

Indian Statistical Institute
Mid-Semestral Examination : 2012-13
M-TECH(QR&OR) -- 1st YEAR (E - STREAM)
PROBABILITY-1
{Answer all the questions}

Date: 03.09.12

Full marks: 100

Time: 3 hours

[Symbols have their usual meaning]

1. a) Define the following terms with example:
Random experiment, mutually exclusive events, equally likely events.
b) State and prove Poincare's theorem.
c) Give the expression for $P(A_1 \cap A_2 \cap A_3 \cap \dots \cap A_n)$ (assuming both the cases, that they are independent and they are not independent).
[9+8+3=20]

2. a) Find the mode of a negative binomial distribution.
b) Let us suppose that the number of telephone calls received by an operator during his duty hours follows Poisson distribution with $\lambda = 3$. Find the probability that he will receive a total of 1 call in next 3 days.
c) State and prove the memory-less property of exponential distribution
[7+8+5= 20]

3. a) Let $\{A_n\}$ be monotonic sequence of events. Then Prove that,
$$\lim_{n \rightarrow \infty} P(A_n) = P \lim_{n \rightarrow \infty} (A_n).$$

b) Let there be 5 letters and 5 envelopes, each letter is having a right pair of envelope. What is the probability that all letters will be placed in wrong envelopes?
[10+10=20]

4. a) A person is paying Rs 10/ for each participation of the following game:
He is drawing 2 cards from a deck. He gets Rs 20 if he draws 2 black queens. He gets Rs 30 if he draws 2 kings, He gets Rs 30 if he draws 1 red ace and another black ace. Otherwise he gets nothing. What is his expected gain?
b) Define rth order raw moment (μ'_r) and rth order central moment (μ_r). Express μ_r in terms of μ'_r .
[8+7=15]

5. Assignments.
[25]

INDIAN STATISTICAL INSTITUTE

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

Session : 2012-2013

MID-SEMISTRAL EXAMINATION

Subject : Workshop-I (Engineering Drawing)

Date of Exam: 04.09.2012.

Max. Marks : 40

Time : 1hrs 30 mins

Note: (a) Answer two questions.

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

(c) Marks allotted to each questions are indicated.

1. Draw the projections of a hexagonal pyramid, base 50 mm side and axis 70 mm long having its base on the ground and one of the edges of the base inclined at 45° to the V.P. [20]
2. a) Inscribe a regular heptagon in a circle having its radius 15 mm. [10]
b) Construct a scale of 1 : 4 to show centimetres and long enough to measure up to 5 metres. In that scale show the length of 3.9 decimetres. [10]
3. Draw the projections of a pentagonal pyramid; base 35 mm edge and axis 60 mm long, having its base on the ground and an edge of the base parallel to the V.P [20]

INDIAN STATISTICAL INSTITUTE
M.Tech (QR-OR) 1st Year (S Stream)
Session : 2012-2013
MID-SEMISTRAL EXAMINATION

Subject : Workshop-I (Engineering Drawing)

Date of Exam: 04.09.2012.

Max. Marks : 40

Time : 1hrs 30 mins

Note: (a) Answer two questions.

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

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INDIAN STATISTICAL INSTITUTE

Mid Semester Examination: 2012-13

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

Subject: Statistical Methods I

Date: 04.09.2012

Duration: 3 hours

Note: The total mark carried by all the questions is 115. Answer as many questions as you can. But the maximum you can score is 100.

1. Following table gives the closing value (rounded) of the stock index NIFTY for the past 80 Mondays for the period February 2011 – August 2012.

5697	5414	5486	5581	5013	5069	4850	5220	5114	5279
5506	5736	5476	5634	5133	4812	4967	5381	4908	5275
5396	5910	5517	5482	4946	4805	5127	5228	4906	5197
5456	5912	5486	5211	4751	5063	5236	5179	4986	5118
5519	5885	5366	5073	5078	4763	5368	5234	4848	5200
5333	5750	5471	4899	5092	4693	5532	5226	5054	5283
5521	5551	5627	4920	5361	4706	5483	5201	5064	5348
5450	5545	5661	5125	5284	4750	5340	5209	5115	5413

(a) Construct a suitable frequency distribution table and the Histogram. Offer your comments on the patterns observed in the Histogram.

[12+4+4]

(b) Compute mean, median and mode of the grouped data. What can you say about the observed distribution from the estimates obtained of mean, median and mode? Does the relationship (Mode = 3* Median – 2* Mean) hold approximately as is normally expected? Give an example of a situation where the relationship Mean > Median > Mode may not hold for a positively skewed unimodal distribution.

[3x3+3+2+6]

2. The data on coating thickness (μm) and viscosity (poise) of the coating material are given below:

Viscosity	-0.5	0.1	-0.4	-0.7	-0.1	0.0	0.2	-0.2	0.0	-0.3
Coating thickness	-2	4	0	-5	0	2	9	1	5	3

The data given above are after subtracting the working means of 40 and 20 from viscosity and thickness respectively.

(a) Draw the scatter diagram.

(b) Fit a simple linear regression model (use the method of least squares for estimating the parameters).

(c) Assume the target value of coating thickness is $22 \mu\text{m}$ and the desired variance of thickness is 50% of its present value. What should be the target value of viscosity, i.e. the value around which it should be controlled? What is the desired width of variation of coating thickness (assume $\pm 3s$ as the band)?

[4+12+3+4]

3. Let Q be the quantity that clears the market when the price of the item is P . Let the relationship between the two be given by $Q/1000 = 400 - 2P$, and the price elasticity (E) is defined as $E = - (\text{Percent change in } Q / \text{Percent change in } P)$.

(a) Compute the values of E at $P = 60$ and 80 .

(b) Express E in terms of the variables and the parameters of the demand-price equation given above.

(c) Find the equation of the demand-price curve when the elasticity E is the same for all values of P ?

[3x2+4+6]

4. Derive the expression for E (SSR), the expected value of sum of squares due to regression for a simple linear regression model.

[12]

5. Offer your comments on the following statements:

(a) Mode is the most appropriate measure of central tendency for nominal data.

(b) No measure of central tendency can be computed when the last interval at one end of a grouped data is open-ended.

(c) In a simple regression analysis, it was found that the fitted line passes through the point (\bar{X}, \bar{Y}) , instead of the point $(0, 0)$, which was expected. This shows that some mistake has been committed in computation or there is some problem with the data.

(d) The frequency of the median class of a grouped data is found to be zero. So there is no way to compute the Median for the given data set.

(e) The R^2 values for two simple linear regression models are found to 90% and 0%. This indicates that the independent variable X has a large impact on the dependent variable Y in the first case, and there is no impact of X on Y in the second case.

[3+3+6+6+3x2]

INDIAN STATISTICAL INSTITUTE

Mid-Semestral examination: 2012-13

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

Subject: Operations Research-I

Date of Exam: 05.09.12 Max Marks: 100 Duration: 3 hrs.

GROUP-A (Max Marks: 60)

Assignment: 20 marks

Answer any four questions.

1. What is the difference between deterministic models and probabilistic models?

A diet is being prepared for the students staying in a hostel. The objective is to feed the students at the least cost meeting the daily requirement of all nutrients as: no less than 8 calories can be starch, no less than 15 calories can be protein and no less than 3 calories can be vitamin. The varied diet is to be made of two foods: A and B. Food A costs \$0.60 per kg and contains 11 calories, 4 of which are protein, 2 vitamin and 5 starch. Food B costs \$0.35 per kg and contains 10 calories, of which 7 are starch, 2 are protein, and 1 is vitamin. Formulate this diet mix problem as a LPP to minimize the overall cost.

[2+8=10]

2. (a) Show that the set of vectors $\mathbf{a}^1 = (2,1,4)$, $\mathbf{a}^2 = (1,-1,2)$ and $\mathbf{a}^3 = (3,1,-2)$ form a basis in E_3 .

(b) Show that the following system has no solution.

$$4x_1 + 5x_2 + 10x_3 = 7$$

$$-x_1 + 7x_2 + 4x_3 = 3$$

$$3x_1 - 2x_2 - 4x_3 = 5$$

[5+5=10]

3. Define Basis for E_n and Convex Polyhedron. Prove that every basic feasible solution (b.f.s) of a LPP is an extreme point of the convex set of all feasible solutions K

[4+6=10]

4. Solve the following LPP graphically. Mark all extreme points, feasible region, constraint lines and use isocost line (objective function) approach to find out the optimal solution.

$$\text{Minimize } (24X_1 + 28X_2)$$

Subject to

$$X_1 + X_2 \geq 300$$

$$5X_1 + 4X_2 \leq 2,000$$

$$X_1 \geq 80$$

$$X_2 \geq 100$$

$$X_1, X_2 \geq 0$$

[10]

5. Solve the following assignment problem by Hungarian Method (minimize total cost). The owner's objective is to assign the three projects to the workers in a way that will result in the lowest total cost to the shop. Note that the assignment of people to projects must be on a one-to-one basis. Calculate the lowest total cost f of the project.

Workers	Project		
	P1	P2	P3
Arjun	22	28	12
Bobby	16	20	22
Rajesh	18	24	14

[10]

6. What is the characteristic of basic feasible solution of a transportation problem (T.P.)? Describe two unbalanced situations of a T.P? What is the basic difference between North-West Corner Rule (NWCR) and lowest cost method for solving a T.P.?

[4+4+2 = 10]

OR-1 (group B)

Maximum Marks: 40

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?

[12]

(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.

[10]

2. Derive an expression for the relative error in the Total variable cost when all cost parameters and the annual demand are wrongly estimated. From the table given below, compute the error implication in the total variable inventory cost.

Components of EOQ	True value	Estimated value
Annual Demand	5000	6000
Ordering cost/order	Rs. 60	Rs.55
Carrying cost	20% per year	15%
Unit price	Rs.5 per unit	Rs. 6 per unit

[8]

3. The daily demand for a news paper vendor is normally distributed with mean of 200 units and standard deviation $\sigma=40$. The shortage costs per unit are Rs. 25 and the overstocking costs per unit are Rs. 10. Calculate the optimal quantity of daily replenishment quantity. Derive all the results stating clearly the assumptions involved.

[10]

INDIAN STATISTICAL INSTITUTE

Mid-Semestral Examination : 2012 -2013

Course Name : OR-1 (group B)

Subject name : Inventory Control

Date : Maximum Marks: 40 Duration : 3 Hours (Including Group A and Group B)

Note: Please provide RMMR table

A. Nayanda

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

Subject: SQC1

Date of Exam: 06/09/2012

Max. Marks: 100

Time: 3 hrs.

Group – A (Control Chart)

Answer All Questions.

1. (a) In designing a fraction nonconforming chart with center line at $p = 0.20$ and three-sigma control limits, what is the sample size required to yield a positive lower control limit? What is the value of n necessary to give a probability of 0.50 of detecting a shift in the process to 0.26?
[10]
- (b) A control chart for the number nonconforming is to be established, based on samples of size 400. To start the control chart, thirty samples were selected and the number nonconforming in each sample determined, yielding
$$\sum_{i=1}^{30} D_i = 1200.$$
 What would be the parameters of the np chart?
[10]
2. (a) Briefly discuss the eight dimensions of quality that are contributed by Garvin in 1987.
[8]
- (b) Discuss the traditional definition of quality based on the viewpoint of Juran.
[4]
- © Explain briefly about the Demerit Systems.
[8]
3. A paper mill uses a control chart to monitor the imperfection in finished rolls of paper. Production output is inspected for 20 days, and the resulting data are shown below. Use these data to set up a U -chart for nonconformities per roll of paper. Does the process appear to be in statistical control? What would be the center line and three-sigma control limits to monitor future production?

CONTINUED AT PAGE 2

Day	Number of Rolls Produced	Total Number of Imperfections	Day	Number of Rolls Produced	Total Number of Imperfections
1	18	12	11	18	18
2	18	14	12	18	14
3	24	32	13	18	9
4	22	18	14	20	10
5	22	15	15	20	14
6	22	12	16	20	13
7	20	11	17	24	16
8	20	15	18	24	18
9	20	12	19	22	34
10	20	10	20	21	17

[20]

Group-B (Acceptance Sampling)

Maximum Marks (40)

Q1 (a) Define AQL, LTPD, Type A OC function, Type B OC function, producer's risk and consumer's risk in the context of a Single sampling attribute plan.

Q1 (b) Show that the expression for the type B OC function for a single sampling plan where a random sample of size n is drawn without replacement from lots of size N submitted from a process producing p proportion defective and the a lot is accepted iff the number of defective is less than or equal to c , is exactly given by the cumulative binomial distribution with parameter c , n and p . State the assumptions made.

[18+10= 28]

Q2. Design a single sampling plan for an AQL of 1% and LTPD of 6% with stipulated upper limits on producer's risk and the consumer's risk as 5% and 10% respectively. Assume Poisson approximation for the OC functions.

[12]

Mid-Semester Examination: 2012-13

Course Name : M Tech (QR&OR)
Subject Name : Quality Management System (Group - A)
Maximum Marks : 60
Duration : 3 hours (together with Group - B)

DATE : 07.09.12

Note: Class notes, books and photo-copies of notes / books are allowed. Answer all the questions from this group.

1. XYZ Foods is a restaurant serving special dishes. The restaurant is costly and aims at being the restaurant of choice. The management has found that the restaurant must provide a comfortable atmosphere and the customers do not mind waiting for the food and beverages to be served. In fact the management has found that the customers come for leisurely lunch or dinner. However, while the customers do not mind waiting, they definitely expect good food and good service. Notice that good service includes but is not restricted to being greeted, being taken to a table, taking orders etc. and finally being provided with the bill accurately. In this context
 - a. Identify 10 different ways deficiencies can occur (e.g. incorrect food being served). For each case provide a short (maximum of 5 sentences) description of the way the deficiency is likely to lead to higher costs. The deficiencies identified by you need not be restricted to the process of order taking and servicing (i.e. direct handling of customers) but may include other processes like planning for ingredients and other areas related to the working of the restaurant. [10 X 2 = 20]
 - b. Identify 5 different characteristics of the restaurant (e.g. taste of the food) that you think are quality characteristics and are likely to impact the customers (consider only end customers, i.e. customers who come to the restaurant to have food). Classify each of these characteristics into one of Garvin's eight dimensions of quality. [5 X 2 = 10]
 - c. Classify the same quality characteristics using Kano's model. [5 X 2 = 10]
 - d. Suppose you need to propose methodologies to measure the 5 characteristics identified by you. In this context
 - i. Provide the operational definition for measuring each characteristic (e.g. if taste of food is a characteristic, how will you measure it). Remember that you may choose to take written feedback from the customer as your method of measurement. [5 X 1 = 5]
 - ii. Explain briefly why you think your proposed measures have representational validity. Specify the physical attribute you are trying to measure. [5 X 2 = 10]
 - e. Identify 5 different customers of the restaurant (other than the end customer who takes food at the restaurant and pays for the same). Identify each of these customers as internal or external customers. [5 X 1 = 5]

Handwritten signature and date: 07.09.2012

Mid-Semester Examination: 2012-13

Course Name : M Tech (QR&OR)
Subject Name : Quality Management System (Group - B)
Maximum Marks : 40
Duration : 3 hours (together with Group - A)

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

1. Two of the eight QMPs are a) Involvement of People, and b) Continual improvement. Explain what advantages an organisation gain through proper implementation of these two QMPs. Develop a Quality Policy for an educational institution.
(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.
 - Car repairing in a Service Station
 - Order receiving and delivery in a Coffee Shop.(8+4) = [12]
3. Following are the objective evidences of an internal audit conducted according to ISO 9001: 2008 QMS. For each of the objective evidence, provide your explanation and justification whether it is a nonconformance or not. Mention relevant/appropriate clause number. (any two)
 - (a) The Purchase manager is found to be Management representative for the QMS.
 - (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) QMS Objectives are found to be measured routinely, but no improvement is observed.
(4 x 2) = [8]
4. Assignment (Submit final version of 2 process maps by 11 September 2012)
[10]

INDIAN STATISTICAL INSTITUTE

Mid-semester Exam.

Course Name: M.Tech. (QROR)

Year: 1st year

Subject Name: Programming Techniques and Data Structures

Date: 10.09.12

Maximum Marks: 50

Duration: 2.00 hrs

Answer all questions.

1. With appropriate example, differentiate between the following (any two): 2*5=10
- (a) Binary Search Vs Linear Search
 - (b) while Vs do-while loop
 - (c) Data Structure Vs storage structure

- 2(a). Write the output of the following C code segment: 2*4=8

```
i) void main()
{
    int x=23;
    {
        int x=22;
        printf("x=%d",x);
    }
    printf("\t x=%d",x);
}
```

```
ii) void main()
{
    int x=20,y=51;
    x= y++ + x++;
    y= ++x + ++y;
    printf("x=%d \t y=%d",x,y);
}
```

- 2(b). Rewrite the following code segment using conditional operator: 2

```
int b;
if(a>20)
    b=200;
else
    b=225;
```

3. Let A[4][3][2] is a 3D array where the first element A[0][0][0] is stored in location 4000. Compute the address of A[i][j][k], $0 \leq i \leq 3$; $0 \leq j \leq 2$; $0 \leq k \leq 1$, when A is in

a. Row-Major Order

b. Column Major Order

2*5=10

Assume each element of the array takes 2 bytes and 'l' is the highest dimension.

4. Define a stack? How is it different from a queue? Write an algorithm using stack to convert a decimal number into its binary equivalent. $2+2+6=10$

5. With a suitable example illustrate the difference between "call by value" and "call by address". Write a recursive function to compute the n th Fibonacci number. Is this recursive function better than the iterative one? Justify. $5+4+1=10$

INDIAN STATISTICAL INSTITUTE
M.Tech (QR_OR) 1st Year (S Stream)
Session : 2012-2013
SEMISTRAL EXAMINATION
Subject : Workshop – 1 (Engg. Drawing)

Date of Exam: 19.11.12

Max. Marks : 60
hrs

Time : 3:00

- 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 question is indicated in the bracket.

- 1 A hexagonal prism has one of its rectangular faces parallel to the ground. Its axis is perpendicular to the V.P. and 3.5 cm above the ground. Draw its projections when the nearer end is 2 cm behind the V.P. Side of the base is 2.5 cm long and the axis is 6 cm long. [14]
- 2 A pentagonal pyramid, base 30 mm side and axis 65 mm long, has its base horizontal and an edge of the base parallel to the V.P. A horizontal section plane cuts it at a distance of 25 mm above the base. Draw its front view and sectional top view. [14]
- 3 Show the following elements on a sketch of the threaded end of a screw:- [14]
 - a) Core diameter
 - b) Outside diameter
 - c) Crest
 - d) Flank
 - e) Depth
 - f) Pitch
4. 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 3.69 metres on it. [14]
3. Show by sketch a pair of mating spur gear and a pinion and also indicate any four of the following six parameters 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 the front view and the side view of a Box or Muff coupling and a Half- lap coupling, giving important dimensions, for a 20 mm diameter shafting. [18]

INDIAN STATISTICAL INSTITUTE
First-Semester Examination : 2012-13
M-TECH(QR&OR) – 1st YEAR (E-STREAM)

PROBABILITY -- 1

Note : Answer any FIVE questions

Date: 19.11.12

Full marks:100

Time: 3 hours

[Symbols have their usual meaning]

1. a) State and prove Chebyshev's lemma. State and prove Chebyshev's inequality.
b) State and prove De Moivre's central limit theorem.

[8+12=20]
2. a) Let $X \sim N(0,1)$ and $Y^2 \sim \chi^2$ with degree of freedom n and X and Y^2 are independently distributed. Let $T = X / \sqrt{Y^2/n}$. Find the p.d.f of T .
b) Let (x_1, x_2, \dots, x_n) be a sample of size n drawn from $N(\mu, \sigma^2)$. Let \bar{x} and s^2 be the corresponding sample mean and the sample variance. Obtain the sampling distribution of \bar{x} and s^2 and show that they are independent.

[10+10=20]
3. a) Let A_1, A_2, \dots, A_r be r events not necessarily mutually exclusive. Find the probability of occurrence of exactly m events ($m < r$).
b) There are 3 chests, each having two drawers. Each drawer of chest-1 contains a gold coin, each drawer of chest-2 contains a silver coin. In the third chest there is one gold coin in one drawer and one silver coin in another. A chest is opened at random. A drawer is selected. It is found that it contains a gold coin. What is the probability that the other drawer of the selected chest also contains a gold coin?

[12+8=20]
4. a) Suppose X is a continuous random variable with p.d.f $f(x)$ and c.d.f $F(x)$. Let Y be another random variable such that $y = F(x)$. Find the p.d.f of Y .
b) Let $X \sim N(\mu, \sigma^2)$ and $Y = X^2$. Find the distribution of Y .
c) Let $X_i \sim P(\lambda_i)$, $i = 1, 2$. Let $Y = X_1 + X_2$. Find the distribution of Y . Find the conditional distribution of X_1 given $Y=y$.

[6+6+8=20]
5. a) The quality assurance manager of a bolt manufacturing company knows that his company has a contract with his client that the client will tolerate a maximum of 2% rejection with respect to diameter of the pipes. He has taken a set of 100 observations on diameter of the pipes and estimated the average as 30 cm and the standard deviation as 3 cm. Where should he set his upper specification limit of the diameter of the pipes so that he can satisfy his client (assume that the distribution of the diameter follows Normal distribution and specification for diameter is having only upper specification limit)?

b) Fit a negative binomial distribution to the following data:

x	0	1	2	3	4	5
freq	213	128	37	18	3	1

[10+10=20]

6. a) Explain when do you say that two random variables X and Y are independent? Prove that when X and Y are independent then $\rho_{XY} = 0$. Is the converse true? Justify your answer.
- b) A parent particle can be divided into 0, 1, 2 particles with probability $\frac{1}{4}$, $\frac{1}{2}$, $\frac{1}{4}$ respectively. It disappears after splitting. Beginning with one particle, the progenitor, let us denote by X_i the number of particles in the i th generation. Find i) $P(X_2 > 0)$ and ii) $P(X_1 = 2 / X_2 = 1)$.

[10+10=20]

INDIAN STATISTICAL INSTITUTE

First Semester Examination: 2012-13

Course Name : M Tech (QR&OR)
Subject Name : Quality Management System

Date : 20.11.2012 Maximum Marks : 100
Duration : 3 hours (Group-A & Group-B together)

Note, if any : Answer Group – A and Group – B in separate sheets.

(Group – A)

Answer any 3 questions. Maximum you can score from this group is 60.

1. What is Quality Management? What is Porter's value chain? Explain how value chain may be used to identify various activities required for ensuring customer satisfaction. Do you think this technique may be used for any organization?
[3 + 7 + 6 + 4 = 20]
2. What is strategic quality management? What is cost of quality and what are its components? Explain the point of view that looking at quality from the perspective of cost of quality may position quality defensively rather than strategically. Describe the different organizational structures used for ensuring quality.
[2 + 8 + 5 + 5 = 20]
3. What are the different steps involved in carrying out six sigma projects? Suppose someone states that implementing six-sigma, as suggested by Juran, is same as looking at quality from the big Q perspective. Do you agree? What are the 5 absolutes of quality as suggested by Philip Crosby?
[12 + 3 + 5 = 20]
4. Answer the following
 - (a) What are the eight dimensions of quality identified by Garvin? Explain the dimensions briefly.
 - (b) What is measurement?
 - (c) Suppose you have been asked to measure customer satisfaction for IT services provided to different organizations by a software service provider. The customer satisfaction will be measured through a survey. Answer the following in this context
 - i. What do you mean by customer in this situation? Give examples of each type.
 - ii. Suppose a questionnaire has been designed. What are the validation checks that you will implement to ensure proper measurement of satisfaction of the customers?

[10 + 2 + (3 + 5) = 20]

(Group – B)

Answer all the questions. Maximum you can score from this group is 40.

1. You are working in an Educational Institution as Management Representative for implementation of ISO 14001: 2004. List down two of its activities and mention different environmental aspects and associated impacts.

[3+3 = 6]

2. Define Adequacy Audit and Compliance Audit. Prepare a blank format of Nonconformance Report (NCR).

[5+2 = 7]

3. Write short note on the following terms. (any three)

(a) Initial Environmental Review (IER)

(b) Significant Environmental Aspects

(c) Testing Error

(d) Calibration of an Equipment

(e) Emergency Preparedness

[4 + 4 + 4 = 12]

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

[15]

INDIAN STATISTICAL INSTITUTE

First Semestral examination: 2012-13

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

Subject: Operations Research-I

Date of Exam : 22-11-2012

Max Marks: 100

Duration: 3 hrs.

GROUP-A (Max Marks: 50)

Answer any four questions.

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

[5+8=13]

- Describe the physical interpretation of $(C_j - Z_j)$ row and minimum positive ratio of the quantity-to-pivot column substitution rate in Simplex table while solving an LP problem.
 - What are the conditions for optimality, unboundedness, degeneracy and alternative optimum of a LP maximization problem as found from the Simplex table?
 - What is the role of an artificial variable used in Charnes- M method for solving a LP problem? How do you conclude infeasibility of a LP problem using Simplex method?

[4+5+4 = 13]

- 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.

(b) Find the optimal solution to the following L.P.P using duality.

Maximize $(3X_1 - 2X_2)$

Subject to

$$X_1 \leq 4$$

$$X_2 \leq 6$$

$$X_1 + X_2 \leq 5$$

$$-X_2 \leq -1$$

$$X_1, X_2 > 0$$

[4+9=13]

4. (a) What are the properties for a basic feasible solution of a transportation problem to be non-degenerate?

(b) What are the basic differences between North West Corner Rule (NWCR), Minimum cost and Vogel's approximation method (VAM)?

(c) How do you find an improved b.f.s for a transportation problem if the solution is not found as optimal?

[3+3+7=13]

5. Solve the following transportation problem using VAM and test for the optimal solution, where the cell values indicate distance to be travelled from factory to warehouse. Formulate the problem as a LP problem before solving it using VAM.

Factory	W_1 (Warehouse)	W_2	W_3	W_4	Capacity (Supply)
F_1	50	30	60	70	35
F_2	20	80	10	90	60
F_3	100	40	80	30	25
Requirement (Demand)	30	45	25	20	

[9+4=13]

6. Define residual network G_f . What are the equivalent conditions in a flow network considering residual network and cut of a network? Prove that the value of a flow in a network is the net flow across any cut of the network.

[4+4+4=12]

GROUP-B (Max Marks: 50)

Answer all questions

1. Describe a situation where the problem of machine interference arises. There are 16 automatic machines in operations. From past experience it is known that each machine will operate for an average period of 60 hours and then requires an average of 40 hours of repair. Under the assumption of Poisson occurrence of the break down and exponential service time we find from the Finite queue table by Peck and Hazelwood for $N = 15$ and for $X = 0.4$ the following:

M	F
10	0.998
9	0.993
8	0.979
7	0.945
6	0.877
5	0.767
4	0.623
3	0.469

Compute the operator utilization and machine utilization percent for 5 different situations where number of repair persons employed are 4,5,6,7 and 8 respectively. Repair men are paid at the rate of Rs. 50/- per hour /per person whether or not he is actually working and each machine will produce a product representing a profit of 60 Rupees /hour. Calculate the optimum number of repair persons which maximize expected per hour return.

[5+5=10]

2. a) Under the assumption of i) normal lead time demand distribution and ii) Poisson distribution of the lead time demand derive the expressions of expected number of stock out and the expected number of units short in a year. Write down all the assumptions.
- b) Let the annual demand = 60, lead time = 1/12 year, Cost value = Rs 2.00 /per unit, Carrying cost = 0.20 /year, and Order Quantity = 15 units, Cost of being short = Rs 5 /unit. Compute the optimum value of the reorder point under the assumption that lead time demand has a Poisson distribution.

[10+ 10=20]

- 3 a) Under the assumption of Poisson arrivals and exponential distribution of the service time find the steady state probability of n persons in the queue system for m service channels.
- b) Derive the expression for the average system length and the average queue length for Poisson arrivals and exponential distribution of the service time for the single server queue. What is the probability that the system length ≥ 4 given that the rate of arrival is 3 /hour and service rate of 5 /hour.

{10+10=20}

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INDIAN STATISTICAL INSTITUTE
SQC & OR Unit, Kolkata
M. Tech. (QR OR) I Year
Session: 2012-2014
Semester Examination

Subject: Statistical Quality Control 1

Date: 26/11/2012

Time: 3 hours

Full Marks: 100

Group A (Control Chart): Full Marks 50

Answer All Questions

1. Samples of $n = 6$ items each are taken from a process at regular intervals. A quality characteristic is measured, and \bar{x} and R values are calculated for each sample. After 50 samples, we have

$$\sum_{i=1}^{50} \bar{x}_i = 2000 \text{ and } \sum_{i=1}^{50} R_i = 200$$

Assume that the quality characteristic is normally distributed.

- a) Compute control limits for the \bar{x} and R control charts. [7]
- b) If all the points on both control charts fall between the control limits, obtain the natural tolerance limits of the process. [3]
- c) If the specification limits are 41 ± 5.0 , compute the process capability indices C_p and C_{pm} and draw your conclusions regarding the ability of the process to produce items within these specifications. [7]
- d) Assuming that if an item exceeds the upper specification limit it can be reworked and if it is below the lower specification limit it must be scrapped, what percent scrap and rework is the process producing? [6]
- e) Make suggestions as to how the process performance could be improved. [2]

2. 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

[25]

Group B (Acceptance Sampling): Full Marks 50

Answer All Questions

1(a) Define AOQ for a single sampling acceptance rectification plan. Derive the expression for AOQL and show that there is a unique AOQL. How do we proceed to derive a single sampling plan for a given lot size which minimizes the ATI at a given process average subject to a specified AOQL?

1(b) Design a single sampling plan for lots of size 10000, which minimizes ATI at a process average of 1% subject to an AOQL of 4%. Also find the AOQ value at the process average. Use the following table where x , y and c are having the usual meaning as defined by Dodge.

c	x	y
0	1.00	0.3679
1	1.62	0.8400
2	2.27	1.371
3	2.95	1.942
4	3.64	2.544
5	4.35	3.168
6	5.07	3.812
7	5.80	4.472
8	6.55	5.146
9	7.30	5.831
10	8.05	6.528

[7+8]

2(a) What is the motivation of using a double sampling inspection? Define ASN for a double sampling plan and write down the expressions of ASN, AOQ, ATI for a double sampling acceptance rectification plan.

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

[7+8]

3(a) What are the principles involved while constructing the Mil-Std-105D table with respect to a) the relation between sample size and lot size b) choice of AQL values and c) acceptance number for a given AQL ?

3(b) Find from the Mil-Std-105D standard the single sampling, double sampling and multiple sampling plans under normal, tightened and reduced inspection for lots of size 500, AQL = 4%, and inspection level II. Find for the normal inspection, the approximate value of AOQL, ASN at AQL (for the double and multiple sampling plans) and the LQ with $P_a = 0.10$ from the Table.

[8+12]

AN STATISTICAL INSTITUTE

Semester Examination: 2012-13

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

Subject: Statistical Methods I

Date: 29.11.2012

Duration: 3 hours

Note: This paper carries a total of 115 marks. Answer as many questions as you can. But the maximum you can score is 100.

1. Following table gives the length of service calls in minutes (Y) versus the number of units repaired (X). The repairs made are of the same type.

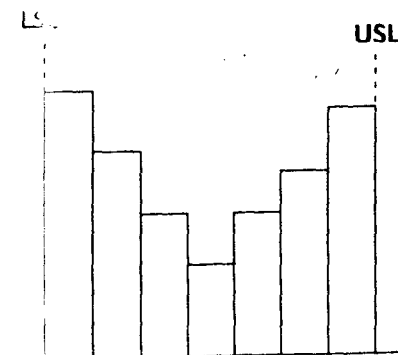
X	1	2	3	4	5	6	6	7	8	9	9	10	10
Y	23	29	49	61	87	96	97	109	119	149	145	154	166

Ideally, we should have $Y = \beta X$ if $X = 0$. So it is decided to use the linear model $Y = \beta X$ for the data. Estimate the coefficient β . Plot the estimated residuals against the corresponding predicted values to examine if the intercept term should be included in the model. Assume that the intercept term is found to be large in a similar study but for a different location. What should be your course of action in such a case?

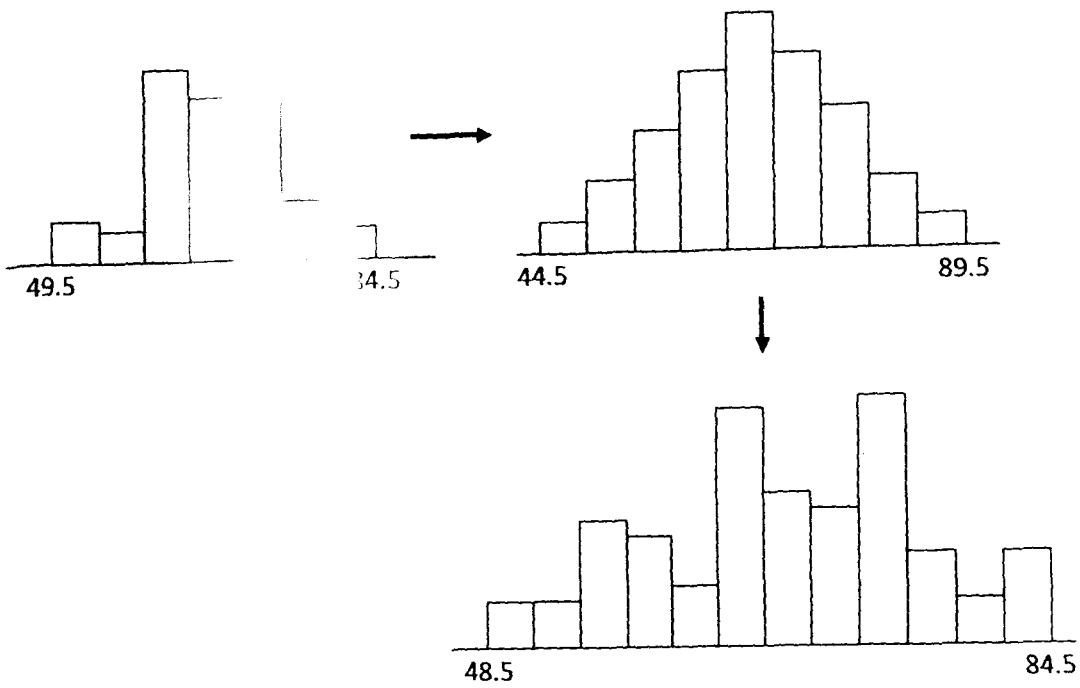
[10+8+5=23]

2. Explain the process conditions under which the histograms of the following types may be observed.

(a) USL = Upper Specification Limit, LSL = Lower Specification Limit



Three histograms are constructed from the same data set, where the no. of observations is 100, and the observed minimum and the maximum are 50 and 83 respectively.



[5+7=12]

8. The following data is given for the stratification of all the firms in a country by farm size and the average acres of corn yield per farm in each stratum. Suppose that 100 firms are to be selected for estimating the mean yield per farm. Compute the sample sizes for each stratum under proportional allocation. Compare the precision of the above method with that of simple random sampling. Suggest an allocation that will be better than proportional allocation.

Farm Size in Acres (h)	Number of Firms (N_h)	Average Corn Acres (\bar{Y}_h)	Standard Deviation (S_h)
Small	394	5.4	8.3
Medium	634	34.5	19.8
Large	148	63.8	35.2

[2+15+5=22]

4. Develop an algorithm for generating 100 random numbers from the following probability distribution. Assume X to be a continuous random variable.

1-2	2-3	3-4	4-5	5-6
0.07	0.38	0.23	0.22	0.10

[20]

5. Let X denote the outcome of throwing a die. The probability distribution of X is given below.

1	2	3	4	5	6
$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$

(a) Compute the mean of X .

(b) Let Y denote the sum of the two outcomes when the die is thrown twice. Show all possible outcomes of the above experiment and hence construct the probability distribution of Y .

(c) Compute the variance of Y .

(d) Establish the relationship between the variances of X and Y .

[4+8+6+4=22]

6. Write short notes on the following:

(a) Implications of scatter diagram

(b) Classification of data based on their inherent characteristics

(c) Ratio and arithmetic mean

(d) Qualitative data

[4x4=16]

INDIAN STATISTICAL INSTITUTE

First-Semester Examination : 2012-13

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

Subject Name : Electrical and Electronics Engineering

Date : 29.11.2012

Maximum Marks : 100

Duration : 3Hrs

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

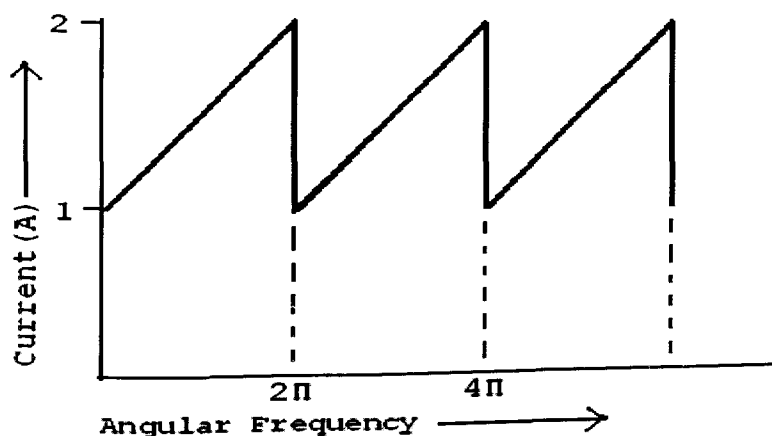
1. Mention True or False [4]
 - a) The feedback is negative when the closed-loop gain is less than the open-loop gain of an amplifier.
 - b) Norton's theorem states that the algebraic sum of the currents at any node must be zero.
 - c) An n-type semiconductor can be formed by doping a Germanium crystal with Phosphorus.
 - d) The depletion layer of a p-n junction diode increases with forward bias.

2. a) 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.

b) Show that, for an AC voltage the angular frequency $\omega = 2\pi/T$ where, T is the time period of one complete cycle.

c) Calculate the average and r.m.s. value of current represented in figure below.

[7+3+(3+3)=16]



3. Draw the equivalent circuit and write the basic operating equations of a transformer. Show that the mutual inductance

M between primary coil (inductance L_1) and secondary coil (inductance L_2) of an ideal transformer is $\sqrt{L_1 L_2}$. Find the value of current in the secondary coil in terms of applied voltage, resistances and inductances of both the coils.

[4+4+8=16]

4. A DC voltage E is applied across a series RLC circuit. Find the steady state current in the circuit when $(R^2/4L^2) > (1/LC)$ and draw the respective curve of current w.r.t. time.

[16]

5. Define & draw the block diagram for a closed loop control system and explain its individual blocks. State and prove superposition principle for a linear system characterized by linear ordinary or partial differential equations. Show that Laplace transformation converts a differential equation, representing a linear system, into an algebraic equation.

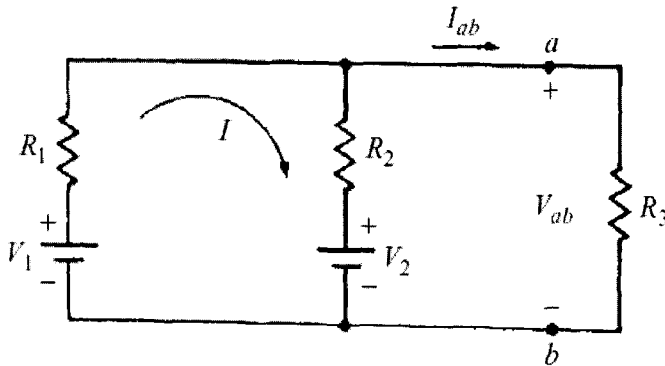
[5+5+6=16]

6. a) State and prove Norton's theorem

[12]

b) For the circuit, given below, $V_1 = 10V$, $V_2 = 15V$, $R_1 = 4 \text{ Ohms}$, and $R_2 = 6 \text{ Ohms}$. Find the Thevenin equivalent for the network to the left of terminals a,b. Assume that the internal resistances of the batteries are 0.

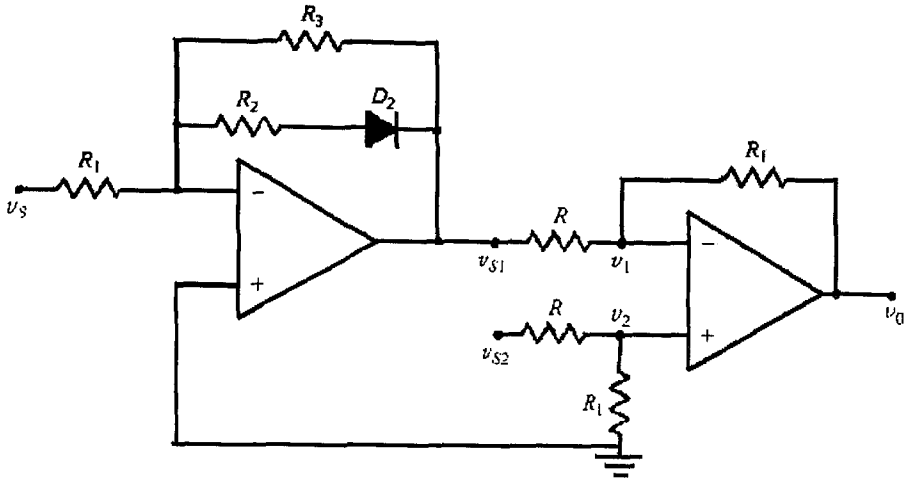
[4]



7. a) Explain the operations of an adder and a differentiator using OPAMP.

b) For the circuit, given below, find the output voltage v_o for $v_s = -1 \text{ volt}$. Assume, diode D_2 is ideal, $R_1 = 2 \text{ kOhms}$, $R_2 = 8 \text{ kOhms}$, $R_3 = 8 \text{ kOhms}$ and $v_{s2} = 0.5 \text{ volt}$.

[(4+4)+8=16]



8. a) What is feedback in context of an amplifier? Draw the block diagram of a negative feedback amplifier and derive an expression for closed-loop gain in terms of feedback ratio and transfer gain. What is the condition for an amplifier to become an oscillator? [1+6+2=9]
- b) An amplifier with negative feedback has a closed-loop gain of 100. Open-loop gain variation of 10% is expected owing to production limitations. Determine the value of open loop gain and feedback fraction β for which closed-loop gain will only vary by 1%. [(2+5+2)+7=16]
9. a) Derive the octave equivalent of $(25.75)_{10}$
 b) Show that an OR gate can be realized with ideal diodes and resistances.
 c) Subtract 01111 from 1000 using 2's complement method and verify the result by doing the same subtraction using 1's complement method.
 d) Construct an OR gate with NAND gates.
 e) State De Morgan's theorem [2+5+5+2+2=16]
10. a) Explain how depletion layer changes with the change of reverse bias of a p-n junction diode.
 b) Find the relation between the parameters α and β of a transistor.
 c) Draw the hybrid-parameter equivalent circuit of a transistor in common emitter mode and calculate the current gain and input resistance in terms of the hybrid parameters. [3+5+(4+4)=16]

INDIAN STATISTICAL INSTITUTE

Semestral Examination

Course Name: M.Tech. (QROR)

Year: 1st year

Subject Name: Programming Techniques and Data Structures

Date: 30.11.12

Maximum Marks: 100

Duration: 3.00 hrs

Answer all questions.

1. Write short notes on any two of the following: 5x2=10
- Dynamic memory allocation
 - Bubble sort
 - AVL Tree
2. Write the output of the following C-code segment with appropriate assumptions and proper explanation. 5x2=10

2.1

```
#include<stdio.h>
Void main()
{
    Int i=3;
    Int *j;
    int **k;
    j=&i;
    k=&j;
    printf("%u,%u,%d",k,*k,**k);
}
```

2.2

```
#include<stdio.h>
Void main()
{
    Int x=4,y=3,p;
    float q,r;
    p=x/y;
    q=x/y;
    r=(float) x/y;
    printf("%d, %f,%f",p,q,r);
}
```

3. Differentiate with example: 5x2=10
- Structure and Union P.T.O
 - Array of pointers and pointer to an array

4. There is a file test.txt containing a paragraph of text. Write a C-program to read the file and create an output file where each sentence of test.txt appears in separate line. 10
5. Write an algorithm to reverse a circular linked list. Explain the work flow of your algorithm with a suitable example. 10
6. Prove that a binary tree with n nodes will have exactly n+1 NULL links. 10
7. (a) Compute the maximum number of nodes that a binary tree of height h can have. Note that the levels start from 0.
 (b) Define a threaded binary tree. Explain with an example. 6+4=10
8. Construct the binary tree from: 10
 Inorder: 15, 32, 45, 61, 80, 92
 Postorder: 15, 45, 80, 92, 61, 32
 Draw the construction step-wise.
9. Define a Binary Search Tree (BST). Perform the following operations sequentially starting from an empty BST. 10
- i) Insert 32
 - ii) insert 15
 - iii) insert 61
 - iv) insert 92
 - v) insert 80
 - vi) insert 45
 - vii) delete 61
 - viii) insert 40
 - ix) delete 45
 - x) delete 15
10. Show the hash table after each insertion of the letters from the word "computerscience" using the hash function:

$$h(x) = k \text{ mod } 19$$
 where x is a letter and k is its position in the alphabet. For example 'c' is in the 3rd position in the alphabet.
 NB: Hash table is of size 19. The letters are case-insensitive. 10

INDIAN STATISTICAL INSTITUTE

SUPPLEMENTARY EXAMINATION 2012-13

Course Name: M.Tech. (QROR)

Year: 1st year

Subject Name: Programming Techniques and Data Structures

Date: 28.12.12

Maximum Marks: 100

Duration: 3.00 hrs

Answer all questions.

1. Write short notes on any four 4x5=20
 - a. Hashing
 - b. Doubly linked list
 - c. Binary search
 - d. Threaded binary tree
 - e. B-tree

2. Write a C program for sorting a set of numbers in ascending order using a bubble sort algorithm. What is the number of comparison operations required in your algorithm? Justify your answer. Derive its time complexity. 10+2+3+5=20

3. (a) What are linear and non-linear data structures? Name a linear data structure that uses pointers.
(b) Write an algorithm for inserting an element 'x' after element 'y' in a given singly-linked list. What is the complexity of your algorithm? (6+2)+(8+4)=20

4. (a) Write a non recursive algorithm for post-order traversal of a binary tree. Explain with an example.
(b) Define a binary search tree (BST). Construct a BST using the following list: 10, 15, 3, 17, 25, 30, 1. Explain the steps. 10+(4+6)=20

5. Write a code to allocate memory for an array of size n where n is the user input, such that the array is initialized to zeroes. Fill the array with consecutive odd numbers starting with 1. Find the mean of the entries in the array. What is the difference between local and global scope of a variable in C? 4+6+6+4=20

INDIAN STATISTICAL INSTITUTE
M. Tech. (QR OR) I Year
Session: 2012-2013
Back Paper First Semester Examination
Group A (Control Chart): Full Marks 50

28.12.12

Time: 3 hours

Answer All Questions

1. a) What's the role of OC curve in \bar{x} and R chart? [2]
- b) Prove that for an \bar{x} -chart if the mean shifts from the in-control value μ_0 to another value $\mu_1 = \mu_0 + \delta\sigma$, then $\beta = \Phi(k - \delta\sqrt{n}) - \Phi(-k - \delta\sqrt{n})$. [4]
- c) Prove that $ARL = \frac{1}{1-\beta}$. [4]
- d) Prove that the economic process centering of a process following normal distribution is $\mu = \frac{U+L}{2} + \frac{\sigma^2}{U-L} \ln \frac{C_1+C}{C_2+C}$, where U and L are upper and lower specification limits, C is the profit per unit for within specification production and C_1 and C_2 are losses per unit due to producing under specification and over specification respectively. [7]
- e) Define the process capability indices C_p , C_{pk} , C_{pm} , and C_{pmk} . [8]

2. A paper mill uses a control chart to monitor the imperfection in finished rolls of paper. Production output is inspected for 20 days, and the resulting data are shown below. Use these data to set up a u -chart for nonconformities per roll of paper. Does the process appear to be in statistical control? What would be the center line and three-sigma control limits to monitor future production?

Day	Number of Rolls Produced	Total Number of Imperfections	Day	Number of Rolls Produced	Total Number of Imperfections
1	18	12	11	18	18
2	18	14	12	18	14
3	24	32	13	18	9
4	22	18	14	20	10
5	22	15	15	20	14
6	22	12	16	20	13
7	20	11	17	24	16
8	20	15	18	24	18
9	20	12	19	22	34
10	20	10	20	21	17

[25]

Group B(Acceptance Sampling): Full Marks 50

Answer All Questions

1(a) Define AQL, LTPD, Type A OC function, Type B OC function, producer's risk and consumer's risk in context of a single sampling attribute plan.

1(b) Derive the properties of the binomial OC i) as a function of sample size for $0 \leq c \leq n-1$ and ii) as a function of process average for $0 \leq c \leq n-1$.

2(a) What are the principles involved while constructing the Mil-Std-105D table with respect to i) the relation between sample size and lot size, ii) choice of AQL values, iii) acceptance number for a given AQL?

2(b) Find from the Mil-Std-105D standard the single sampling, double sampling and multiple sampling plans under normal, tightened and reduced inspection for lots of size 100, AQL = 65 per 100, and inspection level 1.

3. Find for the normal inspection, the approximate AOQL, ASN at AQL (for the double and multiple sampling plans) and the LQ with $P_a = 0.10$ from the Table.

3. When do we use continuous sampling plan? For a CSP-1 with parameters (i, f), derive the expression for AOQ for a given process average.

INDIAN STATISTICAL INSTITUTE
First Semestral Examination (Backpaper): 2012-13

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

Subject: Operations Research-I

Date of Exam : 31.12.12

Max Marks: 100

Duration: 3 hrs.

GROUP-A (Max Marks: 50)

Answer any five questions.

1. Prove that every basic feasible solution (b.f.s) of a LPP is an extreme point of the convex set of all feasible solutions (f.s.).

Show that the set of vectors $a^1 = (2, -1, 0)$, $a^2 = (3, 5, 1)$ and $a^3 = (1, 1, 2)$ form a basis in E_3 .

[6+4=10]

2. Consider the following LP problem. Find the optimal solution using the Simplex method. What evidence indicates that an alternate optimal solution exists?

Maximize Return on Investment $2X_1 + 3X_2$

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

$9X_1 + 3X_2 \geq 9$

$X_1, X_2 > 0$

[8+2=10]

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

Maximize $(3X_1 + 2X_2)$

Subject to

$X_1 + X_2 > 1$

$X_1 + X_2 < 7$

$X_1 + 2X_2 < 10$

$X_2 \leq 3$

$X_1, X_2 > 0$

[10]

4. What is the characteristic of basic feasible solution of a transportation problem (T.P.)? Under what conditions a b.f.s of a T.P. is said to be non-degenerate? What is the basic difference between North-West Corner Rule (NWCR) and lowest cost method for finding an initial b.f.s to a T.P.?

[4+4+2 = 10]

5. Solve the following assignment problem by Hungarian Method (minimize total cost). The owner's objective is to assign the three projects to the workers in a way that will result in the lowest total cost to the shop. Note that the assignment of people to projects must be on a one-to-one basis. Calculate the lowest total cost f of the project.

Workers	P1 (Project)	P2	P3
Arjun	22	28	12
Bobby	16	20	22
Rajesh	18	24	14

[10]

6. Write down the flow properties for a directed graph $G = (V,E)$. Prove these properties by considering both the original flow f and the valid flow f_p for the flow augmenting path p .

[3+7

= 10]

7. Suppose that if f is a flow in a flow network $G = (V,E)$ with source s and sink t . Prove (a) \Rightarrow (b) and (b) \Rightarrow (c) in the following conditions

- f is a maximum flow in G .
- The residual network G_f contains no flow augmenting paths.
- $|f| = c(S, T)$ for some cut (S, T) of G .

[5+5=10]

GROUP-B (Max Marks: 50)

Answer all questions

1. 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 0.7325 for $M=3$. What are the assumptions we have made?

[8]

2. a) Under the assumption of i) normal lead time demand distribution and ii) Poisson distribution of the lead time demand derive the expressions of expected number of stock out and the expected number of units short in a year. Write down all the assumptions.
b) Let the lead time demand be normally distributed with mean 30 units and the standard deviation of 12 units. Cost value = Rs 6.00 /per unit, Carrying cost = 0.20 /year, and Order Quantity = 130 units, Cost of being short = Rs 10 /unit. Compute the optimum value of the reorder point. Derive the necessary expression.

[10+10=20]

3. a) Derive the expression of the waiting time distribution in the steady state for 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 the 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 case of Poisson arrival .

[12+ 6+4=22]

INDIAN STATISTICAL INSTITUTE
Mid-Semester Examination : Semester II (2012-13)
M. TECH. (QR & OR) I Year
Reliability I

Date: 21.02.2013

Maximum marks: 50

Time: 2 hours

This test is open notes. Calculator is allowed. Answer as many as you can. Total mark is 55.

1. (a) In a country with six states, the central government and also the six state governments take part in passing a bill. The states have one point each and the centre has four points. At least six points are needed to pass a bill. Present this as a coherent system with seven components pictorially and also through the structure function (exact expression is not needed). Find structural importance of all the components.

Note: Just to make it more realistic, each component or government could be thought of as a module which passes the bill with certain majority rule; ignore this for the problem at hand.

- (b) Construct a coherent system in which the minimal path sets and the minimal cut sets are identical. Construct two different coherent systems so that the minimal path sets of one are the minimal cut sets of the other and vice versa.
- (c) Prove that there is no modular set of size 2 in a 2-out-of-3 system.

$$[(5+5)+(2+3)+7=22]$$

2. (a) Consider a 2-out-of-4 system with independent components having reliabilities p_i , $i = 1, 2, 3, 4$. Find the system reliability.
- (b) Consider a bridge structure with independent components having component reliabilities as $p_3 = 0.8$ and $p_j = 0.6$ for $j \neq 3$. Compute the tightest possible bounds for the system reliability.
- (c) Consider a coherent system with iid components each having reliability p and the system reliability is $h(p)$. Arrange $h(p)$, $h(p^2)$, $(h(p))^2$, $h(p \text{ II } p)$ and $h(p) \text{ II } h(p)$ in increasing order.

$$[5+(4+4)+6=19]$$

3. (a) Write down the joint p.d.f. of $(X_{(1)}, X_{(n)})$ from a sample of size n from Exponential(λ) distribution having p.d.f. $\lambda e^{-\lambda x}$, $x > 0$, $\lambda > 0$. Hence, or otherwise, obtain means of $X_{(1)}$ and $X_{(n)}$ and their covariance.
- (b) For a stereo system with independent *exponential*(λ_i) component life times, for $i = 1, \dots, 5$, derive the system reliability.

$$[(3+1+2+4)+4=14]$$

INDIAN STATISTICAL INSTITUTE

M. Tech. (QR OR), I Year
Session: 2012-13, Semester II
Mid-Semestral Examination

Subject : Probability II

Date : 22.02.2013

Time : 2 h 30 min

Maximum Marks : 70

Notes:

- (a) Unless stated otherwise, a “Markov Chain” will mean a discrete time parameter, time homogeneous Markov Chain.
(b) The notations have their usual meanings.

(1) Define the following :

- (a) Stochastic process
(b) Markov Chain
(c) Transition probabilities
(d) Hitting time of a state
(e) First passage probabilities

(5 × 4)=[20]

(2) Suppose that $\{X_n | n \in \{0, 1, 2, \dots\}\}$ is a Markov Chain with state space I and transition matrix $P = ((p_{ij}))_{i, j \in I}$.
Find the joint distribution of X_0, X_1, \dots, X_n .

[15]

(3) (a) Show that the k-step transition matrix of a Markov Chain is the k^{th} power of the one-step transition matrix.

(b) Using the result proved in (a), prove the Chapman-Kolmogorov equation for a Markov Chain.

(5 + 5)=[10]

(4) State and prove the Basic Renewal Equation for a Markov Chain.

[15]

(5) Consider a Markov Chain with state space $I = \{0, 1, 2, \dots\}$ and transition probabilities given by :

$$p_{i0} = p \text{ and } p_{i, i+1} = 1 - p \text{ for } i \in I \text{ (} 0 < p < 1 \text{)}$$

(a) Show that

$$P(X_j \neq 0 \text{ for } j \in \{1, \dots, n-1\}; X_n = 0 | X_0 = 0) = (1 - p)^{n-1} p.$$

(b) Give an interpretation of the result.

(3 + 7) = [10]

INDIAN STATISTICAL INSTITUTE
Mid- Semestral Examination: 2012-13

Course Name : M. TECH (QR-OR)-I
Subject Name : MECHANICAL ENGINEERING
Date: 22.02.13 Maximum Marks: 40 Duration: 1 hour 30 minutes
Note, if any :

Answer any two questions

1. a) Briefly discuss about the tensile testing of mild steel and show the corresponding stress-strain diagram for the same. What is meant by toughness of a material? Using stress-strain curve, how is the toughness evaluated? Also explain the true strain in this context.
b) Discuss about Tresca's and von Mises' criteria in metal forming operation.
12 + 8

2. a) Give neatly labeled sketch of a die for closed die forging process. Also mention the salient features of it.
b) Explain the working principle of forward and backward extrusion processes. Also give idea of impact extrusion.
c) Discuss about the lubrication in extrusion process.
6 + 9 + 5

3. a) 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.
b) Discuss the advantages of metal forming processes.
c) What is HERF process? Explain with suitable examples why the HERF processes are used.
8 + 6 + 6

4. a) Discuss about manufacturing process with help of a block diagram showing the input and output of the same.
b) What is recrystallisation? Explain it.
c) What will be the actual shape of the rolls in rolling mills? What is the deflection of the roll at the middle of it?
d) Why is the trimming recess provided on deep drawing die? Explain it.
7 + 5 + 4 + 4

INDIAN STATISTICAL INSTITUTE

M. Tech. (QROR), First Year (E & S streams): 2012-13

Mid-Semester Examination

SQC II

Maximum Marks: 100

Time: 3 hours

DATE - 25.02.13

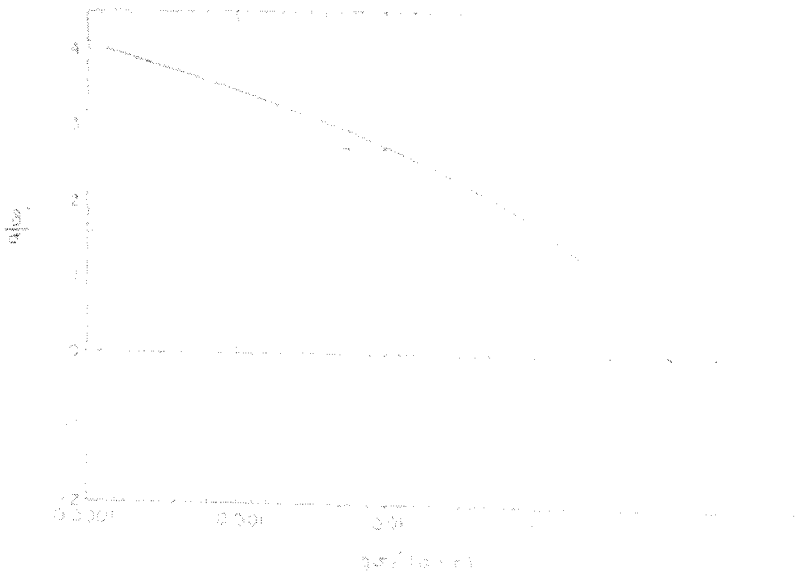
Note: Answer any five questions

1. (a) What do you mean by short-run production process? Give an example.
- (b) What is the problem in applying traditional \bar{x} and R chart for monitoring of short run production processes? What is the simplest approach for overcoming this difficulty?
- (c) Use the following data to set up appropriate short-run \bar{x} and R charts, assuming that the standard deviations of the measured characteristic for each part type are the same. The nominal dimensions for each part are $T_A = 100$, $T_B = 200$ and $T_C = 2000$.

Sample no.	Part type	Measurements			
		M1	M2	M3	M4
1	A	120	95	100	110
2	A	115	123	99	102
3	A	116	105	114	108
4	A	120	116	100	96
5	A	112	100	98	107
6	A	98	110	116	105
7	B	230	210	190	216
8	B	225	198	236	190
9	B	218	230	199	195
10	B	210	225	200	215
11	B	190	218	212	225
12	C	2150	2230	1900	1925
13	C	2200	2116	2000	1950
14	C	1900	2000	2115	1990
15	C	1968	2250	2160	2100
16	C	2500	2225	2475	2390

{4 + 4 + 12 = 20}

2. (a) Define multiple-stream process (MSP). What is the most appropriate control charting technique for monitoring of MSP and what are the statistics plotted in this approach?
- (b) State three drawbacks of group control chart.
- (c) The items manufactured in an industry are packages of food. The weight marked on each package is one ~~pound~~^{kg}, and this is the lower specification limit. The selling price of an accepted package is Rs. 67.5 and the cost of excess material is Rs. 55 per kg. A rejected package is sold for Rs. 37. The standard deviation of the process is approximately 0.00563. Determine the optimum target for the package of food using the δ^*/σ versus $g\sigma/(a-r)$ plot of Hunter and Kartha (1977) given below.



[6+6+8 = 20]

3. (a) State the difference between the SPC and EPC approaches for process control.
- (b) Consider a simple situation involving a process in which feedback adjustment is appropriate and highly effective. Suppose, the process output characteristic of interest at time period $t = y_t$ and the target value for the output variable is T . We

wish to keep y_t as close as possible to the target T . This process has a manipulatable variable x and a change in x will produce all of its effect on y within one period, i.e. $y_{t+1} - T = gx_t$, where g is a constant usually called the process gain. Show that the actual adjustment to the manipulatable variable made at time t , i.e. $x_t - x_{t-1} = -\frac{\lambda}{g}(y_t - T)$. Assume that disturbance can be predicted adequately using an EWMA and $0 < \lambda \leq 1$ is the weighting factor for the EWMA.

- (c) Write down an approach for combining SPC and EPC for the monitoring of a process?

[4 + 10 + 6 = 20]

4. a) Write down the assumptions about the process characteristics made by Duncan in his 'Single Assignable Cause Model for Economic Design of \bar{x} Chart'.
- b) Derive the expected length of a production cycle under the assumptions of Duncan.
- c) Which control chart parameter is mainly affected by the hourly penalty cost for production in out-of-control state?

[4 + 14 + 2 = 20]

5. a) Describe a graphical approach and an analytical approach for detection of autocorrelation in the time series observations
- b) The viscosity of a chemical product is read every 2 minutes. Some data from this process are shown in the table given below (read down, then across from left to right). Set up an unweighted batch means (UBM) control chart with batch = 10, and use it to assess the current state of statistical control of the chemical process.

29.33	30.80	32.43	33.61	28.17
19.98	30.45	32.44	36.54	28.58
25.76	36.61	29.39	35.70	30.76
29.00	31.40	23.45	33.68	30.62
31.03	30.83	23.62	29.29	20.84
32.68	33.22	28.12	25.12	16.56
33.56	30.15	29.94	27.23	25.23
27.50	27.08	30.56	30.61	31.79
26.75	33.66	32.30	29.06	32.52
30.55	36.58	31.58	28.48	30.28
28.94	29.04	27.99	32.01	26.14
28.50	28.08	24.13	31.89	19.03
28.19	30.28	29.20	31.72	24.34
26.13	29.35	34.30	29.09	31.53
27.79	33.60	26.41	31.92	31.95
27.63	30.29	28.78	24.28	31.68
29.89	20.11	21.28	22.690	29.10
28.18	17.51	21.71	26.60	23.15
26.65	23.71	31.47	28.86	26.74
30.01	24.22	24.71	28.27	32.44

(6 + 14 = 20)

6. a) Give some examples of process measurements that cannot be described adequately by a normal distribution.
- b) Define the appropriate process capability indices (C_p , C_{pl} , C_{pu} and C_{pk}) for those process measurements which cannot be described adequately by a normal distribution.
- c) Write down three disadvantages of 'Data transformation approach' for calculation of process capability indices for non-normal process.

- d) Measurements were obtained for a component characteristic on 200 samples. The lower and upper specification limits for the characteristic are 4 and 32 respectively. The summary statistics obtained from the sample observations are given below: Mean (\bar{x}) = 10.5, Std. Dev. (s) = 3.142, Skewness (Sk) = 1.1 and Kurtosis (Ku) = 2.6. Compute process capability indices (C_p , C_{pl} , C_{pu} and C_{pk}) using Pearson's Tables.

[3 + 4 + 3 + 10 = 20]

7. a) Compute the probability of acceptance of a lot in case of a ChSP-1 plan with $n = 5$, $c = 0$ and $i = 3$ applied to the lots with process quality $p = 0.10$.
- b) Describe the procedure of continuous sampling plan CSP-3 using flow diagram.
- c) Let P denote the probability of acceptance of a lot from the reference-sampling plan and $P_a(f, i)$ is the probability of acceptance for the skip-lot sampling plan SkSP-2. Write down the expression for $P_a(f, i)$.

[7 + 10 + 3 = 20]

INDIAN STATISTICAL INSTITUTE

Second Mid-Semester Examination (2012 – 2013)

Course Name : M.Tech (QR & OR)
Subject : Industrial Engineering and Management
Date : 26.02.13
Maximum Marks : 35
Duration : 120 minutes

Question Paper

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

Answer all questions

Marks: (2 X 10 + 5X1 + 2.5X 4 = 35)

1. Which of the following is usually considered a characteristic of a product or line layout?
 - (a) Transforming resources move to the work
 - (b) This layout tends to be very flexible
 - (c) Transforming resources are costly to maintain
 - (d) This layout can easily handle high variety but low volume
 - (e) This layout can easily handle high volume but low variety
2. A product layout:
 - (a) Groups transforming resources into dedicated cells
 - (b) Involves locating the transforming resources entirely for the convenience of the transformed resources

- (c) Is appropriate for low volume operations
- (d) Moves resources to the place where the operation is to be carried out
- (e) Allows a wide variety of products to be manufactured on the same equipment

3. Cell layouts typically:

- (a) Cost more to run than other types of process layout
- (b) Are dominated by the transforming resources
- (c) Locate transforming resources entirely for the convenience of the transformed resources
- (d) Are the most efficient form of process layout
- (e) Involve all the operations on a product being located adjacent to each other

4. Which of the following is not usually considered a characteristic of a fixed position layout?

- (a) Fixed position layouts are able to offer high flexibility
- (b) Transforming resources often move to the work
- (c) Transforming resources are grouped in cells
- (d) Fixed position layouts are often used for large or delicate products or services
- (e) The recipient of the process or the work being undertaken remain in the same place

5. A company has fixed costs of Rs300,000 per annum. It costs Rs5.50 to make each of its products. At what price would the company have to sell its products to give a break-even volume of 20,000 units?

- (a) Rs 17.25
- (b) Rs 20.50
- (c) Rs 20.00
- (d) Rs 16.00
- (e) Rs 18.50

6. The five elements in the management process are

- (a) plan, direct, update, lead, and supervise
- (b) accounting/finance, marketing, operations, and management
- (c) organize, plan, control, staff, and manage
- (d) plan, organize, staff, lead, and control
- (e) plan, lead, organize, manage, and control

7. Which of the following is not an element of the management process?

- (a) pricing

- (b) staffing
- (c) planning
- (d) controlling
- (e) leading

8. Gibson Valves produces cast bronze valves on an assembly line, currently producing 1600 valves each 8-hour shift. If the production is increased to 2400 valves each 8-hour shift, the productivity will increase by

- (a) 10%
- (b) 20%
- (c) 25%
- (d) 40%
- (e) 50%

9. Productivity measurement is complicated by

- (a) the competition's output
- (b) the fact that precise units of measure are often unavailable
- (c) stable quality
- (d) the workforce size
- (e) the type of equipment used

10. 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

11. Table below show jobs, their normal time and cost estimates for cost and crash time the project

Job	Normal		Crash	
	Time (days)	Cost	Time (days)	Cost
1-2	6	1400	4	1900
1-3	8	2000	5	2800
2-3	4	1100	2	1500
2-4	3	800	2	1400
3-4	Dummy	-	-	-
3-5	6	900	3	1600
4-6	10	2500	6	3500
5-6	3	500	2	800

Indirect cost for the project is Rs. 300 per day.

- Draw the network of the project.
- What is normal duration and cost of the project?
- If all activities are crashed, what will be the minimum project duration and corresponding cost.

12.

- State and discuss controlling aspects of project management.
- Labour is considered as the most important unit of productivity measurement. True or false. Justify.
- How does product and process design play an important role to improve the productivity?
- Explain the importance of time study in the context of wage incentive scheme.

INDIAN STATISTICAL INSTITUTE

Mid-Semester Examination: 2012-13 (Second Semester)

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

Subject Name: Instrumentation and Computer Engineering

Date: 27.02.13 Maximum Marks: 60 Duration: 2 Hrs 20 min

Answer any 5 questions.

1. Design a 3 bit synchronous counter such that, the binary equivalent of the series 7, 5, 6, 4, 3, 0, 1, 2 can be realized at the output. [12]
2. What is the difference between an encoder and a decoder? Explain the operation of a 10 to 4 bit encoder with circuit diagram and truth table. [3+9=12]
3. Draw the circuit diagram of a 4 bit dual-slope analog-to-digital (A/D) convertor and explain its operational procedure. [12]
4. a) What are the advantages of automatic control system? Explain the operational procedure and advantages of a PD controller with related equations for any one type of error signal.
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+6)+3=12]
5. What are the advantages of a JK Flip flop over RS flip flop? Explain the operation of a J-K flip flop with truth table. What is race around condition? [2+8+2=12]
6. What is the difference between synchronous and asynchronous counters? Explain the operation of a 4 bit asynchronous counter with circuit and timing diagram. [2+10=12]
7. 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. [7+3+2=12]
8. Explain the operation of a full adder with circuit diagram and truth table. Show that a 3 bit addition can be realized with adders. [9+3=12]

INDIAN STATISTICAL INSTITUTE
Mid -Semester Examination: 2012 – 13
M. Tech (QROR), E-Stream, Semester II
Statistical Methods – II

Date: 01.03.13

Maximum Marks: 100

Duration: 3 Hrs.

Note: Answer all the questions. Maximum you can score is 100.

1. a) State and explain the regularity condition for the Cramer-Rao Inequality.
b) Prove that, under these conditions, the variance of an unbiased estimator T for $\gamma(\theta)$, a function of parameter θ , satisfies the inequality

$$\text{var}(T) \geq \frac{-[\gamma'(\theta)]^2}{E\left[\frac{\partial^2}{\partial \theta^2} \log(X_1, X_2, \dots, X_n | \theta)\right]^2}$$

[5+20=25]

2. a) Define a sufficient statistics in light of Neyman's factorization theorem.
b) If X_1, X_2, \dots, X_n denote a random sample from

$$f(x, \theta) = \begin{cases} \theta^x (1-\theta)^{1-x}; & x = 0, 1 \\ 0, & \text{otherwise} \end{cases}, \text{ where } 0 < \theta < 1.$$

Show that $Y = \sum_{i=1}^n X_i$ is a sufficient estimator for θ .

[4+6=10]

3. a) The percentage of titanium in an alloy used in aerospace castings is measured in 51 randomly selected parts. The sample standard deviation is found as $s = 0.37$. Construct a 95% two-sided confidence interval for σ .
b) i) The fraction of defective integrated circuits produced in a photolithography process is being studied. A random sample of 300 circuits is tested, revealing 13 defectives. Find a 95% two-sided confidence interval on the fraction of defective circuits produced by this particular process.
ii) How large must the sample be if we wish to be at least 95% confident that the error in estimating p is less than 0.02, regardless of the true value of p ?

[5+10 = 15]

4. a) Explain, in brief, the Likelihood Ratio Test.
 b) Let X_1, X_2, \dots, X_n be a random sample from a normal distribution with unknown mean μ and unknown variance σ^2 . Use likelihood ratio test to define the critical region for the following hypothesis:

$$H_0 : \mu = \mu_0$$

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

[5+15=20]

5. a) An engineer, who is studying the tensile strength of a steel alloy, knows that tensile strength is approximately normally distributed with $\sigma = 60 \text{ psi}$. A random sample of 12 specimens has a mean tensile strength of $\bar{x} = 3450 \text{ psi}$.
- Test the hypothesis that mean strength is 3500 *psi*. Use $\alpha = 0.05$.
 - What is the *P*-value for this test?
- b) Consider the following frequency table of observations on the random variable X .

Values	0	1	2	3	4
Observed Frequency	24	30	31	11	4

Based on these 100 observations, is a Poisson distribution with a mean of 1.2 an appropriate model? Perform a goodness-of-fit procedure with $\alpha = 0.05$.

[5+2+13=20]

6. The following table compiled by a personnel manager relates to a random sample of 180 staff taken from the whole workforce of the supermarket chain. Test for association between the gender of staff member and his/her type of job, at the 5% level of significance.

	Male	Female
Supervisor	20	15
Shelf stacker	20	30
Till operator	10	35
Cleaner	10	40

[15]

INDIAN STATISTICAL INSTITUTE
Semestral Examination : Semester II (2012-13)
M. TECH. (QR & OR) I Year
Reliability I

Date: 22.04.2013

Maximum marks: 100

Time: 3 hours

This test is open notes. Calculator and RMM Table are allowed.

Answer as many as you can. Total mark is 103, but the maximum one can score is 100.

1. Consider a stereo system with five independent components, which is a series structure of (1) Radio and Player in parallel, (2) an Amplifier, and (3) two Speakers in parallel.
 - (a) Obtain the structural importance of one of the speakers in the stereo system. How does it change, if there are three speakers instead of two?
 - (b) Let p_i denote the reliability of the i th component. Assuming $p_i = p$ for $i = 1, \dots, 5$, find the reliability importance of all the components and rank them.
 - (c) The Radio and Player both have exponential(α), the Amplifier has exponential(β), and both the Speakers have exponential(γ) life distributions. Find the reliability of the system at time t_0 . Prove that the system's life distribution is IFR.

$$[(4+3)+(4+3)+(4+6)=24]$$

2. Prove that the dual of a module of a coherent system ϕ is also a module of its dual ϕ^D . [8]
3. Consider a system with three independent components, which are required to function till time 1000, 2000, and 1500 hours, respectively. The life distributions for the components are exponential($\lambda = 0.001$). Once a component fails, it is immediately replaced by a spare having identical life distribution. Find the minimum number of spares required to ensure the operation of the system with at least 0.95 probability. [10]

4. (a) Find mean and variance of a Weibull random variable.
 - (b) Consider n independent light bulbs coming from two brand names (40% from brand A and the rest from brand B) having Weibull(λ, p) life distributions with $p = 2$ and 3, for brand A and B, respectively. What is the expected life time of a randomly chosen light bulb? Derive the hazard rate for this life time.
 - (c) A product has a constant hazard α up to time t_0 (known positive constant), after which the hazard changes to β . Obtain the reliability of the product at time t .

$$[(3+4)+(2+4)+3=16]$$

5. (a) Is hybrid censoring a special case of random censoring? Justify your answer.
 - (b) Describe a method of simulating hybrid censored data with sample size n .
[There is credit for using fewer than n random numbers.]

$$[3+8=11]$$

6. Consider grouped data from the failure times of n items on test. Describe the data and then discuss maximum likelihood estimation of mean lifetime and reliability at time t_0 assuming *exponential*(λ) life distribution. [2+8=10]

7. Consider the data given below on some life times from two groups (+ indicating right censored observation).

Group 1:

143, 164, 188, 188, 190, 192, 206, 209, 213, 216, 220, 227, 230, 234, 246, 265, 304, 216+, 244+

Group 2:

142, 156, 163, 198, 205, 232, 232, 233, 233, 233, 233, 239, 240, 261, 280, 280, 296, 296, 323, 204+, 344+

Check validity of exponential distribution in Group 1 using probability plot. Assuming exponential distribution in each group, find 95% asymptotic confidence interval for λ in each group, and test for homogeneity between the two groups.

[10+(3+3)+8=24]

INDIAN STATISTICAL INSTITUTE

Second-Semester Examination: 2012-13

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

Subject Name: Instrumentation and Computer Engineering

Date: 23.04.13 Maximum Marks: 96 Duration: 3 Hrs

Answer any 6 questions.

1. a) Derive the expression of the output voltage for a 4 bit R-2R ladder digital to analog (D/A) converter.
b) The output of the D/A converter 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 $4R$. [12+4=16]
2. What are the differences between an active transducer and a passive transducer? Show the classification of transducers with examples. Explain the operating procedures of electromagnetic transducer and resistance strain gauge. [3+7+(3+3)=16]
3. a) Draw the block diagram of an automatic control system and define control lag, load variable, manipulated variable, process lag, and dead time.
b) Derive the output of a PID (proportional plus integral plus derivative) control action for a step type error signal. Explain with a figure that how the output changes with error signal and time. [(2+6)+(5+3)=16]
4. Explain the operation of a JK flip flop with the truth table. Show the outputs of each gate for every possible input bits. [4+4+4+4=16]
5. a) How a shift register can store a binary number 110?
b) Design a 4 bit asynchronous DOWN counter. Show the circuit and timing diagram. [10+(3+3)=16]
6. a) For a particular program find the relations between i) CPU execution time and clock rate, and ii) number of instructions for a program and number of CPU clock cycles per instruction.
b) A compiler designer is trying to decide between two code sequences 1 and 2 and both the code sequences use three different instruction classes A, B, and C. The required CPI (clock cycles per instruction) for A, B, and C, are 1, 2 and 3, respectively.

P.T.O

The number of instruction counts for A, B, and C are 2, 1 and 2 respectively, in code sequence 1. The number of instruction counts for A, B, and C are 4, 1 and 1 respectively, in code sequence 2. Which code sequence executes more instructions? Which will be faster? What is the average CPI for each sequence?

c) A program runs in 20 seconds on a computer which has a 8 GHz clock. A substantial increase in clock rate is possible but that will increase the number of clock cycles by 1.5 times for the same program to run. What clock rate will be required to run that program in 6 seconds. $[(2+2)+(2+3+2)+5]=16]$

7. What is the decimal value of the 32-bit two's complement (signed integer) number shown below ?
 1111 1111 1111 1111 1111 1100 1111 1100_{two}

How many bits are allocated for the exponent and the fraction part of a double precision floating point number?

Add the numbers 0.5_{ten} and -0.4375_{ten} in binary using scientific notation and floating point addition with 4 bits of precision.

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. $[3+2+5+(3+3)]=16]$

8. a) Explain the operating procedure of a CPU with 7 registers, MUX, ALU and decoder as major components.
- b) The binary OPR word for performing XOR operation between contents in A BUS and B BUS in ALU is 01100. Find the 14 bit control word for performing the operation using seven registers:
 Register1 Content ← Register2 Content XOR Register3 Content
- c) How pop operation is performed in a register stack? Explain with the related algorithm.
- d) Find the reverse polish notation for the expression $(A*B)*[C*(D-E)-F]$. $[7+4+3+2]=16]$
9. Explain the connection procedure of 4 RAMS (each having capacity of 128 words) and 1 ROM (capacity 512 words) with CPU for read and write operations.

What is an associative memory? Explain the operation of an associative memory with emphasis on match logic. $[8+(1+7)]=16]$

INDIAN STATISTICAL INSTITUTE
Second Semestral Examination: 2012-13

Course Name : M. TECH (QR-OR)-I
Subject Name : MECHANICAL ENGINEERING
Date: 24.4.13 Maximum Marks: 100 Duration: 3 hours
Note, if any :

Answer any five questions.
Assume suitable data if necessary.

1. a) What is tolerance? Explain it. Also explain unilateral and bilateral tolerances.
b) Define fundamental deviation and grade of tolerance.
c) A fit is designated as 50 H8-f9. Explain all the terms of it.
d) Briefly discuss about the selective assembly. 5 + 5 + 5 + 5

2. a) Discuss the effects of surface roughness on the performance of a machined component.
b) In the measurement of surface roughness, the heights of 20 successive peaks and troughs were measured from a datum and were 35, 25, 40, 22, 35, 18, 42, 25, 35, 22, 36, 18, 42, 22, 32, 21, 37, 18, 35, 20 micron. If these measurements were obtained over a length of 20 mm, determine the CLA and RMS value of the rough surface.
c) With the help of a neat sketch, discuss the working principle of Talysurf.
d) State Taylor's principle for limit gauge design. Give a neat labeled sketch of a limit plug gauge. 5 + 5 + 6 + 4

3. a) What is meant by wringing of slip gauges? Explain the most important points in wringing of slip gauges. What is the function of protectors in slip gauge use?
b) List the slip gauges to be wrung together to produce an overall dimension of 92.357 mm using two protecting slip gauges of 2.500 mm size.
c) Explain a method to measure the diameter of a bore of about 1 m in diameter precisely. Prove that the method adopted is reasonably accurate. 5 + 5 + 10

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 electro hydraulic forming.
c) Write the differences between forward extrusion and backward extrusion processes. Give necessary sketches. Also discuss about the lubricant used in extrusion process. 5 + 5 + 10

5. a) Define the following terms in connection with metal cutting:
 i) cutting speed ii) feed iii) depth of cut
 b) What is tool life?
 c) When operating with roughing cuts on mild steel at 18 m/min, a certain tool gave a tool life of 3 hours between regrinds. Estimate the life of this tool on similar cuts at a speed of 24 m/min. Take the exponent of tool life as 1/8.
 d) A $\phi 40 \times 200$ ms bar is to be turned to $\phi 30$ by using hss turning tool. The feed is 0.5 mm/rev and the cutting speed is 30 m/min. Assuming suitable number of passes, approach and over travel, calculate the machining time. Also sketch the process. 6 + 2 + 5 + 7
6. a) Explain the differences between hot working and cold working of metals.
 b) What are closed die forging and open die forging processes? Discuss with the help of sketches.
 c) Neatly sketch a two high rolling mill and explain the working principle of rolling operation.
 d) What is coining operation? Explain it. 6 + 6 + 5 + 3
7. a) Discuss the necessity of using non conventional machining processes.
 b) With the help of a neat sketch, explain the ultrasonic machining process.
 c) Define machine tool. What is general purpose machine tool? What is CNC machine tool?
 d) Explain generation and forming principles of machining. 5 + 5 + 5 + 5
8. a) With the help of neat sketch explain the scheme of plastic deformation in perfect crystal. Also discuss the mechanics of slip in perfect crystal.
 b) Define true strain. Show the stress- strain diagrams for:
 i. Mild steel
 ii. Copper
 iii. Cast iron. 10 + 10

INDIAN STATISTICAL INSTITUTE

Second Semestral Examination: 2012-13

Course Name : M. Tech. (QROR)

Subject Name : SQC II

Date : 29.04.13 Maximum Marks: 100 Duration: 3 hours

Note : Symbols are having their usual meaning

Answer any five questions

1. (a) Let m be the ideal value, say, for length of a component part. The specification of the component part is $m \pm \Delta$ and the loss sustained at the specification terminal points is 'A'. Determine the average loss per product due to variation.
- (b) At present, diagnosis on production process of one part is being done at its assembly process. That is, the production process of this part is being diagnosed by using the information from 100% inspection at its assembly process. Since any defective is found readily 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/- and time lag l_0 is 800 parts. The production during last 3 months was 300000 parts and finally the number of troubles during last 3 months was 20. Now, the management is considering diagnoses immediately after production of parts. In that case, diagnosis cost B increases to Rs.100/- and time lag l decreases to 5 parts. Moreover, loss due to defective A decreases to Rs.40/- for reduction of supplemental value, and adjustment cost C stays same as the present, namely Rs. 5000/-.
 - (i) Discuss the loss or gain for this proposal in which diagnosis are done immediately after production.
 - (ii) As preventive maintenance a periodical tool change with $\bar{n}' = 10000$ parts is introduced where the risk of trouble before a tool change is 0.02. Discuss the loss or gain for both the above diagnosis systems when this preventive maintenance is introduced. Assume $C = C'$.

2. (a) Let us consider a quality control system where the process is diagnosed on every ' n ' production units by checking a product. If the process is found abnormal, then it is recovered to the normal condition. On the other hand, if the process is found normal, the production is continued without any recovering operation. Suppose, loss due to producing one unit of product under abnormal production process or loss due to a defective product is A , diagnosis cost (per diagnosis) is B , adjustment cost is C , average trouble occurrence interval is \bar{u} and the time lag of diagnosis, i.e. 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) At a production process of ring hollowing of automobile part two types of defectives occur where one type is reworkable defective and is 20% of all defectives and the other type is non-reworkable defective and is 80% of all defectives. The loss due to producing one reworkable defective item is 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 occurred 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 has come 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.

[10+10=20]

3. (a) Suppose, the target value of a quality characteristic of a chemical process is y_0 . The quality characteristic is measurable and adjustable. After an interval of Δ , the value of the quality characteristic is measured (predicted) and

instead of adjusting the whole gap between the measured and the target values. β times the gap is adjusted (β is nonnegative). Determine the optimal value of β .

- (b) Describe an approach of combining SPC and EPC for controlling a production process.
- (c) Describe the procedure of continuous sampling plan CSP-1 using flow diagram.

[10+5+5=20]

4. (a) Name four non-normal distributions that are most commonly fitted to non-normal process data for estimation of process capability indices. State two advantages and two disadvantages of this approach.
- (b) The viscosity of a chemical product is read every 2 minutes. Some data from this process are shown in the table given below (read down, then across from left to right). Set up an unweighted batch means (UBM) control chart with batch $n = 10$, and use it to assess the current state of statistical control of the chemical process.

29.33	28.94	30.8	29.04	32.43	27.99	33.61	32.01	28.17	26.14
19.98	28.50	30.45	28.08	32.44	24.13	36.54	31.89	28.58	19.03
25.76	28.19	36.61	30.28	29.39	29.20	35.70	31.72	30.76	24.34
29.00	26.13	31.40	29.35	23.45	34.30	33.68	29.09	30.62	31.53
31.03	27.79	30.83	33.60	23.62	26.41	29.29	31.92	20.84	31.95
32.68	27.63	33.22	30.29	28.12	28.78	25.12	24.28	16.56	31.68
33.56	29.89	30.15	20.11	29.94	21.28	27.23	22.69	25.23	29.10
27.50	28.18	27.08	17.51	30.56	21.71	30.61	26.60	31.79	23.15
26.75	26.65	33.66	23.71	32.30	31.47	29.06	28.86	32.52	26.74
30.55	30.01	36.58	24.22	31.58	24.71	28.48	28.27	30.28	32.44

[6+14=20]

5. The tensile strength and diameter of a textile fibre are two important quality characteristics that are to be jointly controlled. The quality engineer has decided

to use $n = 10$ fibre specimens in each sample. He has taken 10 preliminary samples. The computed sample means, sample variances and covariance in the preliminary samples are given in the following table. Establish a T^2 control chart.

Sample no.	Sample means		Variance and covariances		
	Tensile strength (\bar{x}_{1k})	Diameter (\bar{x}_{2k})	S_{1k}^2	S_{2k}^2	S_{12k}
1	115.25	1.04	1.25	0.87	0.80
2	115.91	1.06	1.26	0.85	0.81
3	115.05	1.09	1.30	0.90	0.82
4	116.21	1.05	1.02	0.85	0.81
5	115.90	1.07	1.16	0.73	0.80
6	115.55	1.06	1.01	0.80	0.76
7	114.98	1.05	1.25	0.78	0.75
8	115.25	1.10	1.40	0.83	0.80
9	116.15	1.09	1.19	0.87	0.83
10	115.92	1.05	1.17	0.86	0.95

[20]

6. (a) A ChSP-1 plan has $n = 4$, $c = 0$ and $i = 3$. Estimate the probability of acceptance when the process average $p = 0.10$.
- (b) Use the following data to set up short run \bar{x} and R charts using DNOM approach. The nominal dimensions for each part are $T_A = 100$, $T_B = 60$, $T_C = 75$ and $T_D = 50$.

Sample no.	Part type	Measurements		
		M1	M2	M3
1	A	105	102	103
2	A	101	98	100
3	A	103	100	99
4	A	101	104	97
5	A	106	102	100
6	B	57	60	59
7	B	61	64	63
8	B	60	58	62
9	C	73	75	77
10	C	78	75	76
11	C	77	75	74
12	C	75	72	79
13	C	74	75	77
14	C	73	76	75
15	D	50	51	49
16	D	46	50	50
17	D	51	46	50
18	D	49	50	53
19	D	50	52	51
20	D	53	51	50

[4+16=20]

INDIAN STATISTICAL INSTITUTE
Semester Examination: 2012 – 13
M. Tech (QROR), E-Stream, Semester II
Statistical Methods – II

Date: 02.05.2013

Maximum Marks: 100

Duration: 3 Hrs.

Note: Answer any five (5) questions.

1. The city's transportation department is interested in studying the relationship between the temperature and the number of passengers that ride the main bus line in order to better serve their customers. The manager recorded the temperature (in $^{\circ}\text{F}$) at the beginning of the hour, and then had a bus driver to record the number of passengers that boarded the bus throughout the hour. Their findings are listed below.

temperature	passengers
42	173
37	149
46	185
30	123
50	201
43	174
43	175
46	188
46	186
49	198

Assuming a linear relation is valid,

- obtain a least squares regression equation,
- find the value of the correlation coefficient,
- test the significance of regression using Analysis of Variance, and
- find the 95% prediction interval of a future observation at 45°F .

[6+2+7+5=20]

2. a) Derive the least square normal equations for the multiple linear regression model

$$y_i = b_0 + \sum_{j=1}^p b_j x_{ij} + \varepsilon_i, \quad i = 1, 2, \dots, n.$$

- b) Show that above least square normal equations can be expressed in matrix form as

$$X^T X \hat{b} = X^T y,$$

where y is an $(n \times 1)$ vector of response variable, X is an $[n \times (p+1)]$ design matrix corresponding to the model chosen, b is a column vector of regression coefficients of order $p + 1$.

[10+10=20]

3. a) Stating the appropriate linear statistical model and assumptions, derive the expression for the expected value of SS(Treatment) for a single factor fixed effects model.

- b) Five different digital computer circuit designs are being studied in order to compare the amount of noise present. The following data have been obtained.

Circuit Type	Noises Observed				
1	19	20	19	30	8
2	80	61	73	56	80
3	47	26	25	35	50
4	95	46	83	78	97
5	19	17	21	5	32

- i) Is the amount of noise present the same for all five circuits? Use $\alpha = 0.05$.

- ii) Find the 95% confidence interval for the mean of third circuit type.

[10+(7+3)=20]

4. The factors that influence the breaking strength of synthetic fiber are being studied. Four machines and three operators are chosen at random and a factorial experiment is run using fiber from the same production batch. The results are as follows.

Operator	Machine			
	1	2	3	4
1	109	110	108	110
	110	115	109	108
2	110	110	111	114
	112	111	109	112
3	116	112	114	120
	114	115	119	117

- a) Write the corresponding statistical model and hence derive the expression for expected mean square for the model components.
- b) Analyze the above data suitably and draw conclusions. Use $\alpha = 0.05$.
- c) Estimate the variance components of significant effects.

[7+8+5=20]

5. a) An electrical engineer must design a circuit to deliver the maximum amount of current to a display tube to achieve sufficient image brightness. Within his allowable design constraints, he has developed two candidate circuits and tests prototypes of each. The resulting data (in microamperes) are as follows:

Circuit 1	251	255	258	257	250	251	254	250	248
Circuit 2	250	253	249	256	259	252	260	251	

Use Mann-Whitney U test to test $H_0 : \mu_1 = \mu_2$ against the alternative $H_1 : \mu_1 > \mu_2$. Use $\alpha = 0.05$.

- b) Shelf life of medicinal products is dependent on the temperature at which they are stored. The table, in next page, gives the shelf life (y) of a cough syrup and the corresponding storage temperature (x), collected from the QC Laboratory of a pharmaceutical company:

Storage Temp.	Shelf Life	Storage Temp.	Shelf Life	Storage Temp.	Shelf Life
18	665	16	716	25	592
13	727	27	537	22	615
21	653	13	721	20	663
28	537	30	507	14	760

- i) Compute Kendal's τ .
 ii) Do the data indicate a significant association between the variables?
 [Critical value for Kendal's test statistic at 5% level is 28]

[10+(8+2)=20]

6. a) Four chemists are asked to determine the percentage of methyl alcohol in certain chemical compound. Each chemist makes three determinations and the results are the following.

Chemist	% of Methyl Alcohol		
1	84.99	84.04	84.38
2	85.15	85.13	84.88
3	84.72	84.48	85.15
4	84.20	84.10	84.55

Apply Kruskal-Wallis test to check whether chemists differ significantly. Use $\alpha = 0.05$.

- b) Assuming $A = \frac{1-\beta}{\alpha}$ and $B = \frac{\beta}{1-\alpha}$, obtain the expression for the sequential testing procedure for the number of defective items r when items are taken one by one at random from a large batch that contains a proportion p of defective items, where α and β are respectively the probability of type I and type II error.

[10+10=20]

INDIAN STATISTICAL INSTITUTE

Second End-Semester Examination (2012 – 2013)

Course Name : M.Tech (QR & OR)
Subject : Industrial Engineering and Management
Date : 03.05.13
Maximum Marks : 40
Duration : 150 minutes

Question Paper

Direction: Attempt Any Eight questions. All questions carry equal marks.

1. How does management reduce ineffective time to improve the productivity?
2. Explain Delphi Technique in the context of optimizing facility location.
3. A time study of an assembly line worker in a car plant produced the following results:
Cycle time of 2.50 minutes; worker performance rating of 95 percent. Assuming an average allowance for the activity as 10 percent of the normal time, calculate the standard time.
4. How is value delivery process important with marketing?
5. What are the differences between product layout and grouping technology layout?
6. Consider the following:
 - (i) A machine costs Rs 30,000.
 - (ii) Running costs (payable at the end of the year):
Year 1 Rs 5,000
Year 2 Rs 5,500

(iii) Trade-in allowance:

Disposal after 1 Year Rs 16,000

Disposal after 2 years Rs 13,000

Calculate the optimal replacement cycle if the cost of capital is 10%.

7. What do you mean by holistic marketing? Explain with an example.
8. State and explain in brief the integrated marketing.
9. What are the disadvantages of ROCE?
10. Describe the three E's of value for money?
11. The cash flow of a project have been estimated as follows:

Year	Rs.
0	(50,000)
1	6,000
2	10,000
3	8,000
4	7,000

The cost of capital is 6%. Convert these cash flows to a PV. Calculate the NPV of the project to assess whether it should be undertaken.

12. A payment of Rs 1000 is to be made every year for 3 years, the first payment occurring in one year's time. The interest rate is 10%. What is the PV of the annuity?
13. How is human factor engineering important to improve the workplace system?
14. Explain the Standard Hour Plan (SHP) and Piecework of wage incentive schemes. Also mention the advantages of SHP over Piecework.

INDIAN STATISTICAL INSTITUTE

Semestral Examination (Backpaper): Semester II (2012-13)

M. TECH. (QR & OR) I Year

Reliability I

Date: ~~31.07~~ 2013

Maximum marks: 100

Time: 3 hours

Answer all the questions. Calculator and RMM Table needed.

1. Prove that the min path sets of a coherent system are the min cut sets of its dual and vice versa. [8]
2. Consider a bridge structure with independent components having component reliabilities as $p_3 = 0.8$ and $p_j = 0.6$ for $j \neq 3$. Compute the tightest possible bounds for the system reliability. [10]
3. Consider a stereo system with five independent components, which is a series structure of (1) Radio and Player in parallel, (2) an Amplifier, and (3) two Speakers in parallel. The Radio and Player both have exponential(α), the Amplifier has exponential(β), and both the Speakers have exponential(γ) life distributions. Find the reliability of the system at time t_0 . Prove that the system's life distribution is IFR. [4+6=10]
4. Consider a system with three independent components, which are required to function till time 1000, 2000, and 1500 hours, respectively. The life distributions for the components are exponential($\lambda = 0.001$). Once a component fails, it is immediately replaced by a spare having identical life distribution. Find the minimum number of spares required to ensure the operation of the system with at least 0.95 probability. [10]
5. (a) Give an example of a life distribution which is neither IFR nor DFR.
(b) Let X have a Gamma distribution. Prove if it is IFR or DFR stating the conditions.
(c) Give an example to show that the sum of two DFR random variables is not necessarily DFR. [3+5+4=12]
6. Find moment generating function of a Gamma random variable and hence find its mean and variance. [4+2+4=10]
7. (a) Describe type II censored data. With type II censored data from exponential (λ) life distribution, find an exact 95% confidence interval for reliability at time $t = t_0$. Give an asymptotic 95% confidence interval for the same. Prove that the maximum likelihood estimate of expected life time is unbiased.
(b) The following are 15 random numbers between 0 and 1.
.494 .634 .248 .245 .278 .671 .598 .986 .179 .478 .299 .055 .460 .966 .904
Simulate 25 type II censored observations from exponential ($\lambda = .04$) life distribution with 15 failures, using the above 15 random numbers, giving details of the simulation method. Find the exact and asymptotic 95% confidence interval for reliability at time $t = 40$, as derived in (a) above, based on this simulated data.

8. Consider randomly censored life time data on products from two different brands, the i th brand having n_i products under consideration, for $i = 1, 2$. The life time T_i of a product of i th brand has a Weibull distribution with parameters λ_i and p (independent of i). The interest is to test for homogeneity of the two brands. Formulate the null hypothesis. Develop an asymptotic test giving details of the method. [2+8=10]