

INDIAN STATISTICAL INSTITUTE

Mid-Semester Examination : 2010-11(First Semester)

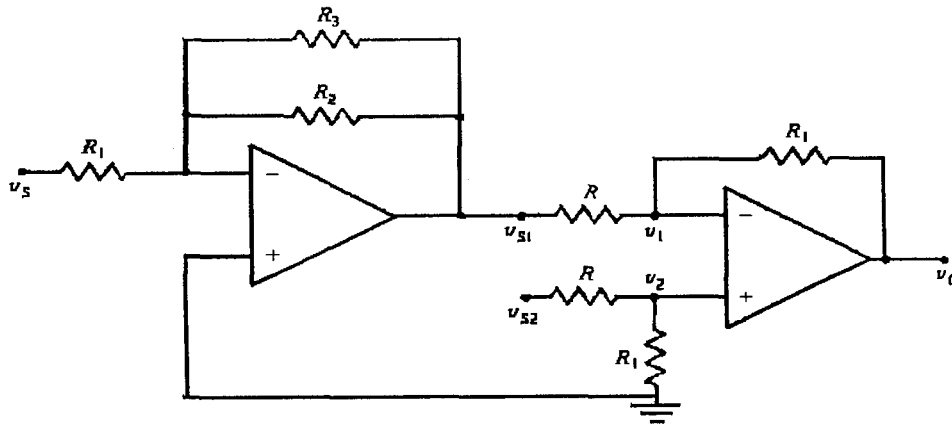
Course Name: M. TECH. (QROR) I Yr.

Subject Name : Electrical and Electronics Engineering

Date : 13.9.2010 Maximum Marks : 50 Duration : 2Hrs

GROUP A: Answer any 5 questions.

1. What is an OP-AMP? Explain the operations of an OPAMP as a differentiator and an adder. [2+3+3=8]
2. For the circuit, given below, find the output voltage v_0 for $v_s=1\text{volt}$, $R_1=2\text{kOhms}$, $R_2=8\text{kOhms}$, $R=2\text{kOhms}$ and $R_3=8\text{kOhms}$. [8]



3. a) If $f(t)$ is a complete response of a circuit, then define the steady state response and the transient response of that circuit. [3]
b) A series RL circuit is excited by a battery of e.m.f. E at time $t=0$. Find the steady state current and the transient current in that circuit. [5]
4. Explain with a diagram how AC voltage can be generated for a rectangular coil having N turns rotating in a uniform magnetic field with an angular velocity of ω radian/second. [8]
5. Find the series resonance frequency for a circuit having a capacitor (C), inductor (L) and a resistor (R) connected in series with an A.C. voltage $V_0 e^{j\omega t}$.

M-TECH(QR&OR) -- 1st YEAR (E STREAM)
SESSION: 2010-2011
MID-SEMESTRAL EXAMINATION

PROBABILITY-1
{Answer all the questions}

Date: 13.9.2010

Full marks:100

Time: 3 hours

[Symbols have their usual meaning]

1. a) Define monotonic sequence of events. Let $\{A_n\}$ be monotonic sequence of events, each belonging to sigma field of events $A \subseteq \Omega$, then prove that,
 $\lim_{n \rightarrow \infty} P(A_n) = P(\lim_{n \rightarrow \infty} A_n)$.
b) State and prove Poincare's theorem.

[10+10=20]

2. a) Define r th order raw moment, r th order central moment and r th order factorial moment. Express r th order central moment in terms of r th order raw moment.
b) Write down the probability density function of Gamma distribution with parameter α and p . Find out its moment generating function, mean, variance and skewness. Comment on the shape of the distribution.

[8+12=20]

3. a) A machine normally makes items of which 10% are defective. An inspector selects a sample of size 15. If it contains no defective item then the lot is accepted. What is the probability that the lot will be rejected?
b) Fit negative binomial distribution to the following data:

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

[10+10=20]

4. a) State and prove Bonferroni's inequality.
b) Arrange the following quantities in increasing order of magnitude with proper equality or inequality sign between them
 $P(A)$, $P(A)+P(B)$, $P(A \cup B)$ and $P(A \cap B)$
c) Assume that $P(A)$ and $P(B)$ are non zero, If A and B are mutually exclusive can they be independent?
d) Explain the difference between pairwise independent and mutual independent events.

[10+4+2+4=20]

5. a) Find the probability density function and the mean of a both sided truncated Normal distribution.
b) A quality characteristic is Normally distributed with mean μ and variance σ^2 . Specification limits for that characteristic is (35 - 63). 7% of the items fall below lower specification limit and 11% fall above upper specification limit. Find μ and σ .

[10+10=20]

INDIAN STATISTICAL INSTITUTE
SQC & OR Unit, Kolkata
M. Tech. (QR OR), II Year
Mid-Semestral Examination

Subject : OR I

Date : 14.09.2010

Time : $2\frac{1}{2}$ hours

Full Marks : 70

1. Define the following:

- (a) Linear independence of a set of vectors.
- (b) Basis
- (c) Convex set
- (d) Convex hull
- (e) Extreme point of a convex set.

$5 \times 5 = [25]$

2. Solve the following linear programming problems graphically:

- (a) Maximize $z = 3x_1 + 2x_2$

Subject to :

$$\begin{aligned}x_1 + 2x_2 &\leq 6 \\2x_1 + x_2 &\leq 8 \\x_1 - x_2 &\geq -1 \\x_2 &\leq 2 \\ \text{and } x_1, x_2 &\geq 0\end{aligned}$$

- (b) Maximize $z = -3x_1 + 2x_2$

Subject to :

$$\begin{aligned}x_1 - x_2 &\leq 0 \\x_1 &\leq 3 \\ \text{and } x_1, x_2 &\geq 3\end{aligned}$$

$(10+10)=[20]$

3. Suppose $SCIR^n$ is a convex set. Show that the convex combination of any finite number of points in S is also a member of S .

[15]

P.T.O

Indian Statistical Institute
Mid-Semester Examination: 2010-2011 (Semester-I)
Course Name: M.TECH.(QROR) I Yr.(E-Str)
Subject Name: Statistical Methods-I

Date: 15/09/2010

Maximum Marks: 100

Duration: 3 hrs.

Note: The paper carries 110 marks. Answer as much as you can but the maximum you can score is 100. You can answer any part from any question.

1. Fill in the blanks with appropriate word/words:

- a) Data are numerical values of observations on _____ of _____ belonging to a _____.
- b) Variables assessed on a nominal scale are called _____ variables.
- c) The class width is the difference between the class _____.
- d) Frequency density is the _____ of frequency and the _____.
- e) For grouped data, the class with the highest _____ is called the _____ class.
- f) _____ statistics is the area of statistics concerned with the summarization, graphical representation and numerical description of data.
- g) Numerically valued variables are of two types – _____ and _____.
- h) Mean absolute deviation is minimum about _____.
- i) A distribution with positive excess kurtosis is called _____.

($\frac{1}{2} \times 14$) = [7]

2. Calculate the variance of x from the following table.

x	-4	-3	-2	-1	0	1	2	3	4
Frequency	1	2	7	10	16	8	8	2	1

Hence find the variance of u from the following frequency distribution of a continuous characteristic. (No marks will be given for direct computation from the first principles.)

Class interval (u)	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60
Frequency	4	8	28	40	64	32	32	8	4

[8]

3. The heights of the 400 trees, selected randomly from a small wood, are measured to the nearest meter and are as follows.

Height (nearest m)	5 – 8	9 – 11	12 – 13	14 – 15	16 – 19	20 – 22	23 – 26	27 – 36
Number of trees	16	60	62	59	71	41	36	55

- a) Draw a histogram of the given data.
- b) Compute the arithmetic mean, the median and the percentile rank of the height 28.5 m.
- c) Estimate the proportion of trees with heights between 12 m and 25 m, both inclusive, in the wood.
- d) Identify the modal class and compute the mode.

($6 + \overline{5} + 5 + 6 + 6 + \overline{1} + 6$) = [35]

4. Write short notes on any two of the following.

- a) Relative measures of dispersion,
- b) Skewness and its measures based on the frequency distribution,
- c) Scales of measurement,
- d) Bivariate frequency distribution table.

(5 × 2) = [10]

5. Show that $AM \geq GM \geq HM$.

[10]

6. Express the 4th sample central moment (m_4) in terms of sample raw moments m_1', m_2', m_3', m_4' .

[5]

7. a) Obtain the least square estimators of the parameters of a simple linear regression equation of y on x . (State your assumptions clearly.)
- b) Show that your above estimators are unbiased for the respective parameters. Obtain the variance of the regression coefficient.
- c) Show that the correlation coefficient between y and its predicted value \hat{Y} is non-negative and is numerically same as the correlation coefficient between y and x .
- d) Prove that the correlation coefficient, r , lies between -1 and 1 . Hence interpret the cases $r = \pm 1$ and $r = 0$.

(6 + 9 + 6 + 6 + 5 + 3) = [35]

INDIAN STATISTICAL INSTITUTE

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

Session : 2010-2011

MID-SEMISTRAL EXAMINATION

Subject : Workshop-I (Engineering Drawing)

Date of Exam: 15.09.2010

Max. Marks : 40

Time : 2:00 hrs

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 is 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) Construct a regular heptagon on a line AB which is 25 mm long. [10]
b) Draw a scale of 1:60 to show metres and decimetres and long enough to measure up to 6 metres. In that scale show the length of 4.7 metres. [10]

- 3 A hexagonal prism has one of its rectangular faces parallel to the ground. Its axis is perpendicular to the V.P. and 4.5 cm above the ground. Draw its projections when the nearer end is 2.5 cm behind the V.P. Side of base 3 cm long; axis 6 cm long. [20]

Mid-semester Examination: (2010-2011)
MTech (QR&OR) I Year
Programming Techniques & Data Structures

Date:16.09.10

Full Marks: 50

Duration: 2 hours

Attempt all questions:

1. Write brief notes on any five of the following:

- (a) *extent* of a variable (b) *scope* of an identifier (c) *local* and *global* variables (d) program counter (e) accumulator (f) stack (g) queue (h) positional number system
2X5=10

2.(a) State with reasons what the output of the following C code would be, if the input text line is: "MALAYALAM"?

```
#include <stdio.h>
#define EOL '\n'
void DS(void);
main()
{
    printf ("please enter a text line\n");
    DS();
}
void DS(void)
{
    char c;
    if ((c=getchar()) !=EOL)
        DS();
    putchar(c);
}
```

(b)What are the outputs of the following C programs?

```
(i) #include<stdio.h>
main()
{
    int var=5;
    printf ("%f ",var);
}
```

```
(ii) # include <stdio.h>
main( )
{
    int i=2, j=3, k=0;
    int p;
    p=(i, k, j);
    printf("%d\n", p);
}
```

```
(iii) #include <stdio.h>
main()
{
    int var1=2,var2=12,var3=12;
    var1=var2=var3;
    printf("%d",var1);
}
```

```
(iv) #include<stdio.h>
main()
{
    char batch[ ]="MTech in QR&OR";
    char *ptr;
    ptr=batch;
    while(*ptr!='\0')
    {
        printf("%c",*ptr);
        ptr++;
    }
}
```

$$3+(3 \times 4)=15$$

3) What are the two types of function calls? Write a C function for swapping the values of two variables. What type of function calling do you require here? $4+5+1=10$

4) Write a C program for calculating (a) the transpose (b) the trace (sum of the diagonal elements) of a square matrix. $7+8=15$

OR

Explain the concept of array of pointers. Sort any array of integers in ascending order by "bubble sort" technique. $5 + 10$

INDIAN STATISTICAL INSTITUTE
SQC & OR Unit, Kolkata
M. Tech. (QR OR), I Year
Mid-Semestral Examination

Subject : Statistical Quality Control I

Date : 17.09.2010

Time : 3 hours

Full Marks : 100

Group A : Control Chart

(Answer All Questions)

- 1.
- a) The tensile strength of a metal part is normally distributed with mean 40 lb and standard deviation 8 lb. If 50,000 parts are produced, how many would fail to meet a minimum specification limit of 34-lb tensile strength? How many would have a tensile strength in excess of 48 lb?
- b) The normal distribution is often assumed as the appropriate probability model for a random variable. In many instances, it is difficult to check the validity of this assumption; however, the central limit theorem is often a justification of approximate normality – Explain.
- c) For a normal population, find the maximum likelihood estimator of the population variance when the population mean is unknown. Show that this estimator is biased. Modify this to get an unbiased estimator of the variance.
- [7+8+15=30]
- 2.
- a) Based on the distribution of relative range and the distribution of average, derive the central lines and the 3σ control limits for R -chart and \bar{X} -chart.
- b) Carry out Pareto analysis and identify the vital few error types from the following data with Pareto diagram on a graph paper.

<u>Error Type</u>	<u>Error Frequency</u>
C	420
E	180
G	60
D	210
B	870
A	960
H	60
J	30
F	180
I	30

[10+20=30]

Group B : Acceptance Sampling

(Answer all the questions. Answer questions 1-8 with detail justification.)

1. A vendor ships items in lots of 1000. You decide to use the sampling plan (80, 7), i.e. sample size of 80 and acceptance number of 7 corresponding to an AQL of 4%. The first lot is inspected and accepted. This means
 - a. The lot is not more than 4% defective
 - b. The probability of accepting the lot is 0.75
 - c. There is high chance that the lot is 10% defective
 - d. All of the above

[5]

2. The AQL for a given sampling plan is 1.0%. This means that
 - a. The producer takes a small risk of rejecting a lot that is 1.0% defectives or better
 - b. The average level of defectives in accepted lots is 1.0%
 - c. The average level of defectives in rejected lots is $\geq 2.0\%$
 - d. The average quality level of the plan is 1.0%

[5]

3. Using a 10% sample of each lot with an acceptance number of zero regardless of lot size
 - a. Results in a constant level of protection against a bad product
 - b. Assures a constant producer's risk
 - c. Abdicates the responsibility for predetermining quality requirements
 - d. Provides an AQL of zero and an LTPD of 10%

[5]

4. Considerations to be made prior to the use of any sampling plan is/are
 - a. The consumer's and producer's risks must be specified
 - b. The method of selecting samples must be specified
 - c. The characteristics to be inspected must be specified
 - d. The method of lot formation must be specified
 - e. All of the above

[3]

5. The OC curve of an acceptance sampling plan
 - a. Demonstrates how the plan will reject all of the lots worse than AQL
 - b. Shows the ability of the plan to distinguish between good and bad lots
 - c. Shows how to use a sampling plan for minimizing sampling risks
 - d. Shows the probability that a lot contains a certain number of defectives

[3]

6. The steeper the OC curve, the
- a. Less protection for both producer and consumer
 - b. More protection for both producer and consumer
 - c. Lower the AQL
 - d. Smaller the sample size
- [3]
7. The probability of accepting material produced at an acceptable quality level is defined as
- a. A
 - b. β
 - c. AQL
 - d. $1-\alpha$
 - e. $1-\beta$
- [3]
8. In acceptance sampling, the probability of accepting a rejectable lot is called
- a. α
 - b. β
 - c. AQL
 - d. LTPD
 - e. None of the above
- [3]
9. Discuss the advantages and disadvantages of acceptance sampling.
- [5]
10. Discuss the differences between type A and type B OC curves
- [5]

INDIAN STATISTICAL INSTITUTE
SQC & OR Unit, Kolkata
M. Tech. (QR OR), I Year
Mid-Semestral Examination

Subject : Quality Management & Systems

Date : 20.09.2010

Time : 3 hours

Full Marks : 100

Group A : Quality Management

(Answer Any Three Questions)

1. Define TQM. Explain Deming wheel or cycle. What are the deadly diseases and sins mentioned by Deming? Explain Deming's Chain reaction.

[5+5+7+3=20]

2. Explain the steps involved in Juran's quality trilogy.

[20]

3. Explain the quality maturity grid with regard to Crosby philosophy. Mention Crosby's 14 steps for quality improvement.

[6+14=20]

4. Define 'Quality' as expressed by Taguchi. Derive Taguchi's loss function $L(y) = k(y - m)^2$ where the notations have the usual meaning. How one arrives at the value of the constant k in this loss function? From this loss function prove

that for nominal is the best characteristic the S/N ratio $\eta = 10 \log \left(\frac{-2}{S^2} \right)$ and for

smaller the better type characteristic $\eta = -10 \log \left(\frac{1}{n} \sum_{i=1}^n y_i^2 \right)$.

[3+5+2+7+3=20]

Group B : Systems

Assignment [40]

INDIAN STATISTICAL INSTITUTE
Second Semestral Examination: (2009 – 2010)

M. Tech (QROR), First Year (E-stream)

Statistical Methods – II (Back paper)

Date: **06.10.10**

Maximum Marks: 100

Duration: 3 Hours

GROUP: A

Full Marks: 50

Note: Answer all questions

1. (a) When the first proof of a book containing 250 pages was read, the following distribution of misprints was obtained:

No. of misprints per page	Frequency
0	139
1	76
2	28
3	4
4	2
5	1
Total	250

Fit a Poisson distribution and test the goodness of the fit when $\alpha = 0.05$. (16)

- 2.(a) If x_1, x_2, \dots, x_n are the values of the random samples from exponential population, find the maximum likelihood estimator of its parameter θ . (6)
- (b) Discuss about Yate's correction for 2×2 contingency table. (3)
- (c) State three important properties of maximum likelihood estimator (3)

(d) The weights at birth for 15 babies born in a Calcutta hospital are given below. Each figure is correct to the nearest tenth of a pound.

6.2 6.7 7.1 6.9 7.5 5.7 4.8 6.8
7.6 7.8 8.1 5.0 5.8 7.9 8.5

Give two limits between which the mean weight at birth for all such children is likely to lie with a confidence of 95%. (6)

3. (a) Let x_1, x_2, \dots, x_n be a random sample of size 'n' from the population of X, where $X \sim N(\mu, \sigma^2)$ and σ^2 is known. You are to test the following hypothesis:

$$H_0: \mu = \mu_0 \text{ vs } H_1: \mu \neq \mu_0$$

Show that the likelihood ratio test for the above problem leads to a z-test. Write down the critical region. (10)

(b) Two experimenters, A and B, take repeated measurements on the length of a copper wire. On the basis of the data obtained by them, which are given below, test with 5% level of significance whether B's measurements are more accurate than A's. It may be supposed that the readings taken by both are unbiased.

A's obs.	12.47	11.90	12.77	11.96	12.78	12.44	12.13	11.86	12.25	12.29
B's obs.	12.06	12.23	12.46	11.98	12.22	12.34	12.46	12.39	-	-

(6)

GROUP: B

Full Marks: 50

Note: Answer all the questions.

1. The strength of paper (y) used in the manufacture of cardboard boxes is related to the percentage of hardwood concentration (x) in the original pulp. 16 samples were manufactured, each from different batch of pulp, in a pilot plant under controlled condition. The hardwood concentration of the pulp and tensile strength of the resulting samples were measured. The data are shown below.

x	1.0	1.5	1.5	1.5	2.0	2.0	2.2	2.4
y	101.4	117.4	117.1	106.2	131.9	146.9	146.8	133.9
x	2.5	2.5	2.8	2.8	3.0	3.0	3.2	3.3
y	111.3	123.0	125.1	145.2	134.3	144.5	143.7	146.9

- i) Fit a simple linear regression model to the data.
- ii) Calculate coefficient of determination for the fitted model and interpret it.
- iii) Test for lack of fit and significance of regression.
- iv) Find the 90% confidence interval for the slope.

(6+2+8+4)

2. a) What is a *measurement*? Describe different measurement scales.

b) In paint application driers are used to speed up the drying process. A chemical engineer with a view to determine the effect two driers, selected 40 panels and painted 20 panels each with paints containing drier A and drier B respectively and recorded the drying time. Data thus obtained are given below.

Panel	Drier A	Drier B	Panel	Drier A	Drier B
1	68	73	11	65	72
2	64	62	12	59	60
3	68	66	13	78	78
4	82	92	14	67	66
5	58	38	15	65	68
6	80	87	16	76	77
7	72	77	17	61	72
8	65	70	18	86	86
9	84	88	19	74	72
10	73	79	20	88	97

Assume the two distributions to be continuous. Do the data indicate that *Drier A* results in reduced drying time? Use Wilcoxon Signed-Rank test with $\alpha = 0.05$.

(10+10)

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

<i>Temperature</i> [°C]	<i>Pressure [kg/cm²]</i>		
	200	215	230
Low	90.4	90.7	90.2
	90.2	90.6	90.4
	90.2	90.7	90.4
Medium	90.1	90.5	89.9
	90.3	90.6	90.1
	90.4	90.5	89.8
High	90.5	90.8	90.4
	90.7	90.9	90.1
	90.6	90.6	90.2

State the linear model for the above experiment and carryout a suitable analysis to find if the factors or their interactions affect the yield of the chemical process. [$\alpha = 0.05$]

(10)

INDIAN STATISTICAL INSTITUTE
First-Semester Examination : 2010-11
M-TECH(QR&OR) – 1st YEAR (E-STREAM)

PROBABILITY -- 1

Note : Answer all the questions

Date: 3.12.10

Full marks:100

Time: 3 hours

1. a) State and prove Chebyshev's inequality.

b) State and prove central limit theorem due to Lindeberg and Levy. Explain the application of central limit theorem in the field of SQC.

[8+12=20]

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

b) Let $X_i \sim \text{iid } N(0,1)$, $i=1,2$. Let $Z = X_1/X_2$. Find the distribution of Z. Find the median of Z.

[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) Let $X \sim \text{Bin}(n, p)$. Prove that,

$$P(X \leq k) = \frac{1}{\beta(n-k, k+1)} \int_0^q z^{n-k-1} (1-z)^k dz$$

[12+8=20]

4. a) Define $F = \frac{y_1^2/n_1}{y_2^2/n_2}$

Where, $y_i^2 \sim$ independent χ^2 with degree of freedom n_i , $i = 1, 2$

Find the p.d.f of F.

b) Let $X_i \sim$ independent Negative binomial distribution with parameters r_i and p respectively, $i=1,2$.

Let $Y = X_1 + X_2$. Find the distribution of Y.

[12+8=20]

5. a) Let ρ be the correlation co-efficient between two random variables X and Y. Prove that $-1 \leq \rho \leq 1$.

b) The quality assurance manager of a pipe manufacturing company knows that his company has a contract with his client that the client will tolerate a maximum of 4% 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 24 cm and the standard deviation as 2.5 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)?

[12+8=20]

INDIAN STATISTICAL INSTITUTE
M.Tech (QR_OR) 1st Year (S Stream)
Session : 2010-2011
SEMISTRAL EXAMINATION

Subject : Workshop – 1 (Engg. Drawing)

Date of Exam: 03.12.10.

Max. Marks : 60

Time : 3:00 hrs

Note : (a) Answer question No.6 (compulsory) and any other three questions.
(b) Write your Name and Roll no. at one corner of the drawing sheet.
(c) Marks allotted to each questions is indicated.

1. (a) 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 3.76 metres on it. [7]
(b) A tetrahedron of 7.5 cm long edges is resting on the ground on one of its faces, with an edge of that face parallel to the V.P. Draw its projections and measure the distance of its apex from the ground. [7]
2. A rectangular pentagon of 30 mm side has one side on the ground. Its plane is inclined at 45° to the H.P. and perpendicular to the V.P. Draw its projections and show its traces. [14]
3. Show the following parts on a sketch of the threaded end of a screw.
 - a) Core diameter
 - b) Outside diameter
 - c) Crest
 - d) Flank
 - e) Depth
 - f) Pitch[14]
4. Show by sketch a pair of mating spur gear and a pinion and also indicate the following parts of it in the figure.
 - a) Root diameter
 - b) Addendum circle
 - c) Dedendum circle
 - d) Fillet radius[14]
5. The pictorial drawing of a machine part is given. Draw the top view and the front view of it. Insert all the dimensions in the views. Use third angle projection method. Ref. Fig.1 [14]
6. Sketch a sectional front view and the side view of a Socket and spigot joint. Use suitable dimensions to complete the drawing. [18]

P. T. O.

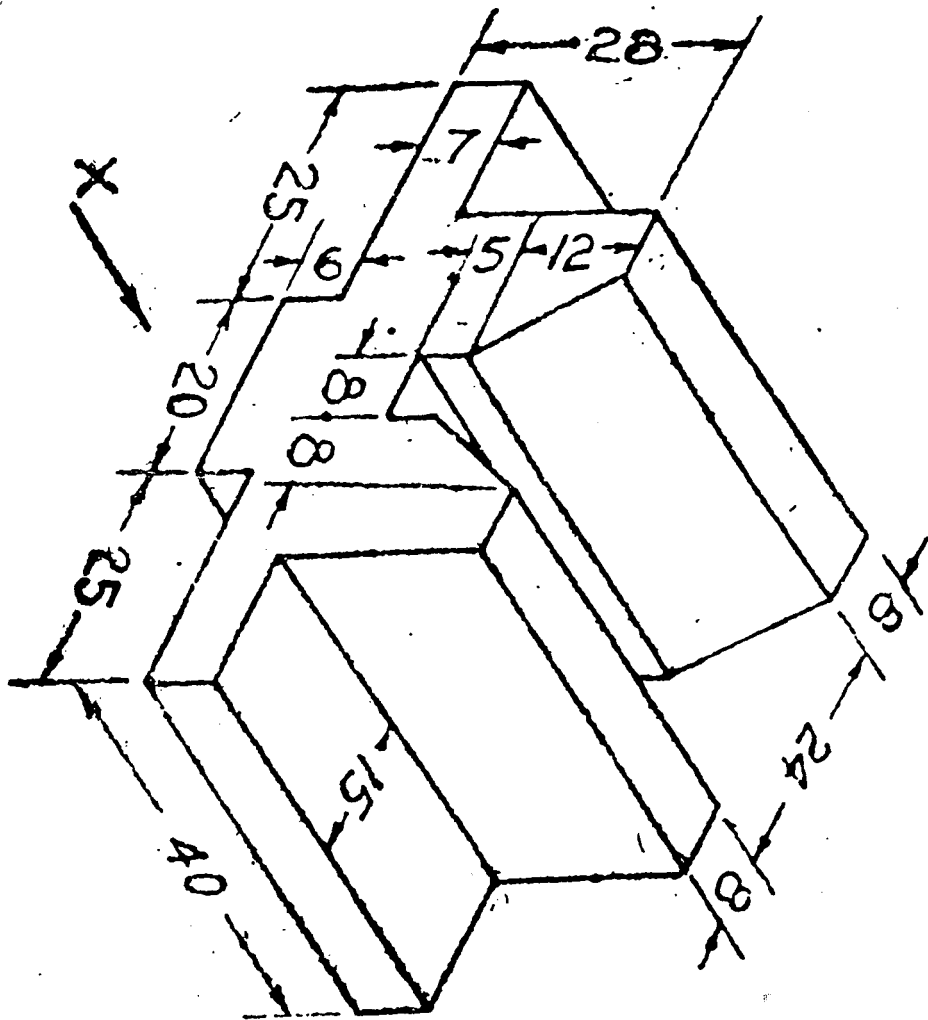


Fig. 1

INDIAN STATISTICAL INSTITUTE

First-Semester Examination : 2010-11

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

Subject Name : Electrical and Electronics Engineering

Date : 6.12.10

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 purpose of an oscillator is to convert an AC signal to DC.
 - b) A transformer is used to convert a DC voltage to AC.
 - c) Phosphorus acts as a pentavalent impurity atom in a Ge crystal.
 - d) The average value of an AC current is zero.

2.
 - a) An inductor (L) is connected in series with a resistance (R). Now a capacitor (C) is connected in parallel with the series LR. If an AC voltage $V_0 e^{j\omega t}$ is now applied across this circuit then determine the condition for resonance and the parallel resonant angular frequency. [8]
 - b) What will be the admittance and impedance of the circuit at parallel resonance? [2]
 - c) Draw and analyze the curve showing the variation of current with angular frequency of the AC voltage for the same circuit. [3]
 - d) Draw the phasor diagram of current components at resonance. [3]

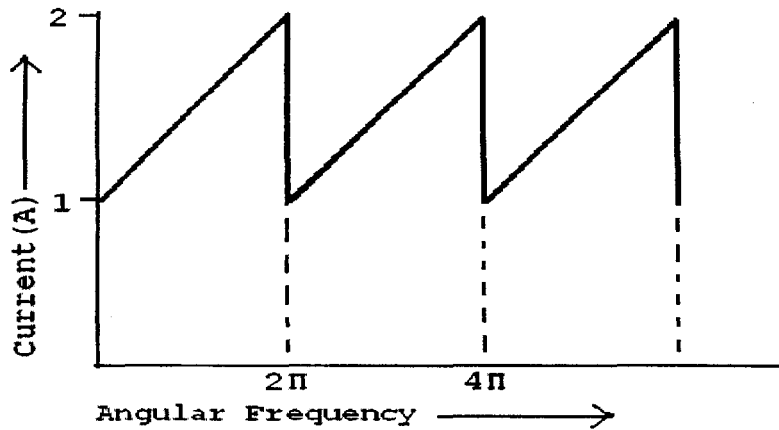
3. Define a control system. Draw the block diagram for a closed loop control system and explain individual blocks. Explain the superposition principle for a linear system characterized by linear ordinary or partial differential equations. Show that Laplace transformation converts a differential equation, representing a linear system, into an algebraic equation. [2+3+5+6=16]

4. What is a transformer? What are the conditions for being an ideal transformer? Draw the circuit and write the basic equations of a transformer. Find the value of current in the primary coil in terms of applied voltage in the primary coil and resistances and inductances of both the coils. Define the efficiency of a transformer. [2+2+2+8+2=16]

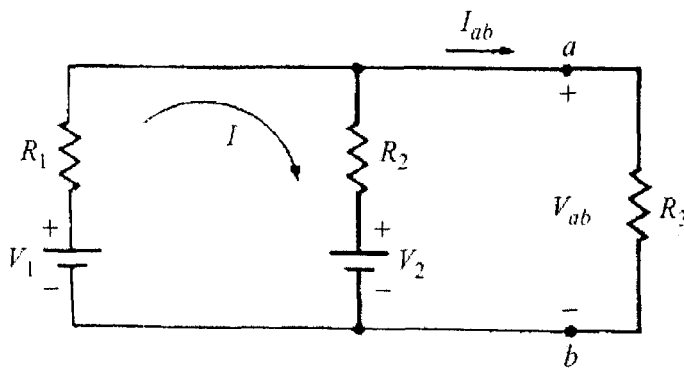
P.T.O.

5. Explain with a diagram how AC voltage can be generated for a rectangular coil having N turns rotating in a uniform magnetic field with an angular velocity of ω radian/second. [8]

Calculate the average and r.m.s. value of current represented in figure below. [4+4]

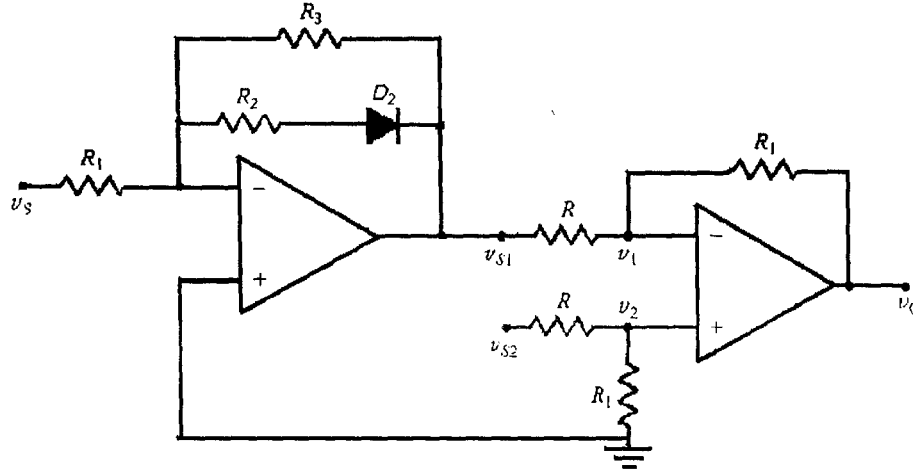


6. a) State Ohm's law and show that application of this concept can be generalized to a mechanical system. [4]
 b) Show that the concept of voltage drop across an inductor is equivalent to a law of Newtonian mechanics. [4]
 c) For the circuit, given below, $V_1 = 10V$, $V_2 = 15V$, $R_1 = 4$ Ohms, and $R_2 = 6$ Ohms. Find the Thevenin equivalent for the network to the left of terminals a, b . Assume that the internal resistances of the batteries are 0. [8]



7. a) Explain the operations of an OPAMP as an integrator. [4]

b) For the circuit, given below, find the output voltage v_0 for $v_{S1}=1\text{volt}$ and $v_{S2}=-1\text{volt}$. Assume, diode D_2 is ideal, $R_1=2\text{kOhms}$, $R_2=8\text{kOhms}$, $R_3=8\text{kOhms}$, $R=2\text{kOhms}$, $R_1=8\text{kOhms}$ and $v_{S2}=0.5\text{volt}$. [6+6=12]



8. What is feedback? 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]

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%. [7]

9. a) Derive the binary equivalent of 25.75
 b) Show that an AND gate can be realized with diodes, batteries and resistances.
 c) Why NAND gate is called universal gate?
 d) Construct an OR gate with AND and NOT gates. [3+6+3+4=16]

10. a) Draw the basic circuit and AC equivalent circuit (using hybrid parameters) of a tuned collector oscillator. [3]
 b) Analyze the circuit, find the frequency of oscillations and determine the relationship among the various parameters for oscillations to sustain. [4+2+7=13]

Indian Statistical Institute
Semester Examination: 2010-2011 (Semester-I)
Course Name: M.TECH.(QROR) I Yr.(E-Str)
Subject Name: Statistical Methods-I

Date: 06 / 12 / 2010

Maximum Marks: 100

Duration: 3 hrs.

Note : (i) This paper carries 115 marks. Question number 9 is compulsory. From the remaining questions, answer as much as you can but the maximum you can score is 85. The marks are indicated in [] on the right margin.

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

1. Explain with suitable examples, the distinction between (a) an attribute and a variable, (b) a discrete variable and a continuous variable.

(2 ½ × 2) = [5]

2. Consider the frequency distribution of systolic blood pressure (mm Hg), readings for 400 people shown below. The blood pressure (BP) readings are recorded to the nearest whole number.

Systolic BP	Frequency
100 – 109	60
110 – 119	140
120 – 129	100
130 – 139	56
140 – 149	32
150 – 169	12

Estimate the approximate percentage of people having a systolic BP reading between 115 and 125 mm Hg, both inclusive. Compute the mean and the sample standard deviation of the systolic BP readings. Compute the median of the data.

(4+4 + 5+2) = [15]

3. Show that mean deviation about A , MD_A , may be denoted by the formula

$$n.MD_A = S_2 - S_1 + A(n_1 - n_2)$$

where, S_1 is the sum of values which are less than A and there are n_1 such observations; S_2 is the sum of values which are greater than A and there are n_2 such observations. Hence or otherwise, show that MD_A is minimum when A is the median.

(3 + 7) = [10]

4. Using Cauchy-Schwarz inequality or otherwise, prove that $b_2 \geq \min(1, b_1)$, where $b_2 = m_4/m_2^2$ and $b_1 = m_3^2/m_2^3$, m 's are the central moments.

[8]

5. Suppose the random variables x_1 , x_2 and x_3 satisfy the relation $a_1x_1 + a_2x_2 + a_3x_3 = k$. Determine the total correlation coefficient r_{12} in terms of the standard deviations and the constants a_1 , a_2 and a_3 .

For n pairs of values of x and y , the regression equation of y on x is found to be $y = 5 + 4x$. If $\bar{x} = 0$, $r = 0.8$ and $s_x = 2$, determine \bar{y} and standard error $s_{y.x}$.

$$(7 + \sqrt{1 + 2}) = [10]$$

6. Let x_1, x_2, \dots, x_n be a random sample from a normal population with mean μ and variance σ^2 . Find the probability density function of $\frac{1}{(n-1)} \sum_{i=1}^n (x_i - \bar{x})^2$, where \bar{x} is the sample mean.

[12]

7. Describe a general method of inversion for simulating observations from a univariate continuous distribution. Using this method discussed by you, outline the procedure of generating observations from the triangular distribution $Triangular(a, b, c)$, $a < b < c$. [Use the random digits table given overleaf.]

$$(8 + 12) = [20]$$

8. Obtain the expectation and variance of sample mean for a random sample of size n drawn from a dichotomous population of size N with replacement. Obtain an unbiased estimator of the variance of sample mean.

$$(4 + 7 + 9) = [20]$$

9. Assignments

[15]

TABLE - RANDOM DIGITS

11164	36318	75061	37674	26320	75100	10431	20418	19228	91792
21215	91791	76831	58678	87054	31687	93205	43685	19732	08468
10438	44482	66558	37649	08882	90870	12462	41810	01806	02977
36792	26236	33266	66583	60881	97395	20461	36742	02852	50564
73944	04773	12032	51414	82384	38370	00249	80709	72605	67497
49563	12872	14063	93104	78483	72717	68714	18048	25005	04151
64208	48237	41701	73117	33242	42314	83049	21933	92813	04763
51486	72875	38605	29341	80749	80151	33835	52602	79147	08868
99756	26360	64516	17971	48478	09610	04638	17141	09227	10606
71325	55217	13015	72907	00431	45117	33827	92873	02953	85474
65285	97198	12138	53010	94601	15838	16805	61004	43516	17020
17264	57327	38224	29301	31381	38109	34976	65692	98566	29550
95639	99754	31199	92558	68368	04985	51092	37780	40261	14479
61555	76404	86210	11808	12841	45147	97438	60022	12645	62000
78137	98768	04689	87130	79225	08153	84967	64539	79493	74917
62490	99215	84987	28759	19177	14733	24550	28067	68894	38490
24216	63444	21283	07044	92729	37284	13211	37485	10415	36457
16975	95428	33226	55903	31605	43817	22250	03918	46999	98501
59138	39542	71168	57609	91510	77904	74244	50940	31553	62562
29478	59652	50414	31906	87912	87154	12944	49862	96566	48825
96155	95009	27429	72918	08457	78134	48407	26061	58754	05326
29621	66583	62966	12468	20245	14015	04014	35713	03980	03024
12639	75291	71020	17265	41598	64074	64629	63293	53307	48766
14544	37134	54714	02401	63228	26831	19386	15457	17999	18306
83403	88827	09834	11333	68431	31706	26652	04711	34593	22561
67642	05204	30697	44806	96989	68403	85621	45556	35434	09532
64041	99011	14610	40273	09482	62864	01573	82274	81446	32477
17048	94523	97444	59904	16936	39384	97551	09620	63932	03091
93039	89416	52795	10631	09728	68202	20963	02477	55494	39563
82244	34392	96607	17220	51984	10753	76272	50985	97593	34320
96990	55244	70693	25255	40029	23289	48819	07159	60172	81697
09119	74803	97303	88701	51380	73143	98251	78635	27556	20712
57666	41204	47589	78364	38266	94393	70713	53388	79865	92069
46492	61594	26729	58272	81754	14648	77210	12923	53712	87771
08433	19172	08320	20839	13715	10597	17234	39355	74816	03363
10011	75004	86054	41190	10061	19660	03500	68412	57812	57929
92420	65431	16530	05547	10683	88102	30176	84750	10115	69220
35542	55865	07304	47010	43233	57022	52161	82976	47981	46588
86595	26247	18552	29491	33712	32285	64844	69395	41387	87195
72115	34985	58036	99137	47482	06204	24138	24272	16196	04393
07428	58863	96023	88936	51343	70958	96768	74317	27176	29600
35379	27922	28906	55013	26937	48174	04197	36074	65315	12537
10982	22807	10920	26299	23593	64629	57801	10437	43965	15344
90127	33341	77806	12446	15444	49244	47277	11346	15884	28131
63002	12990	23510	68774	48983	20481	59815	67248	17076	78910
40779	86382	48454	65269	91239	45989	45389	54847	77919	41105
43216	12608	18167	84631	94058	82458	15139	76856	86019	47928
96167	64375	74108	93643	09204	98855	59051	56492	11933	64958
70975	62693	35684	72607	23026	37004	32989	24843	01128	74658
85812	61875	23570	75754	29090	40264	80399	47254	40135	69916

INDIAN STATISTICAL INSTITUTE
M. Tech. (QR OR), II Year
Semestral Examination

Subject : OR-I

Date : 08.12.2010

Time : 3 hours (Combined with Group B)

Full Marks : 60

Group A : Linear Programming

Note : Answer all the questions

1. Find all basic solutions of the following system of linear equations. Classify them as degenerate or non-degenerate :

$$\begin{aligned}x_1 + 2x_2 + 3x_3 + 4x_4 &= 7 \\2x_1 + x_2 + x_3 + 2x_4 &= 3\end{aligned}$$

[15]

2. Suppose that x is a basic feasible solution of the problem (P) :

(P) : Minimize $z = cx$
Subject to : $Ax = b$
and $x \geq 0$

Show that x is an extreme point of the feasible region F of the problem (P).

[15]

3. Describe the Big-M Method in detail.

[15]

4. Define the concept of Duality. State and prove the Weak Duality Theorem. Illustrate the result with suitable numerical examples.

[15]

P.T.O.

OR –I
Group B
Maximum Marks (40)
Answer all questions

1. There are 8 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 Hazel wood for $N=8$ and for $X = 0.4$ the following:

M	F
1	0.3104
2	0.6188
3	0.8438
4	0.9333
5	0.9896

Compute the operator utilization and machine utilization percent for 5 different situations where number of repair persons employed are 1,2, 3, 4 and 5 respectively.

Repair men are paid at the rate of Rs. 100 per hour /per person and for each hour of machine idleness we incur a loss of profit of 30 Rupees /hour calculate the optimum number of repair persons which minimize the total loss.

(8)

2. Derive the expression for the pdf and the expectation of the waiting time for Poisson arrivals and exponential distribution of the service time for the single server queue. What is the probability that an arrival has to wait more than one hour given that the rate of arrival is 3 /hour and service rate of 5 /hour.

(10)

3. 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.

3 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, Shortage Cost = Rs 5 /unit. Compute the optimum value of the reorder point under the assumption that lead time demand has a Poisson distribution.

(8+4)

Page 2

(c) 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	600
Ordering cost/year	60	55
Carrying cost	20% per year	15%

(5)

Assignment :5 Marks

End semestral Examination: (2010-2011)
M. Tech. (QROR) I Year
Programming Tech. & Data Structures

Date: 10.12. 2010

Full Marks: 100

Duration: 3 hours

Answer any 5 questions. Each question carries 20 marks.

1. Make a comparison between an iterative function and a recursive function. Can you write a C program that iteratively generates the Fibonacci series? Now can you generate the same series by recursive technique? 4+8+8
2. When is a *break* statement used for a loop? Show how you can verify whether a number is prime, while demonstrating the use of *break* statement? Also write C codes to compute: a) the sum of a series of integers in arithmetic progression b) the greatest common divisor of any two integers. (2+6)+6+6
3. What do mean by: a) scope of an identifier b) extent of a variable c) local static variable and d) stack pointer? Write C programs to (i) insert a new element into a vector (ii) delete duplicates in a vector. (2x4)+(2x6)
4. Explain by examples what do you mean by linear and non-linear data structures? How is a *doubly connected* linked list different from a *singly* linked list? In a tree, elucidate the following concepts: a) root b) leaf node c) level. What do you mean by (i) a strictly binary tree (ii) a complete binary tree? 4+4+(2x3) + (3x2)
5. Explain the concepts of *stacks* and *queues*. Show how you can implement a stack using array and a queue using linked list. 4+8+8
6. What are the different types of traversals in a binary tree? What is a binary search tree (BST)? How are elements deleted from a binary search tree? How is a BST useful for sorting? Show how you can reconstruct a binary search tree from the knowledge of traversals. 3+3+4+2+8
7. Explain what you mean by the binary search technique. Make a comparison between linear and binary search techniques. Sort an array using any technique through the appropriate steps. Then show how you can programmatically implement the binary search algorithm in such a sorted array. 4+3+6+7
8. Define graph as a data structure. Explain how graphs are represented by a) matrices and b) linked lists. What do you mean by *degree* of an undirected graph? What are the two

types of traversals in a graph? How can you (i) vertically concatenate two matrices (ii) replicate a matrix in matlab? State the importance of the colon (:) operator in matlab?

$$2+(2 \times 3)+2+2+(2 \times 3)+2$$

INDIAN STATISTICAL INSTITUTE
SQC & OR Unit, Kolkata
M. Tech. (QR OR) I Year
Session: 2010-2012
Semester Examination

Subject: Statistical Quality Control I

Date: 15/12/10

Time : 3 hours

Full Marks : 100

Use separate answer-script for Group A and Group B
Group A (Control Chart): Full Marks 60

Answer All Questions

1. a) Define repeatability, reproducibility, accuracy, linearity and stability associated with measurement error. [10]
- b) State the standard criterion for evaluating the measurement process with respect to its percentage error. [2]
- c) Twenty units of a product are measured by an instrument by three operators. Each unit of the product has been measured twice by each operator. The USL and LSL of the product are 60 and 5 respectively. It has been found that $\bar{x}_1 = 22.30, \bar{R}_1 = 1.00; \bar{x}_2 = 22.28, \bar{R}_2 = 1.25; \bar{x}_3 = 22.60, \bar{R}_3 = 1.20$. Calculate P/T ratio and conclude about the measurement process. [5+3=8]
2. a) Explain how the disadvantages of a Shewhart control chart are overcome by CUSUM chart? [3]
- b) Define the CUSUM quantity for a sample average against a target value μ_0 [2]
- c) State the estimate of the mean for a sustained pattern with constant slope running from observation j to observation i. [3]
- d) What are the disadvantages of the CUSUM control chart? [4]
- e) Describe the procedure for constructing the tabular form of the CUSUM control chart. [8]

P. T. O.

3. a) What's the purpose of OC curve for \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 $\beta = \Phi(k - \delta\sqrt{n}) - \Phi(-k - \delta\sqrt{n})$, where notations have usual meanings.

[4]

c) Prove that $ARL = \frac{1}{1-\beta}$.

[4]

d) A stable process has upper and lower specifications at $USL = 62$ and $LSL = 38$. A sample of size $n=20$ from this process reveals that the process mean is centered approximately at the midpoint of the specification interval and that the sample standard deviation $s=1.75$. Calculate the point estimate of c_p and the 95% confidence interval on c_p .

[5]

e) A sample of size $n=20$ from a stable process is used to estimate C_{pk} , with the result that $\hat{C}_{pk} = 1.33$. Calculate an approximate 95% confidence interval on C_{pk} and draw your conclusion.

[5]

Group B (Acceptance Sampling): Full marks: 40

Answer All Questions

1. Write the formulae for obtaining single sampling plans with specified AQL, $1-\alpha$, LTPD and β . The MIL STD 105E gives the single sampling normal inspection plan ($n = 315, c = 0$) for AQL of 4%. Use the above formulae to check whether the plan is a reasonable one when AQL=4% and LTPD=10%. $[3 + 4] = [7]$
2. Derive the formulae for constructing the AOQ and ATI curves for double sampling with rectifying inspection. Draw the AOQ curve for the single sampling rectifying inspection plan ($n = 28, c = 1$) for lots of size 5000 and process average of 0.5% defective. Find the AOQL for the plan. What happens if the process average is improved to 0.05% defective but the same sampling plan is used? $[4 + 6 + 2 + 5] = [17]$
3. Discuss the advantages and disadvantages of variables sampling. Also write down the steps involved in a variables single sampling procedure. $[4 + 4] = [8]$
4. Define break-even quality and discuss its usefulness. When can you use break-even quality as the indifference quality? $[3 + 3 + 2] = [8]$

SQC 1 (Control Chart): Back Paper**Time: 3 hours**Answer All Questions

Group - B

Date : 1.2.11

1. a) Show 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.

b) What are the assumptions for constructing a sloping \bar{X} -R control chart? Show that under these assumptions the estimators of the parameters α and β for estimating the central trend

line are $\alpha = \bar{\bar{X}}$ and $\beta = \frac{\sum_{i=1}^m h_i \bar{X}_i}{\sum_{i=1}^m h_i^2}$, where α is the intercept, β is the slope of the straight line

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

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

[7+2+5+3+3 = 20]

2. a) How the major disadvantage of a Shewhart control chart is overcome by CUSUM chart?

b) Define the quantity plotted for controlling process centering while constructing a CUSUM chart.

c) Draw a V-mask and discuss how the performance of the CUSUM chart is determined by different parameters of the V mask.

d) How to detect an out-of-control point by using V-mask?

e) Once an out-of-control point has been detected, what will be the estimate of the new process level from the CUSUM?

f) Describe the tabular CUSUM procedure for controlling the process centering.

g) What are the disadvantages of the CUSUM control chart?

P. T. O.

[2+1+5+3+2+5+2 = 20]

3. The amount of cement placed in a bag is specified as 50 ± 0.25 lb. Twenty random samples of five bags each are taken, with \bar{X} and R values as shown in the following table. In this table, data are coded by subtracting 50 lb. If the true process fraction nonconforming is as large as 1%, the process is unacceptable. Construct a **modified control chart** with 3-sigma limits and conclude about process stability.

Data for Bags of Cement

Sample Number	\bar{X}	R	Sample Number	\bar{X}	R
1	0.0771	0.0673	11	0.0340	0.0710
2	-0.0442	0.0730	12	-0.1363	0.0790
3	-0.1037	0.0751	13	-0.0509	0.1070
4	-0.0191	0.0607	14	0.0585	0.0786
5	0.0783	0.0674	15	-0.0915	0.0717
6	-0.0299	0.0926	16	0.0513	0.0802
7	0.0762	0.1101	17	-0.0630	0.1043
8	-0.0075	0.0723	18	-0.0527	0.0668
9	-0.1209	0.0647	19	-0.0599	0.0403
10	-0.0642	0.1093	20	-0.0501	0.0690

[20]

Back Paper

(Group B: Acceptance Sampling)

Answer All Questions

1. A company uses a sample size equal to the square root of the lot size. If 1% or less of the items are in the sample are defective, the lot is accepted; otherwise, it is rejected. Submitted lots vary in size from 1000 to 5000 units. Comment on the effectiveness of this procedure. [8]
2. Suppose that a single sampling plan with $n = 150$ and $c = 2$ is being used for receiving inspection where the vendor ships the product in lots of size $N = 3000$. (a) Draw the AOQ curve and find the AOQL. (b) Draw the ATI curve for this plan. [6 + 6] = [12]
3. Consider rectifying inspection for single sampling. Develop an AOQ equation assuming that all defective items are removed but not replaced with good ones. [8]
4. Write down the steps involved in obtaining a single sampling plan from MIL STD 105E. [6]
5. Discuss the differences between type A and type B OC curves. [6]

INDIAN STATISTICAL INSTITUTE
MID-SEMESTRAL EXAMINATION: 2010-11 (Second Semester)
M. Tech. (QR OR); II Year; E Stream
Probability II

Date : 23.02.2011

Full Marks : 60

Duration : 2 hours

Note : Unless stated otherwise, a Markov Chain will mean a discrete time parameter time homogeneous Markov Chain.

(1) Define the following :

- (a) Stochastic process (b) State space and parameter space of a stochastic process
(c) Markov Chain (d) Transition Probabilities.

(4 × 4) = [16]

(2) Suppose $\{X_n | n = 0, 1, 2, \dots\}$ is a Markov Chain. Derive the joint distribution of the random variables X_0, X_1, \dots, X_n .

[15]

(3) State and prove the Chapman-Kolmogorov Equations with reference to a Markov Chain.

[20]

(4) A couple has planned to celebrate their 25th wedding anniversary in Honeymooner's Paradise, a popular resort in Mussourie. Counting today as the first day, they are supposed to be there on the third and fourth day. They are thinking of buying a vacation insurance which promises to reimburse them for the entire vacation cost of Rs. 25000 if it rains on both days of their stay, and nothing is reimbursed otherwise. The insurance costs Rs. 1000. Suppose that the weather in Mussourie changes according to the following model:

The weather of Mussourie is classified as sunny (1), cloudy (2) and rainy (3). Assume that tomorrow's weather depends on today's weather only.

Let X_n = Weather condition of Mussourie on day n ($n = 1, 2, \dots$)

P. T. O.

$$X_n = \begin{cases} 1 & \text{if it is sunny on day } n \\ 2 & \text{if it is cloudy on day } n \\ 3 & \text{if it is rainy on day } n \end{cases}$$

Assume that $\{X_n | n = 1, 2, \dots\}$ is a Markov Chain with transition probability matrix:

$$P = \begin{bmatrix} 0.5 & 0.3 & 0.2 \\ 0.5 & 0.2 & 0.3 \\ 0.4 & 0.5 & 0.1 \end{bmatrix}$$

Assume that it is sunny today in Missouri. Should the couple buy the insurance?

[10]

M-TECH(QR&OR) -- 1st YEAR (E&S STREAM)
SESSION: 2010-2011
MID-SEMESTRAL EXAMINATION

SQC-II

{Answer all the questions}

Date: 24.02.11
~~27.2.2011~~

Full marks:100
Time: 1½ hours

[Symbols have their usual meaning]

1. Use the data below to set up short run \bar{x} and R charts. The nominal dimension for each part are $N_A = 90$, $N_B = 60$, $N_C = 125$, and $N_D = 150$. Write a report on your analysis presenting the conclusion and recommendations.

Sample number	Part number	X_1	X_2	X_3
1	A	95	92	93
2	A	81	78	90
3	A	83	80	99
4	A	91	94	87
5	A	96	92	90
6	B	57	60	59
7	B	61	64	63
8	B	60	58	62
9	C	123	125	127
10	C	128	125	126
11	C	127	125	124
12	C	125	122	129
13	C	124	125	127
14	C	123	126	125
15	D	150	151	149
16	D	146	150	150
17	D	151	146	150
18	D	149	150	153
19	D	150	152	151
20	D	153	151	150

[25]

P.T.O

2 A machine has 4 heads. Samples of size 3 are selected from each head and the \bar{x} and R sample values of an important quality characteristic are given below. Establish a suitable control chart for the process. Write a report on that.

Sample number	Head							
	1		2		3		4	
	X	R	X	R	X	R	X	R
1	23	2	24	1	26	2	25	3
2	21	1	25	2	24	3	24	4
3	24	2	22	5	23	1	27	2
4	25	3	24	3	22	2	23	5
5	24	1	20	2	21	4	24	2
6	23	2	21	1	25	3	26	1
7	21	2	23	2	24	1	25	3
8	22	3	24	4	23	2	19	4
9	20	1	22	3	22	2	20	5
10	21	3	25	1	21	2	20	1
11	22	2	27	1	20	4	22	2
12	20	1	25	2	19	4	24	1
13	24	4	27	4	22	1	25	2
14	23	1	25	2	23	2	23	3
15	25	2	28	1	22	3	24	1
16	24	4	24	2	25	4	26	3
17	23	3	22	1	21	2	22	4
18	22	2	21	3	24	2	25	1
19	21	1	20	2	23	1	26	5
20	22	4	19	2	22	3	22	2

[25]

3. Assignment

[50]

INDIAN STATISTICAL INSTITUTE
Mid-semester Examination: 2010-2011 (Second Semester)

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

Reliability-I

Date: February 21, 2011

Full Marks: 60

Duration: 2 hours.

Note: Answer all questions.

1. (a) Consider a coherent system with 3 components. The structure function of the system is $\phi(x) = \max\{\min(x_1, x_2), \min(x_1, x_3), \min(x_2, x_3)\}$, where x_1, x_2 and x_3 are binary variables representing the state of the components. Check whether all the components are relevant to the system. Write down the dual of ϕ .
- (b) Consider the system in (a) and assume that all components are independent. Let p_1, p_2 and p_3 be the component reliabilities and $p_1 \leq p_2 \leq p_3$. Which component is most important to the system and under what condition?
- (c) Consider a fault tree with 5 basic events B_1, \dots, B_5 . The gate (G_0) corresponding to top event is an OR-gate. The inputs to the gate G_0 are G_1, B_3 and G_2 . G_1 is an AND-gate with the inputs B_1 and B_2 . G_2 is an AND-gate with the inputs B_4 and B_5 . Draw the fault tree and find the min cut sets. Now replace all the events (top events and basic events) and gates by their compliments. Apply the min cut set algorithm on the converted tree and list the set of basic events. What is the significance of new sets?

[7+5+8=20]

2. Let ϕ be the structure function of a coherent system. Consider the following property

$$\phi(x \amalg y) \geq \phi(x) \amalg \phi(y),$$

where $x \amalg y = (x_1 \amalg y_1, \dots, x_n \amalg y_n)$.

- (a) What is the implication of the above result?
- (b) If ϕ is parallel, then show that $\phi(x \amalg y) = \phi(x) \amalg \phi(y)$.
- (c) Show that $h(\underline{p} \amalg \underline{p}') \geq h(\underline{p}) \amalg h(\underline{p}')$, where $\underline{p} = (p_1, \dots, p_n)$ with $P(X_i = 1) = p_i$ and $\underline{p}' = (p'_1, \dots, p'_n)$ with $P(Y_i = 1) = p'_i$. Assume that all Components are independent.

[2+4+4=10]

3. (a) What do you mean by modular decomposition of a coherent system? Is modular decomposition unique? -justify your answer with an example.
- (b) A spacecraft navigation system has three modules connected in series. Module 1 has single A-type component, Module 2 consists of 3 identical B-type components connected in parallel and Module 2 consists of 2 identical C-type components connected in parallel. The reliability of a A-type, B-type and C-type components are 0.9, 0.7 and 0.8, respectively.
- (i) Find the min path sets and min cut sets of the system. Compute the reliability of the system (Assume that components are independent).
- (ii) Compute structural importance of each component.

[4+6+5=15]

4. Consider a coherent system with min path sets P_1, \dots, P_p . Suppose the components are independent and p_1, \dots, p_n are the component reliabilities. Then show that

$$h(\tilde{p}) \leq \sum_{r=1}^p \prod_{i \in P_r} p_i.$$

[5]

5. Consider a series system with n associated components. Let T_1, \dots, T_n be the component lifetimes and T_s the system lifetime. Then show that

$$P(T_s > t) \geq \prod_{i=1}^n P[T_i > t].$$

[10]

- 1 (e) Marketing Research links the consumer, customer and public to the marketer through
- (A) Information
 - (B) Sales
 - (C) Computer
 - (D) All the above

2 (a) Mention major non-tangible factors which need to be considered in deciding location of a factory. How to collect information on such factors?

2 (b) A new factory to be located either at location A or at location B. Relevant information are as follows:

Factors	Alternative A	Alternative B	Weights
Land cost	Rs. 8 crores	Rs. 5 crores	35%
Building cost	Rs. 6 crores	Rs. 4.5 crores	20%
Taxes	Rs. 6 lakhs	Rs. 5 lakhs	20%
* Labour situation	2	1	10%
* Research climate	1	3	5%
* Community attitude	3	1	10%

(*) 1 indicates most desired

How will you compare A and B with respect to all the given factors? Describe properties of your method. In the given case, which location will be chosen? Please justify.

3 (a) Describe major benefits of an efficient layout design within a factory and requirements of a good layout

3(b) Write short note on

- i) SEZ
- ii) Process layout
- iii) Reliability of an questionnaire

4 (a) A questionnaire for market survey may have

- I. Close ended items
- II. Open ended items

- (A) I is true but II is false
- (B) II is true but I is false
- (C) Both I and II are true
- (D) Both I and II are false

- 4 (b) The process of identification of people to serve and ways to serve is known as
- (A) Situation Analysis
 - (B) Target Marketing
 - (C) Positioning
 - (D) Planning
4. (c) The data which are needed to be collected from the field for Marketing Research are –
- (A) Primary data
 - (B) Secondary data
 - (C) Attitudinal data
 - (D) Opinion data
- 4 (d) As per practice in Time Study, leveling factor is
- I. over 100%
 - II. less than 100%
- (A) I is true but II is false
 - (B) II is true but I is false
 - (C) Either I or II is false
 - (D) Both I and II are false
- 4(e) Average of observed score as recorded in “Time Study Record Sheet” is –
- (A) Average of all sample observations
 - (B) Average of ratios of standard time and actual time observed
 - (C) Average of all sample observations plus allowances
 - (D) Average of sample observations excluding abnormal values
- 5 (a) $\text{Standard time} \times 100 \div \text{Actual time of a worker}$ indicates
- (A) Efficiency of the worker
 - (B) Poor capability of the worker
 - (C) How efficiently standard time was fixed
 - (D) Efficiency of the Time Study exercise
- 5 (b) The following question was asked in a Market Survey
“For each pair of departmental stores, circle the store you would be more likely to patronize
- Arambug or In & Out
 - In & Out or Big Bazar
 - Big Bazar or Arambug :

INDIAN STATISTICAL INSTITUTE
Mid – semester Examination (2010 – 2011)

Course Name : **M. Tech. (QR & OR)**
Subject : **Industrial Engineering & Management**

Date : 22nd February, 2011

Maximum Marks : 50

Duration : 90 minutes

(Note : Number of copies of the question paper required : 14)

QUESTION PAPER

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

Answer any Five Questions. All questions carry equal marks

1. (a) The condition that “Sum of weights is equal to unity” ensures
 - A) Closed set
 - B) Open set
 - C) Convex set
 - D) Non – convex set

1. (b) Association of two attributes can be measured by
 - A) Product moment correlation
 - B) Square of correlation coefficient
 - C) Cornbach Alpha
 - D) Chi – square value from contingency table

1. (c) Economy of scale implies
 - A) If production increases, cost decreases
 - B) Decrease in product cost per unit with increase in volume of production
 - C) Lower break-even cost
 - D) Economics of production of scales

- 1.(d) Benefit – cost ratio of a project considers
 - (A) Total cost and income for each year
 - (B) Capital cost and rate of return
 - (C) Variable cost and income for each year
 - (D) Total cost and income for the project life

Contd.... P/2

The answers will give rise to a variable which is in

- (A) Nominal scale
 - (B) Ordinal scale
 - (C) Interval scale
 - (D) Ratio scale
5. (c) Success of Customer Relationship Management (CRM) does not depend on
- (A) the new product proposed to be introduced
 - (B) Teamwork
 - (C) Data integration
 - (D) Customer profile
5. (d) Which of the following does not flow from Time Study ?
- (A) How much time a job should take for completion
 - (B) Determination of standard time
 - (C) Minimization of wastages
 - (D) Recording of time required to do each element of an industrial operation
5. (e) Assume that performance of 100 workers follow Normal distribution with mean 30 and variance 100. Roughly, how many workers would be expected to perform between 20 and 40 ?
- (A) Around 34
 - (B) Around 68
 - (C) Around 14
 - (D) None of the above is true
6. Consider following information emerged from a Time Study exercise
- (i) Maintenance time
 - a) Get out and put away tools : 12 min/day
 - b) Cleaning of machines 5 min/day
 - c) Oiling of machines 5 min/day
 - d) Replenish coolant supply 3 min/day
 - (ii) Interruption time
 - a) Interruption by Foremen 5 min/day
 - b) Interruption by porters etc. 4 min/day

- | | |
|---------------------------------------|------------|
| (iii) Delay time due to power failure | 6 min/day |
| (iv) Personal time | 20 min/day |

Calculate total allowance, total available cycle time, productive hours (assume one working day = 8 hours)

6. (a) Standard time for a job is equal to
- (A) Average time
 - (B) Average time PLUS K. Standard deviation, where value of K to be determined by Management Policy
 - (C) Average time plus allowances
 - (D) Average time x Rating factor + Allowances
- 6 (b) Ratio of explained variance and total variance is
- (A) Correlation
 - (B) Square of correlation
 - (C) Reliability
 - (D) None of the above

INDIAN STATISTICAL INSTITUTE
Mid-Semester Examination: 2010-11(Second Semester)

Course Name: M. Tech (QROR)

Subject Name: Statistical Methods II

Date: 28.02.11 Maximum Marks: 100

Duration: 3 Hrs

Group A

Maximum Marks: 60

Note: Answer any three questions

1. (a) Define the following:
 - i) Statistic and Estimator
 - ii) Uniformly most powerful unbiased test (UMPUT) (4+4=8)
- (b) Show that the maximum likelihood estimator of σ^2 is a biased but efficient estimator of σ^2 . (8)
- (c) Discuss the weaknesses of method of moments and method of least squares for estimating a population parameter. (4)

2. (a) Let x_1, x_2, \dots, x_n be a random sample of size 'n' from the population of X, where $X \sim N(\mu, \sigma^2)$. Derive the estimators for μ and σ using the method of moments. (6)
- (b) Show that sample mean is an unbiased, consistent, efficient and sufficient for estimating mean μ in normal distribution. (8)
- (c) A random sample of 100 farms in a certain year gives an average yield of barley of 2000 lbs per acre with standard deviation of 192 lbs. A random sample of 100 farms in the year shows an average yield of wheat of 2100 lbs per acre with

standard deviation of 224 lbs. Construct 95% confidence interval for the mean difference of the yield of barley and wheat. (6)

3. (a) Let x_1, x_2, \dots, x_n be a random sample of size 'n' from the population of X, where $X \sim N(\mu, \sigma^2)$. Determine $100(1-\alpha)\%$ confidence interval for σ^2 when μ is unknown. (6)

(b) 10 bullets from an enemy gun show an average diameter of 5μ (micron) with a standard deviation of 0.02μ . Obtain a 99% confidence interval for the diameter of the enemy gun barrel taking the diameter of a gun barrel to be 0.01μ more than that of the bullets. (6)

(c) Let a random sample of size 'n' is drawn from a population of X, where $X \sim N(\mu, \sigma^2)$, the parameter σ^2 being known. Show that the maximum likelihood estimator of μ is an MVB estimator for μ . (8)

4. (a) Let x_1, x_2, \dots, x_n be a random sample of size 'n' from the population of X, where $X \sim N(\mu, \sigma^2)$ and σ^2 is known. You are to test the following hypothesis:

$$H_0: \mu = \mu_0 \text{ vs } H_1: \mu \neq \mu_0$$

Show that the likelihood ratio-test for the above problem leads to a z-test. Write down the critical region. (12)

(b) Given a random sample of size 'n' from Laplace distribution, i.e.

$$f(x; \theta) = e^{-|x-\theta|}, \quad -\infty < \theta < \infty$$

Find the maximum likelihood estimator of θ . (8)

Group B

Maximum Marks: 40

Note: Answer any all questions

1. The strength of paper (y) used in the manufacture of cardboard boxes is related to the percentage of hardwood concentration (x) in the original pulp. 16 samples were manufactured, each from different batch of pulp, in a pilot plant under controlled condition. The hardwood concentration of the pulp and tensile strength of the resulting samples were measured. The data are shown below.

x	1.0	1.5	1.5	1.5	2.0	2.0	2.2	2.4
y	101.4	117.4	117.1	106.2	131.9	146.9	146.8	133.9
x	2.5	2.5	2.8	2.8	3.0	3.0	3.2	3.3
y	111.3	123.0	125.1	145.2	134.3	144.5	143.7	146.9

- i) Fit a simple linear regression model to the data.
- ii) Calculate coefficient of determination for the fitted model.
- iii) Test for lack of fit and significance of regression.
- iv) Find the 90% confidence interval on the slope.

(6+2+10+2=20)

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

$$TSS = SS(\text{treatment}) + SS(\text{error})$$

- b) A manufacturer of paper is interested in improving the tensile strength of the product. Product engineering thinks that tensile strength is a function of the hardwood concentration in the pulp. A team responsible for the study decided to investigate four levels of hardwood concentration: 5%, 10%, 15% and 20%. Test specimens are made in the pilot plant and following data were obtained.

Hardwood Concentration	Tensile Strength (in psi)					
5	7	8	15	11	9	10
10	12	17	13	18	19	15
15	14	18	19	17	16	18
20	19	25	22	23	18	20

[10+10=20]

INDIAN STATISTICAL INSTITUTE

Mid-Semester Examination: 2010-11(Second Semester)

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

Subject Name: Instrumentation and Computer Engineering

Date: 01.03.11 Maximum Marks: 60 Duration: 2 Hrs 20 min

GROUP A: Answer any 4 questions.

1. a) Derive the octal equivalent of 23.36
b) Show that an AND gate can be realized with diodes, batteries and resistances.
c) Why NAND gate is called universal gate? Construct OR, AND and NOT gates with NAND gate.
e) Subtract 1010 from 1100 using 2's complement method.
[2+5+3+2=12]
2. What are the advantages of a JK Flip flop over RS flip flop? Explain the operation of a master slave J-K flip flop with truth table and show that it can avoid the race around condition.
[2+8+2]
3. What is an encoder? Explain the operation of an encoder with circuit diagram and truth table to encode the decimal numbers from 0 to 15.
[2+10]
4. 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]
5. What is a T type Flip flop? Show with circuit and timing diagram that a 4 bit asynchronous counter can be designed with T type Flip flops.
[2+10=12]
6. What is the difference between combinational and sequential digital circuits? How a shift register can store a binary number 1101? Show the reading of the register after each clock pulse for the same binary number.
[2+7+3=12]

GROUP B: Answer any 1 questions.

1. a) Derive the expression of the output voltage for 4 bit R-2R ladder digital to analog (D/A) convertor.

b) The output of the same 3 bit R-2R ladder D/A convertor is now connected with inverting terminal of an OPAMP through a resistance $2R$. Derive the expression of the output analog voltage of the OPAMP for a feedback resistance of $4R$. [9+3=12]

2. Design a 3 bit synchronous counter such that the binary equivalent of the series 2, 1, 0, 3, 4, 6, 5, 7 can be realized at the output. [12]

INDIAN STATISTICAL INSTITUTE
Second Semester Examination: 2010-11
M. Tech (QROR), First Year (E-stream)
Statistical Methods – II

Date: 20.4.11

Maximum Marks: 100

Duration: 3 Hrs.

GROUP: A

FULL MARKS: 40

Note: Answer all questions

1. (a) Define the following

i) Level of significance

ii) Uniformly most powerful unbiased test (UMPUT)

(2 + 4 = 6)

(b) Let x_1, x_2, \dots, x_n be a random sample of size 'n' from the population of X, where $X \sim N(\mu, \sigma^2)$ and σ^2 is known. You are to test the following hypothesis:

$$H_0: \mu = \mu_0 \text{ vs } H_1: \mu \neq \mu_0$$

Show that the likelihood ratio test for the above problem leads to a z-test. Write down the critical region for the level of significance α . (10)

2. (a) The weights (in pounds) of 9 boys before they are subjected to a change of diet and after a lapse of six months are recorded below.

Sr. No	1	2	3	4	5	6	7	8	9
Wt (before)	109	112	98	114	102	97	88	101	89
Wt (after)	115	120	99	117	105	98	91	99	93

Test whether there has been any significant gain in weight as a result of the change in diet. (8)

- (b) The breakdowns occurring during a year for each of 4 machines in a factory were classified as follows according to shift, there being three shifts daily. Judge whether the differences among the four machines may be attributed to sampling fluctuations alone.

Shift	Machine			
	1	2	3	4
1	15	9	18	20
2	16	18	29	31
3	19	15	19	27
Total	50	42	66	78

(8)

- (c) 1072 schoolboys were classified according to intelligence, and at the same time their economic conditions were recorded. The results are shown in the following table. Judge whether there is any association between intelligence and economic conditions.

Economic conditions	Intelligence			
	Excellent	Good	Mediocre	Dull
Good	48	199	181	82
Not good	81	185	190	106

(8)

GROUP: B

FULL MARKS: 60

Note: Answer as much as you can. Maximum possible score is 60.

1. An experiment was performed to determine the effect of firing temperature and furnace position on the baked density of a carbon anode. A factorial experiment was

designed assuming both furnace positions and firing temperatures to be fixed and the experiment was replicated thrice. The tests were made in random order and the data on baked density thus obtained are given below.

Furnace Position	Firing Temperature ($^{\circ}\text{C}$)		
	800	825	850
1	570	1063	565
	565	1080	510
	583	1043	590
2	528	928	526
	547	1026	538
	521	1004	532

- Write down the appropriate statistical model and obtain the expected mean square for the model components.
- Analyze the data and offer your conclusion. [use $\alpha = 0.05$]
- Use Duncan's Multiple Range Test to determine which level of firing temperature is significantly different from others. [Assume, $r(0.05, 2, 12) = 3.08$ and $r(0.05, 3, 12) = 3.23$] (6+7+7 = 20)

2. a) What is nonparametric statistical method?

b) Explain the advantages of nonparametric methods.

c) The mean axial stress of the alloys used in aircraft structures is being studied. Two alloys are being investigated. Alloy 1 is a traditional material, and alloy 2 is a new aluminum-lithium alloy that is much lighter than the standard material. Ten specimen of each alloy type are tested, and the axial stress is measured. The sample data are given below.

Axial Stress in psi			
Alloy 1		Alloy 2	
3238	3254	3261	3248
3195	3229	3187	3215
3246	3225	3209	3226
3190	3217	3212	3240
3204	3241	3258	3234

Type of Tip	Specimen			
	1	2	3	4
1	9.3	9.4	9.6	10.0
2	9.4	9.3	9.8	9.9
3	9.2	9.4	9.5	9.7
4	9.7	9.6	10.0	10.2

Analyze the data suitably at 5% level of significance and draw your conclusions.

(8+7 = 15)

SEMESTRAL EXAMINATION
Subject : Mechanical Engineering

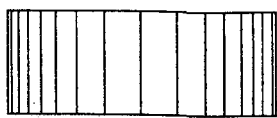
Date : 20-04-2011

Full Marks : 100

Time : 3hrs.

GROUP A
Answer any four

- (a) Explain the effect of temperature on modulus of elasticity. 4 + 6
(b) Explain critical temperature in connection to tensile failure of a material. Also mention the effect of type of loading on critical temperature.
- (a) Explain mechanical hysteresis loop. 4 + 6
(b) With neat stress-strain diagrams, explain the mechanical hysteresis under unidirectional loading and completely reversal loading.
- (a) Classify fits as per IS:919-1963. 5 + 5
(b) Calculate the fundamental deviation of 60 H8/f7 shaft and hole. (Use required chart and formula for fundamental deviation of shaft)
- (a) How can you measure the diameter of a large hole using two balls? 5 + 5
(b) Explain a setup to measure the angle of taper of an external surface without using a sine bar.
- (a) Classify optical flats. 3 + 7
(b) The figures are the test results of flatness using optical flats. Explain the nature of the flatness of the surface.



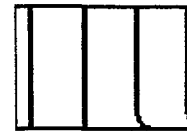
(a)



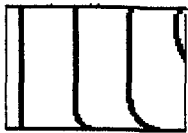
(b)



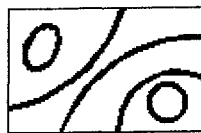
(c)



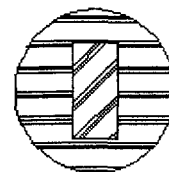
(d)



(e)



(f)



(g)

GROUP B
Answer any four

- With neat sketches explain different types of tool wear. 10
- Explain the factors of selection of grinding wheels as mentioned in IS:1249-1958. 10
- Explain the sequence of operations for cutting a 45 teeth gear with 3mm module. 10
- (a) Mention the sequence of reactions that takes place when an iron work piece is machined by ECM using NaCl as electrolyte. 5 + 5
(b) Discuss the limitations of USM.

Indian Statistical Institute, Kolkata
M.Tech (QROR)

10. Explain PAM process (sketch of the process not required).. 10

GROUP C
Answer any two

11. (a) Mention the constructional features along with their desirable properties a CNC machine.
(b) When are CNC machines not recommended? 6 + 4
12. Write a part program for face milling a 155mm X 200mm surface using a face milling cutter of 32mm diameter. Also draw the tool path. 10
13. Explain different forging operations. Give necessary sketches. 10

INDIAN STATISTICAL INSTITUTE
Second Semester Examination : 2010-11

M. Tech. (QR and OR) I Year (E-Stream)
Probability II

Date : 21.04.2011

Maximum Marks : 100

Duration : 3 hours

- Q1. a) State and prove the Basic Renewal Equation for a Markov Chain.
 b) Obtain a necessary and sufficient condition for a state to be recurrent in terms of the n-step transition probabilities.

(10 +10) = [20]

2. Consider the Markov chain $\{X_n | n = 0,1,2,\dots\}$ with state space $I = \{0,1,2,\dots\}$ and transition probability matrix X.

$$P = \begin{bmatrix} a_1 & a_2 & a_3 & \dots & \dots & \dots \\ 1 & 0 & 0 & \dots & \dots & \dots \\ 0 & 1 & 0 & \dots & \dots & \dots \\ 0 & 0 & 1 & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots \end{bmatrix}$$

- a) Show that the Markov Chain is recurrent.
 b) Compute $p_{ii}^{(n)}$ for $n = 0,1,2,\dots$

(10+10)=[20]

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

[20]

4. Prove that

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

Where N_i = Number of visits to state i at positive times ($i \in I$)

[20]

5. Consider a Markov Chain with state space $I = \{1,2,3,4,5,6\}$ and transition matrix.

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

Find the various classes of this Markov Chain and classify the states as recurrent or transient.

[20]

Indian Statistical Institute
Second Semester Examination : 2010-11
M. Tech(QR & OR) I Year (E & S Stream)

Sub: Reliability-I

Date: April 25, 2011

Maximum Marks: 100

Time: 3 hours.

Note: The paper carries 110 marks. Answer any part of any question, but the maximum you can score is 100.

1. Consider a k -unit parallel system with independent components, in which each component's lifetime is $\text{Exp}(\lambda)$. Find the hazard function of the system lifetime. Derive MTTF of the system.

[10]

2. Consider a lifetime random variable T with reliability function $R(t)$ and cumulative hazard function $\Lambda(t)$. Then, show that

(a) $\Lambda(t) = -\ln R(t)$,

(b) $\Lambda(\infty) = \infty$,

(c) $P(T \geq t+x | T \geq t) = \exp[-\{\Lambda(t+x) - \Lambda(t)\}]$ and

- (d) mean residual life at age t is

$$m(t) = \frac{\int_t^\infty R(y)dy}{R(t)}$$

using the result $\lim_{t \rightarrow \infty} tR(t) = 0$.

[5+2+3+5=15]

3. (a) Define DFR life distribution. Is Weibull distribution applicable when the lifetime distribution is neither IFR nor DFR? Justify your answer.
- (b) Give an example which shows that the sum of two DFR random variables is not necessarily DFR.
- (c) For the Poisson distribution with probability mass function

$$P(T = t) = e^{-\lambda} \frac{\lambda^t}{t!} \quad t = 0, 1, \dots,$$

show that the hazard function is monotone increasing.

[6+4+5=15]

4. (a) What is cold standby redundant system? Give an example.
- (b) Consider a 2-unit standby redundant system with perfect switching. The standby unit carry weak load while in standby mode. The lifetime of the primary unit has constant failure rate λ_1 . The lifetime of the standby unit has hazard rate $\lambda_2(t) = \lambda_2$ while in active mode. While in standby mode, the unit 2 has hazard rate $\lambda_2^*(t) = \lambda_2^*$. (i) Find the reliability of the system at time t_0 . (ii) Find the MTTF of the system.

[3+12=15]

5. (a) Suppose that a lifetime variable T has exponential distribution with mean $1/\theta$. When T is subjected to censoring at T_0 , then we observe $X = \min\{T, T_0\}$. Find the probability of censoring.
- (b) Suppose that n identical items are put on a life test for a pre-fixed time T_0 . All the functioning items are censored at T_0 . Assume that the underlying life distribution is exponential with mean $1/\theta$. Derive the MLE of θ . Find the asymptotic variance of the MLE of θ . Give an asymptotic 95% confidence interval for θ . Obtain the asymptotic variance of the MLE of $R(t_0)$.

[3+(4+2+3+3)=15]

6. Suppose that n identical items are put on a life test. The experiment is continued until a pre-fixed number (r) of items have failed and the remaining items are censored at the r -th failure time. Suppose the lifetime follows exponential distribution with hazard rate λ .

- (a) Find the expected duration of the life test.
- (b) Find the distribution of TTT. Hence find an unbiased estimator of MTTF.

[5+10=15]

7. Consider the following right-censored observations.

(3, 1), (3, 1), (3, 0), (3, 0), (4, 1), (7, 1), (9, 1), (9, 1), (9, 0), (9, 0), (12, 1), (14, 0), (15, 1)

- (a) Determine the Kaplan-Meier estimate at each of the uncensored points for the right-censored lifetime data.
- (b) Give an approximate 95% confidence interval for $R(7)$.
- (c) Assuming that the underlying life distribution is log-normal with parameters μ and σ , write down the likelihood function to obtain MLE of μ and σ . Obtain the score functions. Describe how you will use Newton-Raphson method to obtain the MLEs of the parameters.
- (d) Describe, in details, a suitable graphical method to verify the assumption of log-normal distribution for the given data.

[8+4+8+5=25]

INDIAN STATISTICAL INSTITUTE
Second Semester Examination: 2010-11
M-TECH (QR&OR) -- 1st YEAR (E&S STREAM)
Subject: SQC-II

Date: 28 4.2011

Full marks:100
Time: 3hours

[Symbols have their usual meaning]

Group – A

{Answer all the questions}

Full marks:60

1. a) Why do you need a chain sampling plan? What are the conditions under which a chain sampling plan should be used? Describe the procedure for a chain sampling plan. Derive the expression of OC function for chain sampling plan.
b) Explain the steps of Engineering process control (EPC). Discuss the difference between EPC and SPC (Statistical Process Control).

[2+3+4+3+4+4=20]

2. a) Derive Duncan's model for economic design of \bar{x} chart with single assignable cause. State the assumptions clearly.
b) How does the above model change if you assume that the process is stopped during the investigation and correction of the assignable causes?

[14+6=20]

3. a) For textile fiber tensile strength and diameter are two important quality characteristics. An engineer is interested to establish a control chart for controlling process variability for these two characteristics. Based on 50 samples of size 10 he calculated the sample variance-covariance matrix as

$$S = \begin{matrix} & \begin{matrix} \text{Tensile Strength} & \text{Diameter} \end{matrix} \\ \begin{bmatrix} 1.23 & 0.79 \\ 0.79 & 0.83 \end{bmatrix} & \begin{matrix} \text{Tensile Strength} \\ \text{Diameter} \end{matrix} \end{matrix}$$

Establish a suitable control chart for controlling variability. Write down the formulae for the control limits and the central line of the corresponding chart.

- b) Coefficient of friction (COF) is an important property of Aluminium foil. The management of a foil manufacturing company wanted to estimate the process capability of COF of its product. The following are the estimates obtained from 100 observations. Mean = 40.5, standard deviation = 4.5, skewness = 1.1, kurtosis = 2.2. Specification for COF is (35- 45). Estimate the process capability index.

[10+10=20]

Group – B

{Answer all questions}

Full marks: 40

1. There are three basic steps to be applied in each phase of the product life cycle; these steps are System Design, Parameter Design, and Tolerance Design. Explain how these steps can be applied for the production processes of a product.

[10]

2. An automobile manufacturer requires that the clearance between the cylinder and the piston of a six-cylinder engine be $3_{+7}^{-2} \mu\text{m}$. The loss incurred due to producing a defective cylinder and piston assembly is Rs. 10000, and the monthly production is 50, 000 units. Data showing deviation from the target value for the first two months of production are shown below. What are the quality levels during these two months? What is the improvement, if any, of the quality level?

Month	Deviations
1	-2 3 0 4 5 -2 3 -2 0 -1 -1 -3 0 4 3 -2 0 1 0 5 6 2 -1
2	3 2 0 1 -1 -1 0 -2 3 0 6 -2 4 3 0 -2 0 -1 2 4

[8+2=10]

3. a) The dimensions of a certain product are measured immediately after its final manufacturing process. Measurements are taken twice daily on 4 work pieces processed in succession for a period of 10 days. Measurement data (deviation from target) are shown in the following table. What is the mean squared drift per unit of production?

Day	A.M.	P.M.
1	0 -1 1 0	2 2 2 1
2	0 1 1 2	-1 0 1 1
3	-1 1 2 3	-1 -1 -2 -1
4	-1 -2 -3 -3	1 1 1 2
5	6 5 5 5	-3 -2 -2 -2
6	0 1 1 2	3 4 4 2
7	0 0 1 1	-3 -4 -5 -6
8	1 2 2 1	0 2 1 2
9	7 6 6 6	-5 -6 -7 -7
10	0 0 0 0	2 0 0 0

- b) The annual cost of the control system in 3a) is \$15000, and the annual production is 800,000 units. The characteristic value to be controlled is the dimension of the product, which has a tolerance of $\pm 10 \mu\text{m}$. The loss caused by a defective piece (rework cost) is \$6. What is the quality cost per unit of production?

[5+5 = 10]

4. After establishing the total quality cost per product (unit), show that for the feedback control with measurement intervals greater than one unit of production, the optimal diagnosis interval in terms of number of units is

$$n^* = \sqrt{\frac{2u_0B}{A}} \times \frac{\Delta}{D_0}$$

where u_0 is the current average number of products (units) between successive adjustments, B is the cost per measurement of the product characteristics, A is the in-plant cost of reworking or scrapping a unit that falls outside of tolerance interval, Δ is the tolerance of the product characteristics and D_0 is the current adjustment or control limit.

[10]

INDIAN STATISTICAL INSTITUTE
Second – semester Examination (2010 – 2011)

Course Name : **M. Tech. (QR & OR)**
Subject : **Industrial Engineering & Management**

Date : **19** April, 2011
Maximum Marks : 100
Duration : 180 minutes

(Note : Number of copies of the question paper required : 13)

QUESTION PAPER

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

Answer any Five Questions. All questions carry equal marks

1. [2 X 10]
- (a) Standard time per piece using Work Sampling is directly proportional to
I. total number of pieces produced
II. Performance Index
(A) Only I is true (B) Only II is true
(C) Both I and II are true (D) Both I and II are false
- (b) What will be the effective rate of interest of 8% nominal rate of interest compounded quarterly ?
(A) 8.12% (B) 8.20% (C) 8.24% (D) 8.32%
- (c) Which of the following represent relationship between Modified NPV (MNPV) and Terminal Value (TV) ?
(A) $MNPV \propto TV$ (B) $MNPV \propto 1/TV$
(C) $(TV) (MNPV) = \text{constant}$
(D) There is no relationship between MNPV and TV
- (d) Time value of money is considered in
I. Pay Back Period II. Accounting Rate of Return
(A) I is true but II is false
(B) II is true but I is false
(C) Both I and II are true
(D) Both I and II are false

- (e) A project is acceptable from financial angle if its
- I. $NPV > 0$
 - II. $IRR > \text{Cost of capital}$
 - III. $B-C \text{ Ratio} > 0$
- (A) I and II are true but III is false
 (B) I and III are true but II is false
 (C) II and III are true but I is false
 (D) I, II and III are all true
- (f) An equipment is considered as a total system with its four sub-assemblies as sub-systems which have reliability factors p_A, p_B, p_C and p_D . The total system reliability will be
- (A) $p_A + p_B + p_C + p_D$
 - (B) $p_A \cdot p_B \cdot p_C \cdot p_D$
 - (C) $(p_A + p_B + p_C + p_D)/4$
 - (D) None of these
- (g) Laplace criterion in one-stage decision making considers
- (A) different probabilities for different events
 - (B) all the events are equally probable
 - (C) no probabilities since the decision criterion is Maxmin or Minmax
 - (D) Cell probabilities
- (h) Highest value of pay-off corresponding to the event with highest probability is the starting point of
- (A) Expectation principle
 - (B) Maximax criterion
 - (C) Baye's principle
 - (D) Maximum Likelihood principle
- (i) Involvement of employees and team approaches to designing and organizing work is a central feature for
- | | |
|-----------------------|-----------------------|
| (A) Job design | (B) TQM |
| (C) Value Engineering | (D) Project appraisal |
- (j) The study to fit the work to the body rather than forcing the body to conform the work is known as
- | | |
|-------------------|--------------------|
| (A) TQM | (B) Job enrichment |
| (C) Job designing | (D) Ergonomics |
2. [2X10]
- (a) Major objectives of SIMO chart in the context of Work Measurement are
- (A) Eliminate or combine steps and maximize productivity
 - (B) Simplify methods and minimize motions
 - (C) Minimise idle time and maximize quality
 - (D) Minimise interference and delays
- (b) Observed performance time per unit multiplied by Performance rating is
- | | |
|-----------------|--|
| (A) Normal time | (B) Standard time |
| (C) Time study | (D) Ratio of Normal time and Standard time |

[2X10]

- (a) Let F be the failure rate expressed as number of failures per minute. Relationship between F and mean time between failures (MTBF) is
- (A) $MTBF = a + bF$
 - (B) MTBF is directly proportional to F
 - (C) $F \cdot MTBF = 1$
 - (D) There does not exist any relationship
- (b) Which of the following is false for Value Engineering?
- (A) Saving in cost of a product or service is treated as increased efficiency
 - (B) Attempt to reduce cost results in poor quality
 - (C) Constant search for improvement leads to greater all round efficiency
 - (D) Specifications are viewed with suspicion
- (c) Which of the following need not be considered in replacement of equipment?
- (A) Operating cost
 - (B) Down time cost
 - (C) Repair and maintenance cost
 - (D) Book value of equipment
- (d) Condition-based approach to maintenance of equipment is used in
- (A) Preventive maintenance
 - (B) Predictive maintenance
 - (C) Proactive maintenance
 - (D) All maintenance
- (e) Plot of typical machine life and machine failure graph is
- (A) a monotonically increasing function
 - (B) an exponential curve
 - (C) a straight line with positive slope
 - (D) a bath-tub curve
- (f) In case of pay-offs represented as profits the Savage Criterion for selecting optimal course of action is based on
- (A) Maximin Principle
 - (B) Maximax Principle
 - (C) Minmin Principle
 - (D) Expected pay-off method
- (g) If the employees are allowed to exercise some control over their work including discretion, decision making etc., this is referred as
- (A) Task autonomy
 - (B) Task identity
 - (C) Skilled variety
 - (D) Task variety

(h) Pre-operative expenses (till commencement of commercial production/use) of a project is

- I. Directly proportional to implementation schedule
- II. Increase of POE if the project is time over runned
- (A) only I is true
- (B) only II is true
- (C) both I and II are true
- (D) both I and II are false

- (i) Let A denotes cost of production
 B denotes total administrative expenses
 C denotes total sales expenses
 D denotes royalty payable
 E denotes other income
 F denotes gross profit before interest
 G denotes total financial expenses

Total cost of production is

- (A) $A+B+C+D$
- (B) $A+B+C+D+G$
- (C) $G - (A+B+C) + \text{interest}$
- (D) None of this

- (j) The rate of return for which $NPV = 0$ is known as
- (A) B- C Ratio
 - (B) IRR
 - (C) Annualised rate of return
 - (D) Effective rate of return

4.

[10+10]

a) Suppose a machine was purchased at a cost of Rs.5000. Its annual maintenance cost is RS.1000 in each of the first four years and then it increases by Rs.200 every year. Assume

- (i) the machine has no salvage value
- (ii) maintenance cost is incurred at the beginning of each year
- (iii) time value of money is 10% p.a.

Find the annualized cost for the fifth year.

b) 15 observations have been taken for operation of a machine from a factory. Numerical breakdown of activities are

Description	Make ready	Actual operation	Cleaning	Idle
No.of observations taken	2	6	3	4

How many work sampling observations are required to determine how much of the worker's time is spent on "Actual Operation"? Assume a 5% desired absolute accuracy and 95% confidence level.

- (c) Complete breakdown of elements of a job is not provided in
I. Time Study
II. Work Sampling
(A) Only I is true
(B) Only II is true
(C) Both I and II are true
(D) Both I and II are false
- (d) Which of the following is a sale based incentive plan ?
(A) Hourly pay (B) Piece rate
(C) Commission (D) Straight salary
- (e) Scanlon Plan is a model of
(A) Output based incentive plan
(B) Hourly based incentive plan
(C) Profit sharing
(D) Gain sharing
- (f) Value Engineering may not consider
I. Products with poor profit margin
II. Products with high tooling cost
III. Products with high service cost
(A) I and II are true but III is false
(B) I and III are true but II is false
(C) II and III are true but I is false
(D) I,II and III are all false
- (g) Which of the following carries no fixed rate of dividend
(A) Preference capital
(B) Equity capital
(C) Share capital
(D) Non convertible debenture capital
- (h) While computing cost of various input materials per unit of output, one has to consider
(A) FOB cost
(B) CIF cost
(C) Labour cost
(D) Utilities cost
- (i) Challenging the standards is a major feature of
(A) Innovation
(B) Production planning
(C) Quality control
(D) Value engineering
- (j) Printing of only the symbol at corner of each card is an example of
(A) Cost control
(B) Cost reduction
(C) Product diversification
(D) Profit maximization

5.

[10 + 10]

a) Consider a project for which initial investment is Rs. 1 lakh. Cost of capital is 12% p.a. Benefits (in thousand rupees) are 25, 40, 40 and 50 respectively for the 1st, 2nd, 3rd and 4th year. Find value of NBCR for the project

b) Find IRR (approx.) for the project considering the following cash flow

Year	Cash outgo	Cash inflow
0	100,000	-
1	-	30,000
2	-	30,000
3	-	40,000
4	-	45,000

6.

[10+10]

a) Consider nine independent projects for which following information are available

i) NPV for each project

ii) Cash outflow for each project for the year t ($t = 1, 2$)

iii) Capital budget available C_1 and C_2 for the year 1 and year 2. where C_i is less than total outflow of the nine projects for the i -th year

Problem is to choose a sub-set of the projects. Formulate the problem as a Linear Programming Problem and furnish your observations along with suggestions for better method, if any.

b) Consider the following five projects along with different values of appraisal methods

Project	Outlay (in thousand rupees)	Project life (years)	NPV (in rupees)	IRR (in %)	B-C Ratio
A	10	12	14,777	30	2.48
B	25	4	5,370	22	1.21
C	30	20	14,814	19	1.48
D	38	16	45,688	30	2.20
E	35	9	28,936	29	1.83

Which project receives same rank by all the three above said appraisal method. Show your calculations please.