1. Think about a passenger transportation company that operates intercity luxury buses. The company has a time table and the buses are supposed to be operated as per the time table. The passengers need to book their tickets before boarding the bus. The passengers may book their tickets directly from the booking counter of the company, through websites of the company or through other agents who sale directly as well as through websites. There are various modes of payment like cash, debit cards and credit cards. The bus offers two types of seating arrangements – ordinary and luxury. The company has outsourced the cleaning and maintenance services to another organization. However, the quality of maintenance and cleaning is checked by the maintenance department of the company. The drivers and the onboard staff are employees of the company and they are regularly trained by the training department of the company. Moreover, the company attempts to ensure that all appropriate licenses and documents like interstate licenses, permissions etc. are up to date and are always available with staff. The health condition of the drivers is also checked regularly.
 - a. Identify four different groups of customers. Explain each group briefly.
 - b. Identify six different quality attributes that could be important to the passengers (people who pay and buy tickets – i.e. the people who provide sales income to the company). Classify these attributes from the perspective of Kano model. Ensure that at least two attributes are of *must-be* type. For each attribute briefly explain why do think that the particular attribute is one-dimensional, attractive or must be type. [8 + 12 = 20]
2. Consider a restaurant chain that offers home delivery services for a variety of pizzas, breads and beverages. The restaurant guarantees delivery within a fixed time and does not charge for the food in case they are unable to serve within the stipulated time period. In order to ensure that the delivery can be made at a very short notice, the company has implemented a central system for taking orders and allocating the order to the right outlet.
 - a. In this system identify 10 different ways in which deficiencies can occur. Briefly explain how freedom from these deficiencies is likely to have a positive impact on the cost to the company. Identify these deficiencies as internal or external

PTC

failure as the case may be with a brief justification. You may provide a brief description about the structure of the organization and the food delivery system that you have assumed. [20]

3. Suppose you are planning for a picnic for your friends. Assume that the venue and the menu have already been finalized and also per head contribution for the picnic has been estimated and paid. You have decided to hire a small bus and pick up people from a few specified points (including the starting point from where many will board the bus). You are now trying to ensure that the trip is comfortable as well as enjoyable
- Provide a definition of comfortable and enjoyable. Note that there is no correct definition – you have to provide your own definition with a brief justification. On the basis of this definition identify the customer attributes. Notice that these attributes should naturally specify what you should do to ensure that the trip is comfortable and enjoyable.
 - Identify how you will achieve these (the so called engineering characteristics). Connect the customer attributes and the engineering characteristics using a relationship matrix (the central matrix in the house of quality).
 - Notice that there can be engineering characteristics that contradict each other. Can you identify at least two such characteristics. Provide brief justification why you think the characteristics are contradictory. [8 + 8 + 4 = 20]

07.09.11

Mid-Semester Examination: 2011-12

Course Name : M Tech (QR&OR)
Subject Name : Quality Management System (Group – B)
Maximum Marks : 40
Duration :

Note: Class notes, books and xerox copies are allowed. Answer all the questions from this group.

1. Two of the eight QMPs are a) Process Approach, and b) Factual Approach of Decision Making. Explain what advantages an organisation gain through proper implementation of these two QMPs. Develop a Quality Policy for an educational institution, like ISI.

(6+4) = [10]

2. Prepare a process map on any one of the following processes. Define efficiency indicator and effectiveness indicator of your chosen process.

- Serving food in ISI canteen
- Conducting classes for M Tech (QROR) course

(7+3) = [10]

3. Assignment (last date of submission is today).

[20]

INDIAN STATISTICAL INSTITUTE

Mid-semesteral Exam.

Course Name: M.Tech. (QROR)

Year: 1st year

Subject Name: Database Management Systems

Programming Techniques & Data Structures

Date: 09.09.2011

Maximum Marks: 50

Duration: 2.30 hrs

Answer all questions.

1. Given the following expression in infix.

$$9+3-6/3+7$$

- (a) Write its prefix and postfix equivalent assuming the precedence of operators as per the BODMAS rule.
- (b) Write the algorithm for computing the value of the derived postfix expression in (a) using an array with Last-In-First-Out (LIFO) property.

2. Show examples of the following with pseudo-codes. [5+7]

- (a) A nested structure
- (b) An infinite do-while loop
- (c) A float pointer
- (d) Two dimensional dynamic memory allocation
- (e) A variable declaration with register storage class

[3+3+3+3+3]

3. The equation $x^2 + y^2 = r^2$ represents a circle with centre at origin and radius r . Assuming x and y to be integers only, write a pseudo-code that takes r as input and shows the following:

- (a) The points lying on the circle.
- (b) The number of points lying within the circle.

[6+6]

4. Write three separate programs to take an integer as input and print its prime factors using the following control loops.

- (a) while
- (b) do-while
- (c) for
- (d) Can it be done without any control loops? Justify your answer.

[3+3+3+2]

Indian Statistical Institute
Mid-Semestral Examination : 2011-12
M-TECH(QR&OR) -- 1st YEAR (E - STREAM)
PROBABILITY-1
{Answer all the questions}

Date: 12.09.11

Full marks: 100

Time: 2½ hours

[Symbols have their usual meaning]

1. a) State whether the following statements are true or false:
- i) If $A \subseteq B$ then $P(A) \leq P(B)$
 - ii) If A, B, C are mutually independent events then they are pair-wise independent events.
 - iii) If A and B are mutually exclusive events then $P(A \cap B) \neq 0$.
 - iv) If A, B, C are exhaustive events then $P(A \cup B \cup C) = 1$
 - v) It is possible to have two events A and B which are not mutually exclusive with $P(A) = \frac{1}{2}$, $P(B) = \frac{3}{4}$ and $P(A \cap B) = \frac{1}{8}$.

b) Define sigma field of events. Give axiomatic definition of Probability.

[5+5=10]

2. a) Let A_1, A_2, \dots, A_r be n events such that they are not necessarily mutually exclusive. Give the expression of the probability of occurring exactly m ($\leq r$) events. Give the proof of it.

b) If two dice are thrown, what is the probability that the sum of the numbers on the upper-most face is greater than 8?

[12+8=20]

3. a) State and prove Bayes' Theorem.

b) There are 4 workstations of type A, each having 6 fitters and 3 turners; and 3 workstations of type B, each having 2 fitters and 4 turners. One workstation is selected at random and a person is chosen at random from it. If he is found to be a turner what is the probability that he is working in type A station?

[10+10=20]

4. a) Let X be discrete random variable with its probability mass function

$$P(X = x) = kx \text{ for } x = 1, 2, \dots, n$$

Find the value of k. Find its mean and variance and first quartile.

b) Two athletic teams A and B play a series of independent games until one of them wins 4 games. The probability of each team winning a game is 1/2. Find the probability that the series will end in at most 6 games.

[12+8=20]

5. A set of 6 similar coins is tossed 640 times with the following results:

Number of heads	0	1	2	3	4	5	6
frequency	7	64	140	210	132	75	12

Find the expected frequencies assuming binomial distribution.

[10]

6. Assignment.

[20]

INDIAN STATISTICAL INSTITUTE
M.Tech (QR & OR) 1st YEAR (E & S Streams)
Session: 2011-2013
MIDSEMESTRAL EXAMINATION

Subject: SQC1

Date of Exam: 14.9.11
~~20/08/2011~~

Max. Marks: 100

Time: 3 hrs.

Group – A (Control Chart)

Answer Any Two Questions.

1. (a) Derive the central lines and control limits for a \bar{X} -S control chart for both subgroup average and subgroup standard deviation with an underlying assumption that the subgroup size is constant. [10]
- (b) Establish the method of constructing a \bar{X} -S control chart when the subgroup size varies. [5]
- © For a Normal population, find the maximum likelihood estimator of the population variance when the population mean is unknown. Show that this estimator is biased. Modify this to get an unbiased estimator of the variance. [7+5+3=15]

2. (a) What is the purpose of constructing control chart? [2]
- (b) When do we say that a process is in control? [2]
- © How Deming and Juran explained the aspect of “control” in a process? [5]
- (d) How will you distinguish between a chance / common and an assignable / special cause of variation? [6]
- (e) Explain the concept of rational subgroup. [5]
- (f) Define Type I and Type II errors in the arena of statistical process control. [5]
- (g) What is the rationale for preferring a \bar{X} -chart to a X-chart? [5]

3. (a) Under what circumstances one should opt for constructing an individual-moving range chart? [6]
- (b) What is the underlying distributional assumption for setting up an individual-moving range chart?

[2]

© Twenty successive bales of cotton are weighed (in pounds), with the following results. Set up control charts for the moving range and individual observations.

Bale	Weight	Bale	Weight
1	987.2	11	1002.9
2	956.7	12	947.2
3	969.5	13	990.1
4	952.2	14	976.5
5	970.1	15	1012.9
6	1008.2	16	985.3
7	950.7	17	972.6
8	1012.4	18	997.8
9	975.3	19	934.8
10	951.0	20	989.4

[16]

(d) If the weight of bales of cotton is normally distributed and specification limits are 975 ± 75 pounds, estimate the fraction nonconforming.

[6]

Group-B (Acceptance Sampling)

Maximum Marks (40)

Answer all questions

1. A process is under binomial control producing defective at a process average p . From this process lots of size N are formed and submitted to the consumer. From each lot the consumer takes a random sample of size n without replacement and inspects each item of the sample. If the number of defectives obtained is less than or equal to c the lot is accepted otherwise the lot is rejected. Derive the average probability of acceptance. Show that this probability of acceptance is independent of the lot size and depends only on n & c .

[10]

2. (a) Define type A and type B probability of Acceptance. Give their exact and approximate expressions stating the conditions necessary for such approximations.

2. (b) Define AQL and LTPD. Define producer's risk and consumer's risk in context to type A and Type B OC function.

[10]

3. Show that the following properties of Binomial OC function hold for $0 \leq c \leq n-1$.

i) $B(c, n, p)$ is a decreasing function of n which is concave for $np < c$ and convex for $np > c$.

ii) $B(c, n, p)$ is a decreasing function of p . For $0 < c < n-1$ it is concave for $p < c/(n-1)$ and convex for $p > c/(n-1)$. For $c = 0$ it is convex and for $c = n-1$ concave.

[10]

4. Assignment

[10]

INDIAN STATISTICAL INSTITUTE

First-Semester Examination : 2011-12

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

Subject Name : Electrical and Electronics Engineering

Date :14.11.11

Maximum Marks : 100

Duration : 3Hrs

Question no 1 is compulsory and answer any 6 questions from the rest.

1. Mention True or False [4]
 - a) A transistor is a passive device.
 - b) A transformer is used to convert a DC voltage to AC.
 - c) The binary equivalent of 0.75 is 0.11
 - d) Kirchhoff's current law states that the algebraic sum of the currents at any node must be zero.
2. State the basic differences between the structures of an AC and a DC generator.

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.

A DC shunt generator supplies a load of 7.5kW at 200V. Calculate the induced e.m.f. by the generator if the armature resistance is 0.6 ohm and field resistance is 80 ohms.

[3+7+6=16]

3. Define a control system. Draw the block diagram of a hot water temperature controller and explain its control procedure.

Explain and prove the superposition principle for a linear system characterized by linear ordinary or partial differential equations.

Find the Laplace transform of $\frac{d^2y}{dt^2}$ where, y is a function of time.

[(2+4)+5+5=16]

4. 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 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]

5. 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) 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 series resonant angular frequency. [7+9=16]

6. a) State and prove Thevenin's theorem.

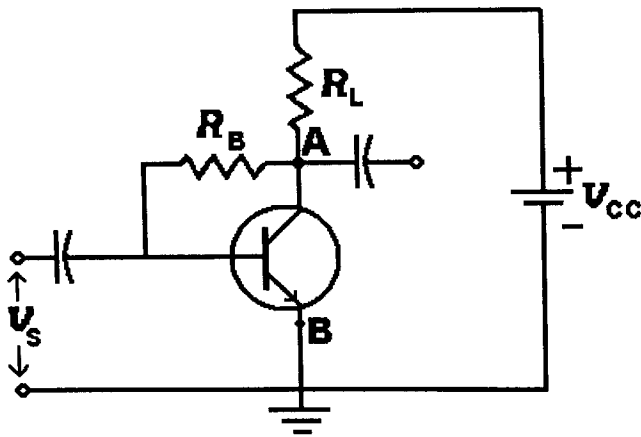
b) Prove that, in a circuit, maximum power is absorbed by the load resistance when the load resistance is equal to the Thevenin equivalent resistance. [10+6=16]

7. Explain the operational principles of an OP-AMP to be used as a noninverting amplifier, adder, integrator and differentiator, respectively. [4+4+4+4=16]

8. 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 $B=49$, $V_{CC}=10V$, and $R_E=2k$ 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]



9. Draw the hybrid-parameter equivalent circuit of a transistor in common emitter mode and calculate the current gain, input resistance and voltage gain in terms of the hybrid parameters.

Explain the operation of an Emitter-Follower circuit with negative feedback. [(4+4+4)+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

First Semestral Examination : 2011 – 12

M.TECH. (QROR) I Year, E-Stream

Statistical Methods – I

Date : 14/11/2011

Maximum Marks :100

Duration : 3 hours

Note: (i) *This paper carries 118 marks. Answer as much as you can but the maximum you can score is 100. You can answer any part from any question. The marks are indicated in [] on the right margin.*

(ii) *The symbols and notations have the usual meaning as introduced in your class.*

1. Define product-moment correlation coefficient (r_{xy}) of the variables x and y . Show that the coefficient of determination (r_{xy}^2) of the variables x and y may be interpreted as the proportion of the total variability of y accounted for by its linear regression on x . Given that $r_{xy} = -0.92$, find the value of the correlation coefficient between y and its predicted value \hat{Y} when y is regressed on x (with analytical justification for the result/s used in your computation). Prove that correlation coefficient (r) lies between -1 and $+1$. Interpret the cases $r = -1, 0$ and $+1$.

(1+3+4+4+3)= [15]

2. What is meant by the expression 'regression line of y on x '? What would be the normal equations if a polynomial regression $Y = a_0 + a_1x + a_2x^2$ were fitted to the given values of x and y ? Suggest a measure of usefulness of this regression equation as a predicting formula.

(2+3+2) = [7]

3. In a p -variate multiple linear regression study involving x_1, x_2, \dots, x_p , let $X_{1.23\dots p}$ represent the predicted value of x_1 and let $e_{1.23\dots p}$ represent the difference $x_1 - X_{1.23\dots p}$, i.e., the residual in predicting x_1 in so far as this can be done using a linear regression equation of x_1 on x_2, x_3, \dots, x_p .

a) Show that $\text{cov}(e_{1.23\dots t}, e_{1.23\dots p}) = \text{cov}(e_{1.23\dots s}, e_{1.23\dots p}), 2 \leq t, s \leq p$.

b) Find the $\text{var}(X_{1.23\dots p})$ in terms of $\text{var}(x_1)$ and determinants of correlation matrix and its cofactor(s).

c) Hence or otherwise, find an expression for multiple correlation coefficient $r_{1.23\dots p}$.

(5+9+3) = [17]

4. Let a simple random sample (SRS), s , of size n be drawn from a finite population of size N .

a) Compute the probability $p(s)$ of selecting the sample s : (i) with replacement (WR) and (ii) without replacement (WOR).

b) Let π_i denote the probability that the i th unit of the population is included in the

sample. Compute π_i under SRSWR as well as under SRSWOR.

- c) Find the variance of the sample mean under SRSWOR? Find an unbiased estimator of the population variance when a simple random sample is taken without replacement.

$$(\overline{2+3+2+3+5+5}) = [20]$$

5. a) In a stratified population the sampling cost, C , for obtaining a stratified simple random sample of size n , made up of n_i observations from the i th stratum ($i = 1, 2, \dots, k$), is

$C = c_0 + \sum_{i=1}^k c_i n_i$, where c_0 is overhead cost and c_i is cost of an individual observation from i th stratum.

The stratified sample mean, $\hat{\mu}_{st}$, based on with replacement sampling from each stratum, is to be used to estimate the population mean μ . Determine the optimum allocation of the n_i 's to minimise $\text{Var}(\hat{\mu}_{st})$ for a fixed total cost C .

- b) The following table lists the stratum sizes (N_i), means (μ_i), variances (σ_i^2) and the unit cost in rupees (c_i) of sampling an individual observation from i th stratum.

Stratum	N_i	μ_i	σ_i^2	c_i
1	200	7.3	4.41	64.00
2	100	11.2	3.24	81.00
3	150	6.9	4.00	64.00
4	250	9.1	9.00	56.25
5	300	9.6	8.41	36.00

- (i) Calculate the overall population mean μ and variance σ^2 .
- (ii) Use the result derived in part (a) to determine the optimum allocation of stratum sample sizes for a SRSWR sampling from each stratum, given a total budget (C) of ₹10000/- when the overhead of cost of administering the survey (c_0) is ₹4030.
- (iii) Work out (for the same total size of sample) the efficiency of the simple random sample mean \bar{y} as an estimator of μ , relative to the stratified sample mean $\hat{\mu}_{st}$ based on your optimum allocation.
- (iv) Calculate the proportional allocation for a total sample size that is obtained in your part (a) of this question.

$$(\overline{10+2+4+7+5+2}) = [30]$$

6. a) Let x_1, x_2, \dots, x_n be a random sample from a normal population with mean 0 and variance σ^2 . Derive the distribution of $\sum_{i=1}^n x_i$.

- b) Let $y_1 = \sum_{i=1}^t x_i$ and $y_2 = \sum_{i=t+1}^n x_i$, $1 < t < n$. Define variates u and v as:

$$u = y_1 + y_2, \quad v = -\sqrt{\frac{(n-t)}{t}} y_1 + \sqrt{\frac{t}{(n-t)}} y_2$$

Derive the joint distribution of u and v and show that they are independent and identically distributed normal variates.

$$(5+9) = [14]$$

7. a) Discuss the general principles of inversion method (or inverse transform method) of generation of observations from a continuous univariate probability distribution.
- b) Find the value of k for the following continuous distribution of a variable X in the range $(-3, 3)$ and generate 4 observations from it:

$$f(x) = \begin{cases} k(3+x)^2, & -3 \leq x \leq -1 \\ k(6-2x^2), & -1 < x \leq 1 \\ k(3-x)^2, & 1 < x \leq 3 \end{cases}$$

[Use the table of random digits given overleaf.]

(7+8) = [15]

TABLE - RANDOM DIGITS

11164	36318	75061	37674	26320	75100	10431	20418	19228	91792
21215	91791	76831	58678	87054	31687	93205	43685	19732	08468
10438	44482	66558	37649	08882	90870	12462	41810	01806	02977
36792	26236	33266	66583	60881	97395	20461	36742	02852	50564
73944	04773	12032	51414	82384	38370	00249	80709	72605	67497
49563	12872	14063	93104	78483	72717	68714	18048	25005	04151
64208	48237	41701	73117	33242	42314	83049	21933	92813	04763
51486	72875	38605	29341	80749	80151	33835	52602	79147	08868
99756	26360	64516	17971	48478	09610	04638	17141	09227	10606
71325	55217	13015	72907	00431	45117	33827	92873	02953	85474
65285	97198	12138	53010	94601	15838	16805	61004	43516	17020
17264	57327	38224	29301	31381	38109	34976	65692	98566	29550
95639	99754	31199	92558	68368	04985	51092	37780	40261	14479
61555	76404	86210	11808	12841	45147	97438	60022	12645	62000
78137	98768	04689	87130	79225	08153	84967	64539	79493	74917
62490	99215	84987	28759	19177	14733	24550	28067	68894	38490
24216	63444	21283	07044	92729	37284	13211	37485	10415	36457
16975	95428	33226	55903	31605	43817	22250	03918	46999	98501
59138	39542	71168	57609	91510	77904	74244	50940	31553	62562
29478	59652	50414	31966	87912	87154	12944	49862	96566	48825
96155	95009	27429	72918	08457	78134	48407	26061	58754	05326
29621	66583	62966	12468	20245	14015	04014	35713	03980	03024
12639	75291	71020	17265	41598	64074	64629	63293	53307	48766
14544	37134	54714	02401	63228	26831	19386	15457	17999	18306
83403	88827	09834	11333	68431	31706	26652	04711	34593	22561
67642	05204	30697	44806	96989	68403	85621	45556	35434	09532
64041	99011	14610	40273	09482	62864	01573	82274	81446	32477
17048	94523	97444	59904	16936	39384	97551	09620	63932	03091
93039	89416	52795	10631	09728	68202	20963	02477	55494	39563
82244	34392	96607	17220	51984	10753	76272	50985	97593	34320
96990	55244	70693	25255	40029	23289	48819	07159	60172	81697
09119	74803	97303	88701	51380	73143	98251	78635	27556	20712
57666	41204	47589	78364	38266	94393	70713	53388	79865	92069
46492	61594	26729	58272	81754	14648	77210	12923	53712	87771
08433	19172	08320	20839	13715	10597	17234	39355	74816	03363
10011	75004	86054	41190	10061	19660	03500	68412	57812	57929
92420	65431	16530	05547	10683	88102	30176	84750	10115	69220
35542	55865	07304	47010	43233	57022	52161	82976	47981	46588
86595	26247	18552	29491	33712	32285	64844	69395	41387	87195
72115	34985	58036	99137	47482	06204	24138	24272	16196	04393
07428	58863	96023	88936	51343	70958	96768	74317	27176	29600
35379	27922	28906	55013	26937	48174	04197	36074	65315	12537
10982	22807	10920	26299	23593	64629	57801	10437	43965	15344
90127	33341	77806	12446	15444	49244	47277	11346	15884	28131
63002	12990	23510	68774	48983	20481	59815	67248	17076	78910
40779	86382	48454	65269	91239	45989	45389	54847	77919	41105
43216	12608	18167	84631	94058	82458	15139	76856	86019	47928
96167	64375	74108	93643	09204	98855	59051	56492	11933	64958
70975	62693	35684	72607	23026	37004	32989	24843	01128	74658
85812	61875	23570	75754	29090	40264	80399	47254	40135	69916

INDIAN STATISTICAL INSTITUTE
First Semester Examination: 2011-12
Course Name: M. Tech. (QR&OR)
Subject Name: Quality Management Systems
Date: 16/11/2011 Maximum Marks: 100 Duration: 3 hours

Group-A Maximum Marks: 50

Note: Books and class notes may be used. The paper carries 62 marks. Answer as much as you can. However, the maximum you can get is 50.

1. A large IT service provider in India carries out customer satisfaction survey every year to assess whether the customers are happy with the quality of services offered. In the survey the service provider asks a variety of questions and the customer provides answers (essentially their perceptions) in 7-point ordinal scale. The different dimensions covered include:
- a. The level of knowledge and understanding of the business of the customer
 - b. Ability to manage complex programmes (carrying out several projects simultaneously using teams located all over the world)
 - c. Ability to show thought leadership in the sense of thinking about technological solutions (choosing the right tool, thinking about new measures and solutions)
 - d. Breadth of services offered by the service provider (whether the service provider has or is capable of meeting various needs of the customer)
 - e. The ability of the service provider to provide solutions that helps improving the business performance significantly
 - f. Delivery within time and budget
 - g. Quality of deliverables
 - h. Whether the service provider has created an user-friendly interface to allow the customer to interact with the service provider
 - i. The ability of the service provider to respond to changing needs of the customer
 - j. Whether the service provider has adequate resources (manpower, hardware, software, communication resources, availability of finance) to solve problems of the customer
 - k. The adequacy of the system of reporting status to the customer
 - l. Level of accuracy of commercial transactions
 - m. Clarity of communication
 - n. Ability to learn from other related solutions

Answer the following

- i. Allocate these dimensions to different dimensions of RATER scale.
- ii. In this survey who is the customer? Do you envisage any difficulty in identifying the customer? Explain in brief.
- iii. Suppose the organization gets high rating in most or all of these dimensions and suppose that these ratings are comparable to or even better than the ratings of their competitors. Do you think that the organization does not face a growth risk? Explain. [Hint: Use the concepts of marketing myopia]

(7+4+6) = [17]

2. Retail organizations sell products from different outlets. It is necessary to ensure that enough products are available on shelf so that sales do not suffer. At the same time, too many pieces should not be kept as this may increase the capital tie-up and may also occupy costly shelf space. In order to solve this problem, most retail organizations attempt to develop forecasting models to estimate the level of sales beforehand. Unfortunately, these forecasts often have a lot of error. Attempts have been made to improve the forecasting models so that sales at store level can be predicted accurately. However, the results have not been very good. Attempts were also made to carry out the forecast at a gross (several stores together) level and make products available through a very efficient supply chain. This also did not succeed much as forecasts often had error and even when they were accurate making the right quantity available through the supply chain often proved quite difficult. Using your knowledge of quality management principles can you think of some solution to this problem? Describe your solution clearly stating all assumptions you have made. Explain why you think that your solution is better than the proposed solutions. [Hint: Recall that two highest forms of solving a problem are to solve and dissolve respectively and quality management experts must first attempt to dissolve the problem.]

[10]

3. Consider the data processes in a BPO organization. The data processes are the ones where the customers send some documents (e.g. purchase orders, cheques, insurance claims etc.). The BPO organization processes the same according to rules specified by the customer and sends the processed documents back. These BPO organizations often implement a certification system called COPC. This system is delivery-focussed and introduces many measures. Some of the measures are touch time (time to start working on the document), processing time, proportion of documents processed without any error and so on. The organization has targets for all these measures and the targets are implemented at an individual level (the times and defects are measured for each individual). The employees who fail to meet the target are penalized. If everyone meets the target, employees belonging to the lower 10th percentile do not get a pay rise.

In order to ensure continuous improvement, the targets are revised every year. Also, the quality control department forms small group of entry and middle level employees to identify root causes of the problem and eliminate the same.

While the junior and middle level employees focus on operational issues the senior management focuses on the collection and set tough financial targets for every quarter. The employees in sales and delivery are measured on the delivery as well as collection parameters.

Which of the 14 principles of Deming are possibly violated by this organization? Explain briefly. State your assumptions, if any clearly.

[10]

4. Answer the following
- Many organizations make credit sales, i.e. the payment for the product / service sold is collected after the delivery. The period of credit varies and can sometimes be very high.

The delay in payment is an issue as this is likely to create a problem of cash flow. It may be noted here that the payments are made against invoices raised by the organization. Individual invoices get delayed for a variety of reasons like accuracy, not reaching on time, not specifying the names or other details of the payee properly, missing the billing cycle and so on. In order to control the payment cycle time, many organizations compute the Days Sales Outstanding or DSO (computed as total outstanding divided by the average daily sales, e.g. if the average daily sale is Rs. 100/- and the outstanding amount is Rs. 1000/- then DSO is 10 days) for the different customers. Target DSO is defined for every customer and whenever this is exceeded, the finance team is supposed to identify the root cause and take action.

- i. What is your opinion about the representational validity of DSO as a measure? State your assumptions about the measures (what are you attempting to measure) and explain.
- ii. Do you think this method of controlling the payment time is likely to work? Explain if your answer is negative.

(5+6) = [11]

- b. Look at the following and classify them as appraisal cost, prevention cost or failure cost
- i. Product redesign
 - ii. Prototype inspection
 - iii. Specification review
 - iv. Procuring material on urgent basis
 - v. Receiving inspection
 - vi. Review of software test plans

(6 x 1) = [6]

- c. A government agency handles a huge number of documents. The agency is expected to keep track of the documents and make the documents available to many subscribers in different forms. The service provided is free (funded by the government) and the subscribers only have to enrol and satisfy some criteria. The subscribers were not at all happy with the systems followed by the agency and demanded upgradation of the system. However, the agency was slow in its response to the needs of the subscribers. In this situation the government has stepped in and has requested a university to develop a plan for upgradation of the system. The university has studied the system and prepared a design. They have then floated a tender and allocated the job of developing the software according to the design to a software developer. The software developer would be paid by the university and the university is answerable to the government for timely completion of the development of the software.
- i. Identify the different stakeholders, customers and service providers.
 - ii. Examine the job of software development. Do you think any activity of a standard Software Development Life Cycle (SDLC) has been skipped? If yes, which one? Explain in brief.

(3+5) = [8]

Group-B Maximum Marks: 50

Note: Class notes, books and xerox copies are allowed. Answer all the questions from this group. Answer Group-B in separate sheet.

1. You are working in an Educational Institution as Management Representative of ISO 14001: 2004. List down two of its activities and mention different environmental aspects and associated impacts. Suggest a suitable Environmental Policy for the institution.
(6+4) = [10]
2. You have been given the responsibility of implementing Emergency Preparedness System in your hostel campus. List down the emergency situations you consider, mentioning the reason of choosing them. Prepare a complete list of training and communication programmes, which you need to organize for successful implementation of Emergency Preparedness System.
(4+6) = [10]
3. Following are the objective evidences of an internal audit conducted according to 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. Mention relevant/appropriate clause number. (any four)
 - (a) Data on disposition of hazardous waste, which is a legal requirement, is not available.
 - (b) The work instruction meant for shop floor operation was being kept under lock and key by the supervisor who is working in the general shift. The supervisor states whenever a worker wants to have a look at it, he is allowed to do so during his presence.
 - (c) Material Safety Data Sheet was not found for the 3 new raw materials, which have been introduced recently.
 - (d) Customer complaints are replied promptly and records are kept. Record shows similar complaints are recurring every month. When asked, the concerned manager says that his duty is only to reply the complaints promptly.
 - (e) EMS Objectives are found to be measured routinely, but no improvement is observed.
 - (f) Customer orders indicate firm delivery dates but dispatch records show delivery dates are rarely met. Concerned manager argues that delivery dates are only indicative and it is not possible and expected also to meet these delivery dates. However, no supporting document was provided.

(4 x 3) = [12]
4. Assignment (last date of submission is today).
[18]

INDIAN STATISTICAL INSTITUTE

First Semestral examination: 2011-12

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

Subject: Operations Research-I

Date of Exam : 18.11.11 **Max Marks:** 100 **Duration:** 3 hrs.

GROUP-A (Max Marks: 50)

Questions (1), (3), (5) and (7) are compulsory. Answer any two questions from the rest.

1. Prove that in LPP, whenever the primal admits of a finite optimal solution, the dual also admits of a finite optimal solution. Furthermore, the respective optimal values of the primal and dual objective functions are equal.

[8]

2. Find the optimal solution to the following LPP using duality

[10]

Maximize $(4X_1 + 3X_2)$

Subject to

$$X_1 \leq 6$$

$$X_2 \leq 8$$

$$X_1 + X_2 \leq 7$$

$$3X_1 + X_2 \leq 15$$

$$-X_2 \leq 1$$

$$X_1, X_2 \geq 0$$

3. Solve the following assignment problem by Hungarian Method (minimize total cost). A company had four machines (X, Y, Z, T) and three jobs (A, B, C) to be done on them. The cost of operations is given below. Determine the optimal assignment for minimum cost.

	X	Y	Z	T
A	18	24	28	32
B	8	13	17	19
C	10	15	19	22

What type of special considerations is possible in the LP formulation of an assignment problem? [8+2=10]

4. Write down the general mathematical formulation of a transportation problem (T.P.) after showing its network representation. What are the two unbalanced situations for a T.P? [5+3=8]
5. 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]
6. Solve the following transportation problem using Vogel's approximation method (VAM) and test the optimal solution. [10]

Factory	W_1 (Warehouse)	W_2	W_3	W_4	Capacity (Supply)
F_1	21	16	25	13	11
F_2	17	18	14	23	13
F_3	32	27	18	41	19
Requirement (Demand)	6	10	12	15	43

7. Write down the flow properties for a flow network $G = (V, E)$. Prove these properties by considering both the original flow f and the valid flow f_p for the augmenting path p . [3+7 = 10]
8. Define cut of a network. Prove the following two results:
- The value of a flow in a network is the net flow across any cut of the network.
 - The value of any flow f in a flow network G is bounded from above by the capacity of any cut of G . [2+3+3 = 8]

GROUP-B (Max Marks: 50)

Answer all questions

- 1(a). A subcontractor undertakes to supply gear boxes to a manufacturer at the rate of 50 per day. As per contract the manufacturer penalizes him Rs. 20 per unit per day for missing the delivery date. The cost of holding a completed gear box in stock is Rs. 15 per month (30 days). His procurement process is such that each month (30 days) he starts a batch of gear boxes and all the units are available for delivery any time after the end of the month. What should his inventory level be at the beginning of each month (i.e. immediately after taking into stock the gear boxes procured in the previous month then shipping gear boxes to fill unsatisfied demand from the previous month)? What should have been his inventory level if cost of failure in delivery is prohibitive enough so that the subcontractor cannot afford to miss a delivery?
- (b). Show that the product of Total number of orders and the Total investment is constant at a given level of total annual Rupee demand of a company using EOQ ordering policy for all the items. Compare this with two other policies. Hence explain the use of the exchange curve (or optimal policy curve) for looking into inventories at an aggregate level in an organisation.

(6 + 6 = 12)

- 2(a). What would be percentage yearly unsatisfied demand when demand during lead time is normally distributed with mean m , and standard deviation σ and the inventory manager operates a two bin system such that he orders a quantity Q whenever the stock level reaches to r units.
- (b). While operating a two bin system the inventory manager orders a quantity of 30 units when ever stock reaches to a certain reorder level. The demand follows Poisson distribution and the annual demand is estimated as 120 units. Given that the lead time : 15 days (1/2 month), cost of a single occurrence of shortage : Rs. 10, unit price of an item Rs 4, holding rate per rupee per year : 20% , what should be the least cost safety stock ?

(6+6 = 12)

- 3(a). Derive the expression of the waiting time distribution in the steady state of a single server queue under the assumption of Poisson arrival and exponential distribution of service time.
- (b). In a security check point of an airport, arrivals are considered as Poisson with an average time of 3 minutes between one arrival and next. The length of security check is assumed to be exponential with mean 1.5 minutes. i) What is the probability that an arrival has to wait more than 10 minutes? ii) What fraction of time in a shift of 8 hours the security person in the counter will be busy?
- (c). Prove that inter-arrival time follows exponential distribution in a single server queue for Poisson arrival.

(10+6+4 =20)

4. Describe a situation where the problem of machine interference arises. How can we compute the operative utilization and machine utilization from the finite queue table when 16 automatic machines are looked after by 3 operatives with service factor of 0.25? From Finite Queue Table, we find the value of F as 0.733 for M=3. What are the assumptions we have made?

(6)

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INDIAN STATISTICAL INSTITUTE

End-semesteral Exam.

Course Name: M.Tech. (QROR)

Year: 1st year

Subject Name: Programming Techniques and Data Structures

Date: 21.11.11

Maximum Marks: 100

Duration: 3.00 hrs

Answer all questions.

1. What is hash collision? Define rehashing. What do you mean by a perfect hash function? The set of numbers {9, 99, 999, 9999, 99999, 9999999} has to be stored in an array of size 10. Write a perfect hash function for its indexing. Justify your answer.
3+2+2+5+3=15
2. Write an algorithm with average case time complexity $O(n \log_2 n)$ for sorting an array of n numbers in ascending order. If the input array is already sorted in ascending order, do you think that the time complexity of your algorithm will still be $O(n \log_2 n)$? Justify your answer.
12+1+2=15
3. Write an algorithm for binary search in an array sorted in ascending order. What is its time complexity? What is the advantage of Fibonacci search over binary search?
12+3+5=20
4. What is a pointer? Consider a linked list with the following elements {2, 4, 6, 7, 10}. Write a pseudo-code for inserting an element in this list so that it still remains sorted.
3+12=15
5. Consider two matrices of dimensions $m \times n$ and $n \times p$. Dynamically allocate memories for these two matrices. Write a C-like pseudo-code to multiply the two matrices. Compute the number of multiplication operations required.
4+10+6=20
6. Define a binary tree. Draw a possible binary tree whose inorder traversal is the following sequence E A C K F H D B G. Is the tree unique? Justify your answer. What is the characteristic of a binary search tree?
2+5+5+3=15

INDIAN STATISTICAL INSTITUTE

First Semestral Examination: 2011-12

Course Name: M. Tech. (QR & OR) I^{year}

Subject Name: Statistical Quality Control - I

Date: 23/11/2011 Maximum Marks: 100 Duration: 3 hours

Note: Use separate answer sheets for Group A and Group B.

(Group A): Control Chart (Answer Any Three Questions.)

Max. Marks: 60

1. The data below represent averages of samples of size five selected hourly from a manufacturing process with $\sigma = 2.0$ and $\mu_0 = 11.0$. Analyze the data using an Exponentially Weighted Moving Average (EWMA) control chart with $\lambda = 0.2$ and $L = 2.7$. Also draw the EWMA chart and comment whether the process is in-control.

Sample No.	\bar{x}	Sample No.	\bar{x}
1	10.45	11	11.39
2	10.55	12	11.69
3	10.37	13	11.51
4	10.64	14	11.28
5	10.95	15	11.38
6	10.08	16	11.25
7	10.50	17	11.63
8	10.87	18	11.88
9	11.25	19	11.46
10	11.46	20	11.67

[20]

2. a) The number of workmanship nonconformities or defects observed in the final inspection of disk-drive assemblies has been tabulated as shown below. Draw an appropriate control chart and comment whether the process is in-control.

Day	Number of Assemblies Inspected	Total Number of Nonconformities or Defects
1	2	10
2	4	30
3	2	18
4	1	10
5	3	20
6	4	24
7	2	15
8	4	26
9	3	21
10	1	8

[10]

b) In a process the fraction defective is found to be $p = 0.01$. What would be the subgroup or sample size if the probability of obtaining at least one defective item in the subgroup or sample is equal to 0.90? [5]

c) In a process it has been found that the average fraction defective $\bar{p} = 0.05$. If 3-sigma limits are used, what minimum sample size you need to take so that you have a positive lower control limit for a fraction defective chart? [5]

3. a) 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]

b) What are the assumptions for constructing a sloping \bar{X} -R control chart? Prove that under these assumptions the parameters for estimating the central trend line are $\alpha = \bar{\bar{X}}$ and $\beta = \frac{\sum_{i=1}^m h_i \bar{X}_i}{\sum_{i=1}^m h_i^2}$, where α is the intercept, β is the slope of the straight line equation

and h is the revised subgroup numbers with $\sum_{i=1}^m h_i = 0$.

[2+5=7]

c) Derive the operating characteristic function and ARL function of an \bar{X} -chart under the assumption that the process standard deviation σ is known and constant. [3+3=6]

4. From the following measurements in mm. of 5 parts or components by 3 appraisers – each part or component being measured by each appraiser twice – estimate the repeatability or Equipment Variation (EV), the reproducibility or Appraiser Variation (AV), Part Variation (PV), Repeatability and Reproducibility Variation (R & R) and the Total Study Variation (TV). What is your conclusion about the adequacy of the measurement system? Note that for $n = 2$; $D_4 = 3.267$ and $D_3 = 0$. The $d_2(n, k)$ values are $d_2(2, 15) = 1.15$; $d_2(3, 1) = 1.91$; $d_2(5, 1) = 2.48$, where n is the sample size and k is the number of samples.

Appraiser Code	Trial Number	Part Number or Sample Number				
		1	2	3	4	5
A	1	0.65	1.00	0.85	0.85	0.55
	2	0.60	1.00	0.80	0.95	0.45
B	1	0.55	1.05	0.80	0.80	0.40
	2	0.55	0.95	0.75	0.75	0.40
C	1	0.50	1.05	0.80	0.80	0.45
	2	0.55	1.00	0.80	0.80	0.50

Acceptance Sampling SQC-1 (Group: B)
Answer all questions
Maximum Marks 50

Q1(a). Derive the expression for the ASN for a double sampling plan with curtailment associated with rejection at second sample.

Q1(b) For a single sampling acceptance rectification plan define AOQ. Derive the expression for AOQL using Poisson approximation for the probability of acceptance and show that there is a unique AOQL for a given sampling plan. For a lot of size 5000 construct a single sampling plan satisfying AOQL = 5% that minimizes ATI at process average of 1.5%. Use the following table:

c	y
0	0.3679
1	0.8408
2	1.371
3	1.942
4	2.544
5	3.168
6	3.812
7	4.472
8	5.146

(6+8 = 14)

c and y usual notation as per Dodge and Romig table.

Q2 a) Using Military Standard 105 D find a single sampling, a double sampling and a multiple sampling plan with AQL = 4 defects per 100 for lots of size 450 under normal, tightened and reduced inspection. Use inspection level II.

Q2(b) For the single sampling plans obtained in (a) above for the normal and tightened inspection find using Military Standard 105 D (i) the limiting quality values for the probability of acceptance of 0.05 and ii) the AOQL value.

(9+4=13)

Q3. Obtain a variable single sampling plan for a double specification limits with lower specification limit 5 mm and Upper specification limit of 12 mm, when process or lots are normally distributed and the standard deviation is known as 1 mm, with a specified AQL = 0.01, RQL = 0.08, producer's risk = 0.05 and consumer's risk = 0.10. Derive all necessary expressions.

[Hint: Note that the minimum proportion defectives is practically 0.]

(6)

Q4. What is the motivation for a sequential probability ratio plan. For the Wald's SPR plan with a specified $p_1, p_2, p_2 > p_1$, α and β derive the equations of two limit lines.

(7)

INDIAN STATISTICAL INSTITUTE
First-Semester Examination : 2011-12
M-TECH(QR&OR) – 1st YEAR (E-STREAM)

PROBABILITY -- 1

Note : Answer all the questions

Date: 25.11 .11

Full marks:100

Time: 3 hours

1. a) State and prove Central Limit Theorem due to Lindberg and Levy.
b) Explain the application of central limit theorem in the field of SQC. [12+3=15]
2. a) Let X and Y be two random variables such that $Y = \log X$. Let $Y \sim N(\mu, \sigma^2)$. Find out the distribution of X. Find E(X) and Var(X).
b) Let $X \sim \text{Bin}(n, p)$. Prove that $P(X \leq k) = \frac{1}{B(n-k, k+1)} \int_0^q z^{n-k-1} (1-z)^k dz$ [12+8=20]
3. a) If X is a random variable with distribution function
 $F_X(x) = P(X \leq x)$
Then prove that
i) F is monotonic non-decreasing
ii) $F(\infty) = 1$
iii) $F(-\infty) = 0$
iv) F is right continuous.
b) Let the joint distribution of X and Y be
 $f(x,y) = cxy, 0 < x < 1, 0 < y < 1$
Find c. Find marginal distribution of X, conditional expectation E(X/y) and conditional variance Var(Y/x). [10+10=20]
4. a) Derive the p.d.f of χ^2 distribution with n degree of freedom.
b) Let χ_1^2 and χ_2^2 be two independent χ^2 variables with degree of freedom n_1 and n_2 respectively.
Let $Z = \frac{\chi_1^2}{\chi_2^2}$. Derive the distribution of Z. [10+10=20]
5. a) Consider r indistinguishable balls randomly distributed in n cells. What is the probability that exactly m cells remain empty?
b) A student takes a multiple choice test consisting of two problems. The first one has 4 possible answers of which one is correct and the second one has 7 possible answers of which one is correct. The student selects one answer at random for each question and gets 5 score if it is correct otherwise he gets 0. Let X be the score of the student. Find E(X) and Var(X).
c) Let the individual monthly wages (in rupees) obtained by a group of people be Normally distributed with mean 50000 and standard deviation 5000. If three people are taken randomly from the group what is the probability that two of them are getting monthly salary more than Rs 58000/- ? [10+7+8=25]

INDIAN STATISTICAL INSTITUTE
M Tech (QR_OR) 1st Year (S Stream)
Session 2011-2012
SEMISTRAL EXAMINATION

Subject : Workshop – 1 (Engg. Drawing)

Date of Exam: 25.11.11

Max. Marks : 60

Time : 3 hrs

Note : (a) Answer question No.6(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 questions are indicated in third brackets.

1. Draw a diagonal scale of R.F. = 3:100, showing metres, decimeters and centimeters and to measure up to 5 metres. Show the length of 3.78 metres on it. [14]
2. A square pyramid, base 40mm 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 triangular prism, base 50 mm side and axis 75 mm long, is lying on the ground on one of its rectangular faces with its axis inclined at 30° to the V.P. It is cut by a horizontal section plane, at a distance of 15 mm above the ground. Draw its front view and sectional top view. [14]
4. Show by means of sketch any four of the following thread forms. [14]
 - a) Whitworth
 - b) Seller
 - c) Buttress
 - d) Knuckle
 - e) Square
5. Draw the sketch of a pair of mating spur gear and a pinion and also indicate any four of the following six components of it in the figure:- [14]
 - a) Root diameter
 - b) Addendum circle
 - c) Dedendum circle
 - d) Fillet radius
 - e) Pitch circle diameter
 - f) Working depth
6. Sketch a sectional front view and the side view of a socket and spigot joint. Use suitable dimensions to complete the drawing. [18]

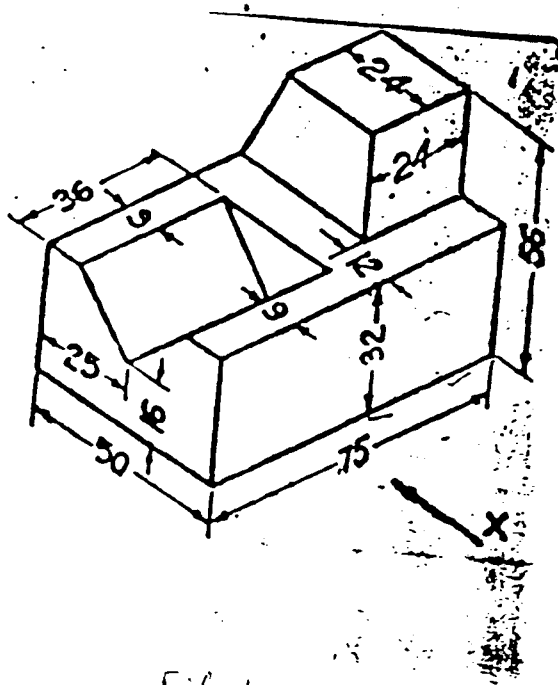


Fig-1

INDIAN STATISTICAL INSTITUTE
First Semestral BACK PAPER Examination : 2011 – 12

M.TECH. (QROR) I Year, E-Stream
Statistical Methods – I

Date : 22/12/2011

Maximum Marks :100

Duration : 3 hours

- Note:** (i) Answer all questions. The marks are indicated in [] on the right margin.
(ii) The symbols and notations have the usual meaning as introduced in your class.

1. Explain with suitable examples the distinction

- a) between an attribute and a variable,
- b) between a discrete variable and a continuous variable.

(4 × 2) = [8]

2. “Most of the Indians have more than average number of legs.”

What is the measure of central tendency being referred to as ‘average’ in the above statement? What would be a proper measure of central tendency in this situation? Discuss the merits and demerits of both the measures.

(2 + 6 × 2) = [14]

3. An analysis of monthly wages paid to the workers in two plants, A and B, belonging to the same industry gives the following results.

	<u>Plant A</u>	<u>Plant B</u>	<u>Plant A & B together</u>
Number of workers	100	*	250
Average monthly wage (Rs.)	1500	*	1560
Standard deviation of distribution of wages (Rs.)	300	*	$\sqrt{134400}$

- a) Calculate the missing values (indicated by ‘*’) for Plant B.
- b) Which plant, A or B, has a larger wage bill?
- c) In which plant, A or B, is there greater variability in individual wages? Justify.

(9+3+3) = [15]

4. a) Show that the multiple correlation coefficient of x_1 on x_2, x_3, \dots, x_p can be expressed in terms of total and partial correlation coefficients.
- b) In a 3-variate case, if $a_1x_1 + a_2x_2 + a_3x_3 = k$, where k is a constant, then find the value of $r_{1.23}$. Offer justification for your answer.
 - c) Suppose the total correlation coefficient is zero. Does it necessarily imply that the partial correlation coefficient between the same variables is also zero? Why?
 - d) In partially destroyed record of an analysis of bivariate data, the following results are

only readable:

Variance of $x = 9$

Regression equations: $8x - 10y + 66 = 0$ and $40x - 18y = 214$.

Find (i) the mean values of x and y , (ii) the correlation coefficient between x and y , and (iii) the standard deviation of y .

$(8 + 4 + 3 + 3 + 7 + 3) = [28]$

5. a) Let x_1 and x_2 be independent and identically distributed $N(0,1)$ random variables. Consider the transformations $x_1 = r \cos\theta$ and $x_2 = r \sin\theta$, where r and θ are the polar coordinates. Find the distribution of r^2 and θ . Thus, obtain a procedure for generating standard normal variables.
- b) Consider the following p.d.f. and generate three observations from this distribution.

$$f(x) = \begin{cases} x & \text{for } 0 \leq x \leq 1 \\ (2-x) & \text{for } 1 < x \leq 2, \\ 0 & \text{otherwise.} \end{cases}$$

[Use the table of random digits given overleaf.]

$(10 + 8) = [18]$

6. a) Explain the terms 'parameter', 'statistic', 'sampling distribution', 'standard error' and 'sampling fraction'.
- b) If x has the exponential distribution with p.d.f.

$$f(x) = \begin{cases} \theta e^{-\theta x}, & 0 \leq x < \infty, \\ 0 & \text{otherwise,} \end{cases}$$

where $\theta > 0$, then find the distribution of $(\sum_{i=1}^n x_i)$, x_1, x_2, \dots, x_n being random and independent observations from this distribution.

$(2 \times 5 + 7) = [17]$

TABLE - RANDOM DIGITS

11164	36318	75061	37674	26320	75100	10431	20418	19228	91792
21215	91791	76831	58678	87054	31687	93205	43685	19732	08468
10438	44482	66558	37649	08882	90870	12462	41810	01806	02977
36792	26236	33266	66583	60881	97395	20461	36742	02852	50564
73944	04773	12032	51414	82384	38370	00249	80709	72605	67497
49563	12872	14063	93104	78483	72717	68714	18048	25005	04151
64208	48237	41701	73117	33242	42314	83049	21933	92813	04763
51486	72875	38605	29341	80749	80151	33835	52602	79147	08868
99756	26360	64516	17971	48478	09610	04638	17141	09227	10606
71325	55217	13015	72907	00431	45117	33827	92873	02953	85474
65285	97198	12138	53010	94601	15838	16805	61004	43516	17020
17264	57327	38224	29301	31381	38109	34976	65692	98566	29550
95639	99754	31199	92558	68368	04985	51092	37780	40261	14479
61555	76404	86210	11808	12841	45147	97438	60022	12645	62000
78137	98768	04689	87130	79225	08153	84967	64539	79493	74917
62490	99215	84987	28759	19177	14733	24550	28067	68894	38490
24216	63444	21283	07044	92729	37284	13211	37485	10415	36457
16975	95428	33226	55903	31605	43817	22250	03918	46999	98501
59138	39542	71168	57609	91510	77904	74244	50940	31553	62562
29478	59652	50414	31966	87912	87154	12944	49862	96566	48825
96155	95009	27429	72918	08457	78134	48407	26061	58754	05326
29621	66583	62966	12468	20245	14015	04014	35713	03980	03024
12639	75291	71020	17265	41598	64074	64629	63293	53307	48766
14544	37134	54714	02401	63228	26831	19386	15457	17999	18306
83403	88827	09834	11333	68431	31706	26652	04711	34593	22561
67642	05204	30697	44806	96989	68403	85621	45556	35434	09532
64041	99011	14610	40273	09482	62864	01573	82274	81446	32477
17048	94523	97444	59904	16936	39384	97551	09620	63932	03091
93039	89416	52795	10631	09728	68202	20963	02477	55494	39563
82244	34392	96607	17220	51984	10753	76272	50985	97593	34320
96990	55244	70693	25255	40029	23289	48819	07159	60172	81697
09119	74803	97303	88701	51380	73143	98251	78635	27556	20712
57666	41204	47589	78364	38266	94393	70713	53388	79865	92069
46492	61594	26729	58272	81754	14648	77210	12923	53712	87771
08433	19172	08320	20839	13715	10597	17234	39355	74816	03363
10011	75004	86054	41190	10061	19660	03500	68412	57812	57929
92420	65431	16530	05547	10683	88102	30176	84750	10115	69220
35542	55865	07304	47010	43233	57022	52161	82976	47981	46588
86595	26247	18552	29491	33712	32285	64844	69395	41387	87195
72115	34985	58036	99137	47482	06204	24138	24272	16196	04393
07428	58863	96023	88936	51343	70958	96768	74317	27176	29600
35379	27922	28906	55013	26937	48174	04197	36074	65315	12537
10982	22807	10920	26299	23593	64629	57801	10437	43965	15344
90127	33341	77806	12446	15444	49244	47277	11346	15884	28131
63002	12990	23510	68774	48983	20481	59815	67248	17076	78910
40779	86382	48454	65269	91239	45989	45389	54847	77919	41105
43216	12608	18167	84631	94058	82458	15139	76856	86019	47928
96167	64375	74108	93643	09204	98855	59051	56492	11933	64958
70975	62693	35684	72607	23026	37004	32989	24843	01128	74658
85812	61875	23570	75754	29090	40264	80399	47254	40135	69916

**M-TECH(QR&OR) – 1st YEAR (E-STREAM)
SESSION: 2011-2012**

**BACKPAPER EXAMINATION
PROBABILITY -- 1**

{Answer all the questions}

Date: 23.12.11

Full marks:100

Time: 3 hours

[Symbols have their usual meaning]

1. a) Give the axiomatic definition of probability.
b) Arrange the following quantities in increasing order of magnitude with proper equality or inequality sign between them
 $P(A)$, $P(A)+P(B)$, $P(A\cup B)$ and $P(A\cap B)$
c) Assume that $P(A)$ and $P(B)$ are non zero
i) If A and B are independent can they be mutually exclusive?
ii) If A and B are mutually exclusive can they be independent?
d) State and Prove Poincare's theorem.

[3+5+5+7=20]

2. a) Let $(X, Y) \sim N_2(\mu_1, \mu_2, \sigma_1, \sigma_2, \rho)$.
Find $E(X/Y)$ and $\text{Var}(X/Y)$.
b) Two absent minded room mates A and B forget their umbrellas in some way or another. A always takes an umbrella when he goes out, while B forgets to take an umbrella with probability $1/2$. Probability that each of them forgets his umbrella at a shop is $1/4$. After visiting 3 shops they return home.
Find the probability that :
i. they have only one umbrella after their return.
ii. B has lost his umbrella given that there is only one umbrella in all after their return.

[10+10=20]

3. a) Let X follow Binomial distribution (with parameters n and p) truncated at $X = 0$.
Find the p.m.f and expectation of X.
b) In a bolt manufacturing company the specification for the length of the bolt is (35-63) cm. The percentage of bolts below the lower specification is 7% and the percentage of bolts above the upper specification is 11%. Assuming the length distribution of the bolts is normal find the mean and variance of the distribution.

[10+10=20]

4. a) Suppose X follows $N(\mu, \sigma^2)$. Let $Y = X^2$. Find the p.d.f of Y .
- b) If A, B, C are mutually independent events. Prove that $A \cup B$ and C are also independent.
- c) For events A_1, A_2, \dots, A_n satisfying $P(A_1 \cap A_2 \cap \dots \cap A_n) > 0$. Prove that,
 $P(A_1 \cap A_2 \cap \dots \cap A_n) = P(A_1) P(A_2/A_1) P(A_3/A_1 \cap A_2) \dots P(A_n/A_1 \cap A_2 \cap \dots \cap A_{n-1})$

[5+5+10=20]

5. a) Let $X \sim N(0,1)$ and $Y^2 \sim \chi^2$ with degree of freedom n . X and Y^2 are independently distributed. Let $t = X / \sqrt{Y^2/n}$. Find p.d.f of t .
- b) Let $X \sim P(m)$.

Show that $P(X \leq m/2) \leq 4/m$ (State the result you have used)

[12+8=20]

INDIAN STATISTICAL INSTITUTE
Mid-semester Examination: 2011-2012 (Second Semester)

M. Tech(QR & OR) I Year (E & S Stream)

Reliability-I

Date: February 20, 2012

Full Marks: 50

Duration: 2 hours.

Note: Answer all questions.

1. (a) Define a coherent system.
- (b) Consider a system with three components. Let x_1 , x_2 and x_3 be the binary state variables and ϕ the structure function of the system. The states of the components and system are given in the following Table. Check whether the system is coherent. Find the min path sets.

x_1	x_2	x_3	$\phi(x)$
0	0	0	0
1	1	0	1
1	0	1	1
1	1	1	1
1	0	0	0
0	1	0	0
0	0	1	0
0	1	1	0

[2+(6+2)=10]

2. Consider a system with three modules connected in series. Module 1 functions if at least one of the components 1 and 2 functions. Module 2 has only one component (3). Module 3 is with three components 4, 5 and 6 connected in parallel.

- (a) Draw the reliability block diagram of the system.
- (b) Find the structure function of the system using min cut sets.
- (c) Calculate the structural importance of component 3.
- (d) Construct fault tree for the failure of the system. Find the min cut sets.

[2+4+5+4=15]

3. Let ϕ be a coherent structure of n independent components with respective reliabilities p_1, \dots, p_n , and system reliability $h(\underline{p})$. Then show that

$$\text{Cov} \left[\phi(\underline{X}), \sum_{i=1}^n X_i \right] = \sum_{i=1}^n p_i q_i \frac{\partial h(\underline{p})}{\partial p_i}$$

[8]

4. Let ϕ be a coherent structure of n associated components with component reliabilities p_1, \dots, p_n . Suppose P_1, \dots, P_r are the min path sets and K_1, \dots, K_k are the min cut sets corresponding to ϕ . Then show that the system reliability satisfy the following

$$\max_{1 \leq r \leq p} \prod_{i \in P_r} p_i \leq P[\phi(\underline{X}) = 1] \leq \min_{1 \leq s \leq k} \prod_{i \in K_s} p_i.$$

[If you use any results to prove the above result, state the results clearly.]

[10]

5. Consider the system in Question 2. Suppose that the component reliabilities are same and equal to 0.6. (i) Find the reliability of the system assuming components are independent. (ii) Find the bounds in Question 4 on system reliability assuming components are associated.

[2+5=7]

INDIAN STATISTICAL INSTITUTE

Mid-Semestral Examination : 2011 – 12

M.Tech. in QR & OR

Subject : PROBABILITY – II

Date: 22.02.2012

Maximum Marks : 70

Duration: 2 Hours

Notes:

- (1) Unless stated otherwise, “M.C.” will refer to a discrete time parameter, time-homogeneous Markov Chain.
- (2) The symbols have their usual meanings.

(1) Define the following:

- (a) Stochastic Process.
- (b) State space and Parameter space.
- (c) Markov property.
- (d) Transition probabilities.
- (e) First passage probabilities.

(5 × 4)=[20]

(2) (a) Suppose $\{X_n | n \in \{0, 1, 2, \dots\}\}$ is a M.C. with state space I , initial distribution $\Pi = \{\Pi(i) | i \in I\}$ and transition matrix $P = \left((p_{ij}) \right)_{i, j \in I}$. Derive the joint distribution of X_0, X_1, \dots and X_n .

(b) Using the result obtained in (a), prove that

$$P(X_0=i_0 | X_1=i_1, \dots, X_n=i_n) = P(X_0=i_0 | X_1=i_1) \text{ for all } n \in \{0, 1, 2, \dots\} \text{ and } i_0, i_1, \dots, i_n \in I \text{ such that L.H.S is defined.} \quad (15 + 5)=[20]$$

(3) Suppose we have two boxes, labeled 1 and 2 and 4 balls, labeled 1, 2, 3 and 4. Initially, some of these balls are in box 1 and the remainder are in box 2. An integer is selected at random from $\{1, 2, 3, 4\}$ and the ball labeled by that integer is removed from its box and placed in the other box. This procedure is repeated indefinitely. Assume that the selections are independent from trial to trial. Let X_n denote the number of balls in box 1 after the n th trial ($n=1, 2, \dots$). Show that $\{X_n | n \in \{0, 1, 2, \dots\}\}$ is a M.C. and find its transition matrix. [10]

(4) (a) State and prove the Chapman – Kolmogorov Equations for a M.C. (You can use the fact that $P^{(m)}=P^m$ for $m=0, 1, 2, \dots$).

(b) Show that

$$p_{ij}^{(n)} = \sum_{k=0}^n f_{jj}^{(k)} p_{ji}^{(n-k)} \text{ for } n = 1, 2, \dots \text{ and } i, j \in I$$

(5+15)=[20]

INDIAN STATISTICAL INSTITUTE
Mid- Semestral Examination: 2011-12

Course Name : M. TECH (QR-OR)-I
Subject Name : MECHANICAL ENGINEERING
Date: 24.02.12 Maximum Marks: 50 Duration: 2 hours
Note, if any :

Answer question No. 1 and three from the rest

1. a) Trimming recess is provided on blanking die.
i) True ii) False
b) Nose of the aero plane is formed by spinning operation.
i) True ii) False
c) No clearance is provided on deep drawing die.
i) True ii) False
d) Spanners are manufactured by drop forging process.
i) True ii) False
e) In grooving operation no feed is required.
i) True ii) False
1 X 5
2. a) Write the differences between hot working and cold working.
b) For a manufacturing system, explain the parameters for judging the quality of a product.
c) Briefly discuss about Tresca's and von Mises' criteria in metal forming operation.
5 + 5 + 5
3. a) Give neat labeled sketches of two high and three high rolling mills. Also discuss about the rolling process.
b) What are closed die forging and open die forging processes? How are the coins manufactured? Explain the process.
c) Show the different sections of drawing die on a sketch. Discuss about the different types of drawing bench.
5 + 5 + 5
4. a) Explain the forward and backward extrusion processes and compare among them.
b) Why is the lubrication necessary in the die-job interface? Give idea about the lubricant.
c) Discuss the deep drawing process with necessary sketch(es).
5 + 5 + 5
5. a) What is HERF process? Explain with suitable examples why the HERF processes are used.
b) With help of neat sketches discuss the explosive forming processes.
7 + 8
6. a) Define mechanism, machine and machine tool.
b) Show the following operations with the help of sketches:
i) turning operation
ii) facing operation
iii) shaping operation
c) Give a classification of machine tools.
5 + 5 + 5

14/02/12

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

Date: 24.02.12.

Maximum Marks: 100

Duration: 3 Hrs.

Note: Answer any five (5) questions.

1. a) Define and explain the following
 - i) Estimator and Estimate,
 - ii) Minimum Variance Unbiased (MVU) estimator.
- b) Prove that MVU estimator is unique.

[5 + 5 + 10 = 20]

2. a) When a statistic is said to be a sufficient statistic?
- b) Show that, if σ^2 is known in a random sample from a normal population, \bar{x} is a sufficient estimator for μ ; but $s^2 = \frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})^2$ is not a sufficient estimator of σ^2 , if μ is known. Suggest a sufficient estimator for σ^2 .

[5 + 15 = 20]

3. a) A particular brand of diet margarine was analyzed to determine the level of polyunsaturated fatty acid (in percentage). A sample of six packages resulted in the following data:

16.8, 17.2, 17.4, 16.9, 16.5, 17.1

Assuming that the level of polyunsaturated fatty acid is normally distributed, find a 99% confidence interval on the population mean μ .

- b) A new filtering device is installed in a chemical plant. Before its installation, a random sample of 8 units yielded the following information about the percentage of impurity: $\bar{y}_1 = 12.5$, $s_1^2 = 101.77$. After installation, a random sample of 9 units yielded $\bar{y}_2 = 10.5$, $s_2^2 = 94.73$.

- i) Can you conclude that the two variances are equal? Use $\alpha = 0.05$.
- ii) Has the filtering device reduced the percentage of impurity significantly? Use $\alpha = 0.05$.

[8 + 4 + 8 = 20]

4. a) Define and explain Uniformly Most Powerful Unbiased Test.
 b) Let x_1, x_2, \dots, x_n be a random sample from a normal distribution with unknown mean μ and known variance σ^2 . Use likelihood ratio test to define the critical region for the following test hypothesis:

$$H_0 : \mu = \mu_0$$

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

[6 + 14 =20]

5. a) The life in hours of a battery is known to be normally distributed with standard deviation $\sigma = 1.25$ hours. A random sample of 10 batteries has a mean life of $\bar{x} = 40.5$ hours.
 i) Is there evidence to support the claim that mean battery life exceeds 40 hours? Use $\alpha = 0.05$.
 ii) What is the P-value for the above test?

- b) Let X denote the number of defects observed on a large coil of galvanized steel. 75 coils are inspected and the following frequency data were observed for the values of X :

Values	1	2	3	4	5	6	7	8
Observed Frequency	1	11	8	13	11	12	10	9

Does the assumption of the Poisson distribution seem appropriate as a probability model for this data? Use $\alpha = 0.01$.

[5 + 2 + 13 = 20]

6. a) Yield of a chemical process is known to be normally distributed with a standard deviation of 3. If the upper and lower confidence limits of the true mean yield, based on a sample of 50 days of plant operation, are found as 91.35 and 89.65 respectively, calculate the corresponding confidence coefficient?

- b) In his experiments with peas, Gregor Mendel observed that 315 were round and yellow, 108 were round and green, 101 were wrinkled and yellow, and 32 were wrinkled and green. According to his theory of heredity, the numbers should be in the proportion 9 : 3 : 3 : 1. Is there any evidence to doubt his theory at 0.01 significance level?

[8 + 12 =20]

Mid-semester Examination

M. Tech. (QR & OR): 2012

Subject: SQC II

Time: 3 hours

DATE - 27.02.12.

Group A: Answer as many as you can but the maximum you can score is 60.

1. State the in-control statistical model for Shewhart \bar{X} -bar chart. Identify the ways in which the assumptions underlying the model may be violated in practice and suggest suitable control charts that may be used in all such cases. Indicate clearly how the suggested control charts take care of the model violations.

[20]

2. Let the random variable Y denote the number of samples required to detect a shift in process mean by a specified amount following some rules. Consider the following two performance measures of a control chart: (i) $E(Y)$ and (ii) $P(Y=1)$. Compare the two measures and offer your comments. Do you think that the second measure is more appropriate for short production run situations? Explain.

[10]

3. Distinguish between (a) Shift and drift (b) Control charting and EPC.

[10]

4. Consider a production process with two observable quality characteristics X_1 and X_2 . For the purpose of process monitoring 25 samples are taken and the averages of X_1 and X_2 are computed. Let one such observation be (65, 40). Compute the T^2 value to be plotted on the T^2 control chart for the observation.

$$\text{Assume } \bar{X} = \begin{bmatrix} 55 \\ 30 \end{bmatrix} \quad S = \begin{bmatrix} 200 & 130 \\ 130 & 120 \end{bmatrix} \quad S^{-1} = \begin{bmatrix} +0.017 & -0.018 \\ -0.018 & +0.028 \end{bmatrix}$$

Find a point which may not indicate an out-of control situation when two separate \bar{X} -bar charts are used but is likely to fall outside the control limits of the T^2 chart.

[15]

5. The Cycle Time (CT) in hours for fifty batches of a batch chemical process is given below. Construct a histogram of cycle time and then examine the stability of the process using a suitable control chart. Offer your comments on the status of the process based on the above analysis.

[25]

Batch	1	2	3	4	5	6	7	8	9	10	11	12	13
CT	11.25	5.33	8.50	10.25	7.00	10.00	6.25	8.58	5.25	6.92	6.00	5.00	7.00
Batch	14	15	16	17	18	19	20	21	22	23	24	25	26
CT	10.50	7.92	8.50	7.33	5.75	6.08	13.00	6.25	11.58	6.50	5.00	6.50	5.50
Batch	27	28	29	30	31	32	33	34	35	36	37	38	39
CT	6.42	5.75	9.75	7.00	8.84	7.75	7.50	11.50	7.50	7.50	4.67	4.75	4.83
Batch	40	41	42	43	44	45	46	47	48	49	50		
CT	4.83	5.42	6.67	5.75	6.00	6.42	4.67	4.67	5.00	7.67	4.75		

Answer any two questions.

1. (a) State the definition of 'Quality' given by Taguchi.
 (b) Give one example of 'loss caused by harmful effects'.
 (c) Let m be the ideal value, say, for length of a component part. $m \pm \Delta$ be the specification of it. 'A' be the loss sustained at the specification terminal points. Determine the average loss per product due to variation.
 (d) Does really quality of product improve by implementing 100% inspection? Explain your answer. [2+2+12+4=20]

2. (a) Let us consider a quality control system where the process is diagnosed on every 'n' production units by checking product and if it is found abnormal, then it is adjusted to the normal condition. On the other hand, if the process is found normal, the production is continues without any adjustment operation. Suppose, loss due to production of a defective product is A , diagnosis cost is B , adjustment cost is C , average trouble occurrence interval is \bar{u} and the number of production units produced before the process is stopped after a product is found abnormal on diagnosis is l . Determine the optimal diagnosis interval for this quality control system.
 (b) An automatic welding m/c is diagnosed once in every 100 products. The diagnosis is done by checking the welded part of a product and if it is found abnormal the process is adjusted. When the welding m/c is under abnormal condition, it produces defective products and all the defectives found will be scrapped. The loss due to scraping one defective item is Rs.50/-. One diagnosis cost is Rs.160/-. Although collecting samples does not take any time, a diagnosis takes 8 minutes and 30 products are produced during 8 minutes. The adjustment cost when the m/c is found abnormal is Rs.2000/-. Further from records it was observed that 16 m/c troubles occurred in the last 2 month, while the total production was 84000 items.
 Estimate the quality control cost per product. Find out the optimal diagnosis interval and the cost at optimal interval. [12+8=20]

3. (a) State three possible actions which can increase the average trouble occurrence interval in a production process.

(b) At a production process of ring hollowing of automobile part two types of defectives occur where one is reworkable defective and is 20% of all defectives and the other is non-reworkable defective and is 80% of all defectives. The loss due to producing one reworkable defective item is Rs.60/- and the loss due to producing one non-reworkable defective item is Rs.500/-. Diagnosis cost is Rs.15/- and adjustment cost is Rs.9800/-. During last one month, 2 machine troubles occur while the total production was 8500 items. Time lag is 4 items. The tool cost within the adjustment cost is Rs.2500/-. Now tool with longer life than the present one came into market with unit cost of Rs.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.

(c) A factory produces LP records by using press machine. It has 40 press machines and each of those presses one LP record per minute. The work hours per week are 40 hours. Once in a while an LP record press machine produces defective record due to some disturbances such as dust, discrepancy of adjustment, etc. At present a diagnosis is done on every 100 records. Suppose the loss due to producing one defective record is Rs.120/-, the diagnosis cost is Rs.800/-, the time lag of diagnosis is 30 records, the average trouble occurrence interval is 8000 records, the average adjustment time is 2 hours and finally the adjustment cost C is Rs.5000/-. Find the optimal diagnosis interval and the optimal number of diagnosis – adjustment operators. [3+9+8=20]

INDIAN STATISTICAL INSTITUTE

Second Mid-Semester Examination (2011 – 2012)

Course Name : M.Tech (QR & OR)
Subject : Industrial Engineering and Management
Date : 29/2/2012
Maximum Marks : 60
Duration : 120 minutes

Question Paper

Direction: For multiple choice questions, please record your answer in your answer sheet indicating clearly the question number.

Answer questions 1 to 10 and any two from the rest

Marks: (2 X 10 = 20 + 20 X 2 = 40) = 60

1. The lay out where the equipment, machinery, plant and people move as necessary is known as:
 - (a) Cell layout
 - (b) Product layout
 - (c) Fixed-position layout
 - (d) Process layout

2. A supermarket is usually positioned as:
 - (a) Product layout
 - (b) Fixed-position layout
 - (c) Process layout
 - (d) Cell layout

3. A self-service cafeteria is usually positioned as:
 - (a) Process layout
 - (b) Product layout

- (c) Fixed-position layout
 - (d) Cell layout
4. A process with high variety and low volume is likely to have a:
- (a) Fixed-position layout
 - (b) Product layout
 - (c) Process layout
 - (d) Cell layout
5. A company has fixed costs of Rs 200,000 per annum. It costs Rs 3.50 to make each of its products. At what price would the company have to sell its products to give a break-even volume of 50,000 units?
- (a) Rs 4.50
 - (b) Rs 8.25
 - (c) Rs 7.00
 - (d) Rs 7.50
 - (e) Rs 8.00
6. Operations management is applicable
- (a) mostly to the service sector
 - (b) to services exclusively
 - (c) mostly to the manufacturing sector
 - (d) to manufacturing and service sectors
 - (e) to the manufacturing sector exclusively
7. Gibson Valves produces cast bronze valves on an assembly line, currently producing 1600 valves each 8- hour shift. If the productivity is increased by 10%, it would then be
- (a) 180 valves/hr
 - (b) 200 valves/hr
 - (c) 220 valves/hr
 - (d) 880 valves/hr
 - (e) 1760 valves/hr
8. The total of all outputs produced by the transformation process divided by the total of the inputs is
- (a) utilization
 - (b) greater in manufacturing than in services
 - (c) defined only for manufacturing firms
 - (d) multi-factor productivity
 - (e) none of the above
9. Which of the following inputs has the greatest potential to increase productivity?
- (a) labor
 - (b) globalization

- (c) management
- (d) capital
- (e) none of the above

10. Productivity can be improved by
- (a) increasing inputs while holding outputs steady
 - (b) decreasing outputs while holding inputs steady
 - (c) increasing inputs and outputs in the same proportion
 - (d) decreasing inputs while holding outputs steady
 - (e) none of the above

11. Explain the three steps of work system design.

12. The utility data for a network is given below. Crash the network to minimum project duration and determine the project cost for that duration.

Activity	Normal		Crash	
	Duration	Cost	Duration	Cost
	Weeks	Rs	Weeks	Rs
0 - 1	1	5,000	1	5,000
1 - 2	3	5,000	2	12,000
1 - 3	7	11,000	4	17,000
2 - 3	5	10,000	3	12,000
2 - 4	8	8,500	6	12,500
3 - 4	4	8,500	2	16,500
4 - 5	1	5,000	1	5,000

- 13.
- (a) Operator training is used to improve productivity. True or False. Explain.
 - (b) Higher productivity means better standard of living. Explain with an example.
 - (c) What are the drawbacks of profit to cost ratio?
 - (d) What are the different steps to be followed to improve a process?

INDIAN STATISTICAL INSTITUTE

Mid-Semester Examination: 2011-12(Second Semester)

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

Subject Name: Instrumentation and Computer Engineering

Date: 02.03.12

Maximum Marks: 60

Duration: 2 Hrs

Answer any 5 questions.

1. What is the difference between an active transducer and a passive transducer? Discuss about the operational procedure of resistance strain gauges, photomultiplier tube and rotary plate capacitor. [3+(3+3+3)=12]
2. Draw the block diagram of an automatic control system and define process lag, control lag and dead time. Explain the operation procedure of a proportional plus integral (PI) control action with related equations. How the output of the controller varies with a step change in error signal? [5+4+3=12]
3. Derive the expression of the output voltage for 3 bit R-2R ladder digital to analog (D/A) convertor. The output of the same 3 bit R-2R ladder D/A convertor is now connected with inverting terminal of an OPAMP through a resistance 2R. Derive the expression of the output analog voltage of the OPAMP for a feedback resistance of 4R. [9+3=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 15. [2+10=12]
5. Explain the operation of a RS flip flop with contribution of it's individual gates for every possible input bits. [3+3+3+3=12]
6. What is the difference between combinational and sequential digital circuits? How a shift register can store a binary number 1101? Show the reading of the register after each clock pulse for the same binary number. [2+7+3=12]
7. Design a 3 bit synchronous counter such that, the binary equivalent of the series 3, 4, 2, 1, 0, 6, 5, 7 can be realized at the output. [12]
8. What is a T type Flip flop? Show the working procedure of a 4 bit asynchronous DOWN counter with circuit and timing diagram. [2+10=12]

INDIAN STATISTICAL INSTITUTE
Semester Examination: 2011-2012 (Second Semester)

M. Tech(QR & OR) I Year (E & S Stream)

Reliability-I

Date: 23 April, 2012

Full Marks: 100

Duration: 3 hours.

Note: Total marks: 108. Answer as many questions as you can but the maximum you can score is 100.

1. Consider a k-out-of-n system of independent and identically distributed components. The reliability of each component is $R(t)$. Find the reliability of the system. Hence find the expected lifetime of the system if $1/\lambda$ is the mean lifetime of each component assumed to be exponential.

[6+8=14]

2. Consider a parallel system of n associated components. Let $R_i(t)$ be the reliability of i th component. Show that the system reliability $R_s(t)$ satisfies

$$R_s(t) \leq \prod_{i=1}^n R_i(t).$$

[16]

3. (a) Define hazard rate. Give an example of IFR life distribution.
(b) Show that if the conditional reliability of a device is decreasing function of age, then the corresponding hazard rate is increasing, provided the pdf of lifetime exist.
(c) Let $F_1(t)$ be a continuous distribution function. For some positive α , define the distribution function $F_2(t)$ such that

$$\bar{F}_2(t) = (\bar{F}_1(t))^\alpha, \text{ where } \bar{F}_1(t) = 1 - F_1(t) \text{ and } \bar{F}_2(t) = 1 - F_2(t).$$

Find the relationship between $\lambda_2(t)$ and $\lambda_1(t)$, the respective hazard rate of F_2 and F_1 .

[3+6+6=15]

4. Consider a series system with three independent components. The hazard rates of first and second components are $\lambda_1(t) = \lambda_1$ and $\lambda_2(t) = 3.5\lambda_2^{3.5}t^{2.5}$, respectively. The third component has life time distribution with pdf $f(t) = \lambda_3^2 t e^{-\lambda_3 t}$, $t > 0$.

- (a) Find the hazard rate of the system.

(b) Check whether the system lifetime distribution is IFR or DFR.

[6+9=15]

5. Consider a 2-unit standby redundant system with a switch. Suppose unit 1 is the active unit and unit 2 is the standby unit. The standby unit carry weak load while in standby mode. The lifetime of unit 1 has constant failure rate λ_1 . The lifetime of unit 2 is exponential with rate λ_2 while in active mode and λ_2^0 while in standby mode. It is known that the switch never fails to activate the standby unit when active unit fails. Assume that all the lifetimes are independently distributed. Find the reliability of the system at time t . Hence or otherwise find the expected lifetime of the system.

[7+5=12]

6. A life test was conducted for a particular type of integrated circuit (IC). A total of 20 ICs were tested and 5 failed before 500 hours, when the test was stopped. Failure times were at 252, 315, 369, 403 and 474 hours. Assume that the lifetime distribution follows log-normal distribution with parameters μ and σ . Maximum likelihood estimates of the log-normal parameters are $\hat{\mu} = 6.56$ and $\hat{\sigma} = 0.534$. The variance-covariance estimate for $\hat{\mu}$ and $\hat{\sigma}$ is

$$\hat{\Sigma}_{\hat{\mu}, \hat{\sigma}} = \begin{bmatrix} 0.0581 & 0.0374 \\ 0.0374 & 0.0405 \end{bmatrix}.$$

- (a) Compute the maximum likelihood estimate of 0.75th quantile. Give an estimate of its standard error.
- (b) Consider the above data. Assume that the lifetime distribution follows exponential distribution with parameter λ . Derive the maximum likelihood estimate of λ . Give an asymptotic 95% confidence interval for λ . Obtain the maximum likelihood estimate of expected number of failures.

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

7. A life testing experiment was conducted with 15 items. The lifetime in hours of 15 items were as follows:

50, 58, 61, 63, 82, 92, 98, 102, 105, 108, 120, 121, 140, 162, 172.

Assume that the lifetime follows exponential distribution with mean $1/\lambda$.

- (a) Derive an exact 95% confidence interval for λ .
- (b) Give the nonparametric estimate of $R(180)$ along with estimated standard error.
- (c) Discuss the method of Q-Q plot to verify whether the lifetime distribution follows exponential distribution or not.

[7+4+5=16]

INDIAN STATISTICAL INSTITUTE
Second Semestral Examination : 2011-12

M. Tech. (QR & OR), I year, E-Stream

Subject : PROBABILITY – II

Date : 25.04.2012

Maximum Marks: 100

Duration : 3 hours

- Notes : (1) Answer all questions.
(2) The symbols have their usual meanings.

(1) Define the following:

- a) Class property
- b) Irreducible Markov chain
- c) Essential and Inessential states
- d) Recurrent and Transient states
- e) Positive and Null Recurrence

(5 × 4) = [20]

(2) Consider a Markov chain with state space $I = \{1, 2, 3, 4, 5, 6\}$ and transition probability matrix:

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

Find the different classes of this Markov chain and classify the states as recurrent or transient. [20]

(3) Consider a Markov chain $\{X_n | n \in \{0, 1, 2, \dots\}\}$ with state space S and transition matrix P . Let i be a recurrent state and T_1 and T_2 denote the times of first and second visits to state i respectively. Show that for all $m \in \{1, 2, \dots\}$

$$P(T_1 = m | X_0 = i) = P(T_2 - T_1 = m | X_0 = i) \quad [15]$$

(4) Show that the one dimensional unrestricted random walk over the set of integers $I = \{\dots, -2, -1, 0, 1, 2, \dots\}$ is recurrent if and only if $p = q = 1/2$. [20]

- (5) Consider a Markov chain with state space I and transition matrix P . For $i \in I$, let N_i denote the number of visits to state i at positive time points $n=1,2,\dots$. Show that

$$E(N_i | X_0 = i) = \begin{cases} \frac{f_{ii}^*}{1 - f_{ii}^*} & \text{if } i \text{ is transient} \\ \infty & \text{if } i \text{ is recurrent} \end{cases}$$

[25]

INDIAN STATISTICAL INSTITUTE
Second Semester Examination: 2011-12

M. Tech. (QR & OR)

Subject: SQC II

Date: 27.04.2012

Maximum marks: 100

Duration: 3 hours

Group: A

Marks: 40

Note: Answer all questions

1. (a) Suppose specification for the length of a product is $m \pm 5$ mm., process average is m and the standard deviation (σ) is $10/6$. Show that the variance of the outgoing products will be $\sigma^2 \times 0.986^2$ if 100% inspection is done. It is given that

$$\int_{-3}^3 \frac{1}{\sqrt{2\pi}} t^2 e^{-\frac{1}{2}t^2} dt = 0.9696.$$

- (b) Suppose, for the product and process described in (a), the inspection cost per product is Rs.3/- and the loss for a defective found is Rs.600/-. Then estimate the total loss per product in the following two cases (i) products are shipped after 100% inspection and (ii) products are shipped without inspection.

- (c) The diagnosis method for a process is as follows: A product immediately after welding operation is taken to a testing room and the welded portion is evaluated by checking its appearance and by a tensile test. It takes 8 minutes from sampling to judgment. Moreover, it is a destructive test. Diagnosis cost is Rs.160/- and the time lag l is the time required to produce 30 products. The loss due to a defective is Rs. 50/-, adjustment cost is Rs.2000/- and average trouble occurrence interval is 5250 products.

A new diagnosis method, which uses supersonic waves, is introduced to examine welding without a destructive test. Its time lag l is 2 products. The diagnosis cost B is Rs.40/- which includes the cost of patrolling by diagnosis operators. Find out if this newly developed diagnosis method is profitable to use.

[5+5+8=18]

2. At present, diagnosis on production process of a part is done at its assembly process by using the information from 100% inspection. Since defective is found easily at the assembly process, its diagnosis cost B_0 is nil. The loss due to a defective part A_0 is Rs.50/-, adjustment cost C is Rs.5000/-, time lag l_0 is 800 parts, the production during last 3 months was 300000 parts and the number of troubles during last 3 months was 20. The management is considering possibility of diagnosing immediately after the production of parts. In that case, the diagnosis cost B increases to Rs.100/- and the time lag l decreases to 5 parts. Moreover, the loss due to defective A decreases to Rs.40/- for reduction of supplemental value, and the new adjustment cost C' remains the same as the present, namely Rs. 5000/-.

(a) Discuss the loss or gain for this proposal in which diagnosis are done immediately after production.

(b) As preventive maintenance, a periodical tool change with interval $\bar{u}' = 10000$ parts is introduced where the risk of trouble before a tool change is 0.02. Discuss the loss or gain for both diagnoses system when this preventive maintenance is introduced. Assume $C = C'$.

[10]

3. Suppose, 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_t , the value of the quality characteristic is measured (predicted) and instead of adjusting the whole gap between the measured value and the target value, β times the gap is adjusted (β is nonnegative). Determine the optimal value of β .

[12]

Group: B

Marks: 60

Note: Total marks: 72. Answer as many questions as you can. But the maximum you can score is 60.

1. The following questions are related to the (economic) design of X-bar chart.

(a) Let ARL1 and ARL2 be the average run lengths when the process is in-control and out-of-control respectively. Define ARL1 and ARL2 in terms of the type I and type II errors. State the assumptions involved, if any. Name the factors affecting ARL1 and ARL2.

(b) Let a Quality Control Cycle (QCC) be defined as the time between the start of two consecutive in-control periods. Draw the sketch of a QCC indicating the various components of the cycle time.

(c) Give examples of process situations where the time lag between sampling and charting the result is (i) negligible, (ii) moderately large and (iii) very large.

(d) Let the in-control time is distributed as an exponential distribution with mean $1/\lambda$. Show that the expected number of samples (S) taken while the process is in control is given by

$$S = \frac{\exp(-\lambda h)}{1 - \exp(-\lambda h)},$$

where h is the sampling interval.

(e) State the various cost components considered in the Duncan's model. State the assumptions made in deriving the expressions for these cost components.

[10+5+3+10+7=35]

2. (a) Distinguish among the operating procedures of CSP-1, CSP-2 and CSP-T (CSP=Continuous Sampling Plan).

(b) Derive the expression for Average Fraction Inspected (AFI) of CSP-1.

(c) Name the plans contained in MIL-STD1235C. In this standard, what is meant by "production interval"? How is it determined?

(d) In CSP-1, we begin with 100% inspection. There are other continuous sampling schemes that begin with sampling inspection and then switch over to 100% inspection. State some reasonable criteria for switching over from sampling to 100% inspection and back to sampling.

(e) Consider a production situation where both lotting and continuous inspection are feasible. Under what sort of defect generation process, a lot based acceptance procedure may be preferred over CSP-1?

[5+10+6+5+5=31]

3. (a) Some individual univariate procedures are needed to analyze the out-of-control signals from a T^2 chart. Then why do we use a T^2 chart?

(b) What are the advantages and disadvantages of using a T^2 chart based on the principal components of the original variables?

[3+3=6]

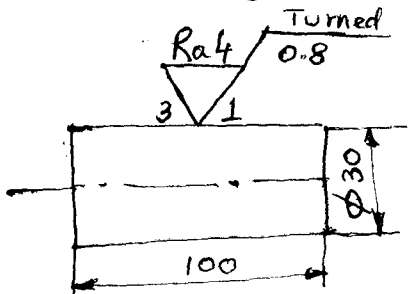
INDIAN STATISTICAL INSTITUTE
Second Semestral Examination: 2011-12

Course Name : M. TECH (QR-OR)-I
 Subject Name : MECHANICAL ENGINEERING
 Date: 30.4.2012. Maximum Marks: 100 Duration: 3 hours
 Note, if any :

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

1. a) Define fit. State and explain the different types of fit in hole basis system. Give illustrative sketches.
- b) Explain upper deviation and lower deviation.
- c) Determine the type of fit for the assembly 40 H7-d8. The diameter step is 30 to 50 mm. The fundamental deviation for 'd' shaft = $-16 D^{0.44}$, IT7=16i, IT8=25i where i (standard tolerance unit in micron) = $0.45(D)^{1/3} + 0.001D$, D is in mm. Sketch to show the dimensions. 7 + 3 + 10

2. a) What are ~~by~~ ^{by} meant ^{by} macro-geometric deviation of surface and surface roughness?
- b) 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 mm²
 Below: 70 90 170 155 mm²
 Why is the vertical magnification so high in comparison to the horizontal magnification?
- d) What are ^{the} effects of surface roughness on the performance of a machined component? Explain clearly.
- c) Explain all the information given in the drawing:



3. a) Define the term 'metrology'. What are accuracy and sensitivity of a measuring instrument?
- b) Explain the controllable error and random error of an instrument.
- c) What is meant by 'end standard' of measurement?
- d) Explain the following terms:
 i) brittleness ii) toughness iv) hardness v) ductility 6 + 4 + 2 + 8

4. a) What is meant by High-Energy-Rate-Forming process? With suitable examples explain its necessity.
- b) With the help of neat sketches, discuss the process of explosive forming (confined and unconfined).
- c) A charge of TNT weighing 10 N is used in an unconfined explosive forming operation. Plot the peak pressure over the work surface with stand-off distance. Given that the constant of proportionality for TNT is 4320, the index of stand-off distance is 1.15. 5 + 7 + 8
5. a) Define the following in connection with metal cutting:
i) cutting speed ii) feed iii) depth of cut
- b) Find out the expression for uncut chip cross section in terms of depth of cut and feed.
- c) A grinding wheel is specified as
A - 36 - L - 7 - V.
Explain all the terms of it.
- d) Give sketches indicating the motions for the following operations:
i) shaping a flat surface ii) drilling a hole 6 + 4 + 6 + 4
6. a) Explain generation and forming principles of machining.
- b) Sketch the Merchant's Circle Diagram and on the diagram show the different forces.
- c) Estimate the power required during the up milling of steel block of 20 mm width using a straight slab milling cutter with 10 teeth, 75 mm diameter, and 10° radial rake. The feed velocity of the table is 100 mm/min, the cutter rotates at 60 rpm, and the depth of cut is 5mm. 4 + 6 + 10
7. a) With help of neat sketch(es), explain the abrasive jet machining. Write the expression for material removal rate. State about the mechanics of material removal, media, abrasives and critical parameters for the said process.
- b) Briefly discuss the process of electrochemical machining.
- c) A single point turning tool is specified as: $6^\circ-10^\circ-7^\circ-8^\circ-10^\circ-30^\circ-0.5\text{mm}$ (ASA). Sketch the tool to show all the relevant features of it. 7 + 5 + 8
8. a) What is tool life? Write Taylor's Tool Life equation and explain it.
- b) Discuss the different modes of tool failure. Write the essential properties of an ideal tool material.
- c) Name some common tool material.
- d) What are machines and machine tools? Give examples of them.
- e) What is CNC machine tool? 5 + 7 + 2 + 4 + 2

INDIAN STATISTICAL INSTITUTE
 Second Semestral Examination: 2011-12
 M. Tech (QROR), I year, E-Stream
 Statistical Methods – II

Date: 30.04.12

Maximum Marks: 100

Duration: 3 Hrs.

Note: Answer any 5 (five) questions.

1. a) Show that in case of single factor fixed effect experimental design, the total variability can be partitioned into two components as follows

$$TSS = SS(treatment) + SS(error)$$

and hence derive the simplified formulas for computing the sum of squares.

b) An experiment was run to determine whether four specific firing temperatures affect the density of certain type of brick. The experiment resulted in the following data:

Temperature	Density				
100	21.9	21.9	21.8	21.6	21.8
125	21.2	21.4	21.3	21.4	
150	21.9	21.8	21.8	21.7	21.9
175	21.9	21.7	21.8	21.9	

Does the firing temperature affect the density of the bricks? Use $\alpha = 0.05$.

[10+10=20]

2. 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 randomly selects four feed rates and uses a high and low drill speed chosen to represent the extreme operating conditions. He obtains the following results.

Drill Speed	Feed Rate			
	0.015	0.025	0.045	0.065
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

- a) Write down the appropriate statistical model, stating appropriate assumptions and hence derive the expression for expected mean squares for the model components.
- b) Suitably analyze the data and draw appropriate conclusion. Use $\alpha = 0.05$.
- c) Estimate appropriate variance components.

[7+10+3=20]

3. A study was initiated to investigate the linear relationship between pavement deflection (y) and roadway surface temperatures (x). Summary quantities were $n = 20$, $\sum y_i = 12.75$, $\sum y_i^2 = 8.86$, $\sum x_i = 1478$, $\sum x_i^2 = 143215.8$ and $\sum x_i y_i = 1083.67$.

- a) Calculate the least square estimates of the slope and intercept.
- b) Test for significance of the regression coefficient using analysis of variance assuming $\alpha = 0.05$. What conclusions can you draw?
- c) Find the 95% confidence intervals on the intercept and the slope.
- d) Calculate R^2 for this model and give the practical interpretation for the same.

[5+6+6+3=20]

- 4 a) What is nonparametric statistical method?
- b) Explain the advantages of nonparametric methods.
- c) The impurity level (in ppm) is routinely measured in an intermediate chemical product. The following data were observed in a recent test:

2.4	2.5	1.7	1.6	1.9	2.6	1.3	1.9	2.0	2.5	2.6
2.3	2.0	1.8	1.3	1.7	2.0	1.9	2.3	1.9	2.4	1.6

It is claimed that the median impurity level is less than 2.5 ppm. State and test the appropriate hypothesis using the Wilcoxon Signed-Rank Test with $\alpha = 0.05$.

[3+5+7=20]

5. a) Two random samples of size 9 and 11, each consisting of 25 tablets, are collected from two machines producing the same tablet under identical manufacturing conditions and average weight of the 25 tablets were recorded. The data are shown below.

Serial Number	1	2	3	4	5	6	7	8	9	10	11
Sample 1	2.1	2.6	3.2	2.7	3.1	2.9	3.3	2.4	3.4		
Sample 2	2.5	2.7	2.8	3.6	4.0	3.0	4.1	3.7	3.8	2.8	3.5

Do the data indicate that two populations follow the same distribution function? Use $\alpha = 0.05$.

b) The weight and systolic blood pressure of 15 randomly selected males in the age group 25 to 30 are shown in the following table.

Subject	Weight	Systolic BP
1	165	130
2	172	153
3	167	133
4	159	128
5	180	150
6	168	132
7	155	128
8	174	149
9	212	151
10	183	158
11	175	146
12	212	150
13	190	150
14	195	163
15	210	140

Compute Spearman's ρ and hence test the existence of association between the variables. Use $\alpha = 0.01$.

[10+10=20]

6. a) The yield of a chemical process is being studied. The two most important variables are thought to be the pressure and temperature. Three levels of each factor are selected and a two-way experiment with three replicates was run. The yield data is shown below.

Temperature	Pressure		
	200	215	230
150	90.4	90.7	90.2
	90.2	90.6	90.4
	90.2	90.7	90.4
160	90.1	90.5	89.9
	90.3	90.6	90.1
	90.4	90.5	89.8
170	90.5	90.8	90.4
	90.7	90.9	90.1
	90.6	90.6	90.2

- i) Do the factors or their interactions affect the yield of the chemical process? Use $\alpha = 0.05$.
- ii) Use Fisher's Least Significance Difference method to determine which levels of the pressure factor are significantly different? Use $\alpha = 0.05$.

b) Derive the necessary expressions for sequential testing of a normal mean with a known variance. Describe the test procedure. Assume $A = \frac{1-\beta}{\alpha}$ and $B = \frac{\beta}{1-\alpha}$, where α and β are the probabilities of type I and type II errors respectively.

[12+8 = 20]

INDIAN STATISTICAL INSTITUTE

Second End-Semester Examination (2011 – 2012)

Course Name	:	M.Tech (QR & OR)
Subject	:	Industrial Engineering and Management
Date	:	2.05.12
Maximum Marks	:	50
Duration	:	150 minutes

Question Paper

Direction: Choose the questions in such a way that the total marks should not cross a total of 50.

1. Prove that the required number of observations to predict true time within $\pm 5\%$ precision and 95% confidence level is given by

$$N' = \left(\frac{40 \sqrt{N \sum x^2 - (\sum x)^2}}{\sum x} \right)^2$$

The notations have the usual meanings. [4]

2. How does the “time study” improve the productivity? [3]
3. How “time study” is useful for Benchmarking of a process? [2]
4. “Human Factor Engineering” is an interdisciplinary subject. True or False. Justify. [3]
5. What are the important steps to be followed to perform a task in service sector? [3]
6. How is “Motion Study and Time Study” useful for calculating wage incentive? [4]
7. What are the aims of material handling method? [2]

8. Conveyor belt is used for a material handling equipment in case of intermittent production. True or False. Justify. [3]
9. Debt is preferable than Equity. True or False. Justify. [2]
10. What are the fundamental objectives of Financial Management? [3]
11. What is gearing in Financial Management? [2]
12. Define and explain three E's of Value for money. [4]
13. A project will involve spending Rs 1.8 million now. Annual cash flows from the project would be Rs 350,000. What is the expected payback period? [3]
14. What do you mean by time value of money? [2]
15. An organization is considering a capital investment in new equipment. The estimated cash flows are as follows:

Year	Cash Flow
	Rs
0	(240,000)
1	80,000
2	120,000
3	70,000
4	40,000
5	20,000

The company's cost of capital is 9%. Calculate the NPV of the project to assess whether it should be undertaken. [5]

16. Explain the inflation on cash flows. [3]
17. What is Risk in Financial Management? How do you estimate the risk? [4]
18. What is annuity? [1]
19. State the issues of replacement decisions. [3]

20. What is standard time used in “time study”? [2]
21. Which is the popular wage incentive plan in India? Explain its advantages. [4]
22. Which are the important factors to select material ^{handling} equipment? [2]
23. A project requires an initial investment of Rs 800,000 and then earns net cash inflows as follows:

Year	1	2	3	4	5	6	7
Cash Inflows (Rs 000)	100	200	400	400	300	200	150

In addition, at the end of the seven-year project the asset initially purchased will be sold for Rs 100,000.

Determine the project’s ROCE using:

- (a) Initial capital cost
- (b) Average capital investment. [6]

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INDIAN STATISTICAL INSTITUTE

Second-Semester Examination: 2011-12

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

Subject Name: Instrumentation and Computer Engineering

Date: 04.05.12

Maximum Marks: 98

Duration: 3 Hrs

Answer any 7 questions.

1. Draw the circuit diagram of a 4 bit dual-slope analog-to-digital (A/D) convertor and explain its operational procedure.
[3+11=14]
2. 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 $4R$.
Can we call a D/A convertor as any particular type of transducer?
Justify your answer. [8+3+3=14]
3. Show the classification of transducers with examples? Discuss about the operational procedure of an electromagnetic transducer and rotary plate capacitor. [7+4+3=14]
4. What are the differences between on-off control and PID (proportional+integral+derivative) control? Explain the operational procedure of a PID controller with related equations for any one type of error signal. What are the advantages of a PID controller over PI controller? [3+8+3=14]
5. a) What are the advantages of automatic control system? Draw the block diagram of a hot water temperature controller and explain its control action.
b) A PI (proportional+integral) controller is used for control of certain process. The settings are as follows. K_p (gain)=2%, P_o =40%, Reset rate=2%/min, E_p (error signal)= $4t+6$ where, t =time. What will be controller output in percentage after 2 minutes?
[(3+7)+4=14]
6. Explain the operation of a JK flip flop with truth table. Why master slave JK flip flop is more advantageous than JK flip flop?
[11+3=14]
7. Explain the working principle of a full adder with circuit diagram and truth table. Show that a 3 bit addition can be realized with adders.
[11+3=14]

8. a) Negate 2 using 32-bit signed binary representation and then negate it again to check the result.

b) Define scientific notation and normalized scientific notation.

c) Give an example of exponent underflow by subtracting two numbers using IEEE 754 binary representation and 32 bit precision. Derive the decimal equivalent of those two numbers.

d) Add the numbers 0.75_{ten} and -0.4375_{ten} in binary using scientific notation and floating point addition with 4 bits of precision.

[3+2+5+4=14]

9. a) Why registers are included in the CPU? Explain the procedure of transferring data from registers to ALU, within a CPU.

~~b) The binary OPR selects 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 in CPU registers

- R1 Content \leftarrow input
- R2 Content \leftarrow input XOR R1 content
- Register3 Content \leftarrow Register2 Content + Register4 Content
[(2+5)+(3+2+2)=14]

10. What is a stack? Show the sequence of micro-operations for performing a pop operation in a 64 word register stack.

Find the reverse polish notation for the expression $(3 \times 4) + (5 \times 6)$ and show the related stack operations, with diagrams, for the same expression.
[(3+6)+(2+3)=14]

11. What is a content addressable memory (CAM) and what are the advantages? Draw the block diagram and circuit diagram of a CAM. Explain the operation of a CAM for finding a matched word.

[4+(2+3)+5=14]