SLR-ES-383

Seat No.		Set	P

M.Sc. (Semester - IV) (CBCS) Examination March/April-2019
Statistics
INDUSTRIAL STATISTICS

Day & Date: Tuesday, 07-05-2019
Time: 03.30 PM To 6.00 PM Max. Marks: 70

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.

Q.1 Choose Correct Alternative from the following. **14**

1) Quality is inversely proportional to _____.
   a) Variability b) Cost
   c) Method d) Time

2) _____ visualizes the most significant problem to be worked out first.
   a) Histogram b) Control chart
   c) Pareto chart d) Flowchart

3) _____ control is solely based on sampling inspection.
   a) Product b) Process
   c) Both product and process d) None

4) Warning limits increase _____.
   a) probabilities of both true and false alarms
   b) probability of only false alarm
   c) probability of only true alarm
   d) none

5) The probability of false alarm for $\bar{X}$ chart with 3 σ-limits and with usual assumptions is _____.
   a) 0.027 b) 0.27
   c) 0.0027 d) 0.0027%

6) _____ variability is avoidable.
   a) Chance-cause
   b) Assignable cause
   c) Both chance and assignable cause
   d) None of chance and assignable cause

7) CUSUM and EWMA charts are developed specially for detecting _____ shifts efficiently.
   a) Small b) Large
   c) both small and large d) none of a, b, c

8) $C_p \ldots . C_{pm}$
   a) $\leq$ b) $\geq$
   c) $<$ d) $>$

9) When $\mu = \frac{\text{LSL} + \text{USL}}{2}$
   a) $C_p \leq C_{pk} \leq C_{pm}$ b) $C_p \geq C_{pk} \geq C_{pm}$
   c) $C_p \geq C_{pk} = C_{pm}$ d) $C_p = C_{pk} = C_{pm}$

10) The Six Sigma programme was first implemented in _____.
   a) Motorola b) General
   c) Measure d) Mean

11) The full form of 'M' in DMAIC is _____.
a) Metric **b)** Material
c) Measure d) Mean

12) AQL stands for _____.
a) average quality limit b) average quality level
c) acceptable quality limit d) acceptance quality level

13) In acceptance sampling, the risk of accepting a bad quality lot is known as ___.
a) Consumer's risk b) Producer's risk
c) a Type II error d) a type I error

14) A graph showing the probability of accepting the lot as a function of the percent defective in the lot is called _____.
a) a power curve
b) a control curve
c) an operating characteristic curve
d) an LTPD curve

Q.2 A) Answer the following (Any Four) **08**
1) Define quality from consumer's perspective.
2) Define specification limits of a quality characteristic.
3) Describe the control statistic of a CUSUM chart for monitoring an upward shift in the process mean.
4) Define process capability index C_{pm}
5) What are the objectives of 'Define' step in a DMAIC process?

B) Write Short Notes(Any two) **06**
1) Types of quality characteristics
2) Need of multivariate control charts
3) Power requirements in designing a sampling inspection plan

Q.3 A) Answer the following (Any two) **08**
1) Describe the dimensions of quality
2) Describe moving average control chart
3) Describe curtailed and semi-curtailed sampling plans

B) Answer the following (Any one) **06**
1) Describe six-Sigma methodology.
2) Explain the construction and operation of a tabular CUSUM control chart for monitoring the process mean

Q.4 A) Answer the following (Any two) **10**
1) Describe product control
2) Describe Deming's PDCA cycle
3) Describe an algorithm of obtaining a single attribute sampling plan based on hypergeometric distribution

B) Answer the following (Any one) **04**
1) Describe fishbone diagram
2) Describe c chart

Q.5 Answer the following (Any two) **14**
a) Describe construction, operation, and the underlying statistical principle of $\bar{X}$ and *R* charts.
b) Describe construction, operation, and the underlying statistical principle of Hotelling's T^2 chart
c) Define the process capability indices C_p and C_{pk} State their interpretation with necessary underlying assumptions

SLR-JS-384

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination Oct/Nov-2019
Statistics
INDUSTRIAL STATISTICS

Day & Date: Wednesday, 06-11-2019 Max. Marks: 70
Time: 03:00 PM To 05:30 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.

Q.1 Fill in the blanks by choosing correct alternatives given below. **14**

1) _____is not a seven SPC tool.
   a) histogram b) check sheet
   c) single sampling plan d) pareto chart

2) _____ is helpful in searching the root-cause of a problem.
   a) Flow chart b) Control chart
   c) Check sheet d) Fishbone diagram

3) Generally, in process control, cost of production is _____ as compared to that in product control.
   a) high b) low
   c) almost the same d) exactly the same

4) Control chart is _____tool.
   a) an on-line process control
   b) an off-line process control
   c) a product control
   d) both a process and product control

5) _____variability is unavoidable.
   a) Chance-cause
   b) Assignable cause
   c) Both chance and assignable cause
   d) None of chance and assignable cause

6) The probability of type II error for $\bar{X}$ chart with 3 σ-limits and with usual assumptions _____.
   a) is 0.027
   b) is 0.9973
   c) depends on the size of a shift in the process mean
   d) cannot be determined

7) Shewhart chart is a particular case of _____.
   a) CUSUM chart
   b) EWMA chart
   c) Both CUSUM and EWMA charts
   d) SPRT chart

8) C_p___C_{pk}
   a) $\leq$ b) $\geq$
   c) $<$ d) $>$

9) When $\mu = \frac{LSL+USL}{2}$,
   a) $C_p \leq C_{pk} \leq C_{pm}$ b) $C_p \geq C_{pk} \geq C_{pm}$
   c) $C_p \geq C_{pm} = C_{pk}$ d) $C_p = C_{pk} = C_p$

10) _____ invented the PDCA cycle.
   a) Shewhart b) Deming
   c) Montgomery d) Fisher

11) The full form of 'M' in DMAIC is_____.
   a) Metric b) Material
   c) Measure d) Mean

12) Acceptance sampling is used for all but which one of these?
   a) Incoming raw material b) Work-in-progress
   c) Final goods d) Incoming purchased parts

13) In acceptance sampling, the risk of rejecting a good quality lot is known as _____.
   a) Consumer's risk b) Producer's risk
   c) a Type II error d) a type I error

14) The maximum number of defective items that can be found in the sample and still lead to acceptance of the lot is called _____.
   a) the upper limit b) the acceptance number
   c) the acceptance criterion d) AQL

Q.2 A) Answer the following. (Any Four) **08**

1) Define quality from manufacturer's perspective.
2) Explain any two dimensions of quality.
3) Describe the control statistic of a CUSUM chart for monitoring a downward shift in the process mean.
4) Define process capability index.
5) What ppm of nonconforming products corresponds to the Six Sigma level when the mean of the key quality characteristic is subject to vary within the middle 3σ range of the quality characteristic?

B) Write Notes. (Any Two) **06**

1) Control limits and specifications limits for a quality characteristic.
2) V-mask CUSUM procedure.
3) Power requirements in designing a sampling inspection plan.

Q.3 A) Answer the following. (Any Two) **08**

1) Describe phase I of control chart.
2) Describe c chart.
3) Describe double sampling plan.

B) Answer the following. (Any One) **06**

1) Described the DIMAC cycle.
2) Explain the construction and operation of an EWMA control chart for monitoring the process mean.

Q.4 A) Answer the following. (Any Two) **10**

1) Describe process control.
2) State various sensitizing rules used in control charting.
3) Describe an algorithm of obtaining a single attribute sampling plan based on binomial distribution.

B) Answer the following. (Any One) **04**

1) Describe Pareto chart.
2) Describe moving average control chart.

Q.5 Answer the following. (Any two) **14**

1) Describe construction, operation, and the underlying statistical principle of *p* chart.

2) Describe construction, operation, and the underlying statistical principle of Hotelling's T^2 chart.

3) Define process capability index C_p with the necessary underlying assumptions. State and prove its relationship with the probability of nonconformance.

SLR-MB – 634

Seat No.	

M.Sc. (Part – II) (Semester – IV) (CGPA) Examination, 2016
STATISTICS (Paper – XVII)
Industrial Statistics (New)

Day and Date : Friday, 1-4-2016 Total Marks : 70

Time : 2.30 p.m. to 5.00 p.m.

Instructions : *1) Attempt **five** questions.*
*2) Q. No. **1** and Q. No. **2** are **compulsory**.*
*3) Attempt **any three** from Q. No. **3** to Q. No. **7**.*
*4) Figures to the **right** indicate **full** marks.*

1. A) Choose the correct alternative :

1) The statistical process control chart used to control number of defects per unit of output is the _____

a) P-chart b) C-chart c) $\bar{X}$-chart d) R- chart

2) In most acceptance sampling plans, when a lot is rejected, the entire lot is inspected and all defective items are replaced. When using this technique the AOQ _____

a) becomes a larger fraction b) becomes a smaller fraction

c) is not affected d) none of these

3) An appropriate distribution of run length is _____

a) normal b) binomial c) geometric d) Poisson

4) Which of the following is useful in searching the root cause of a problem ?

a) Control chart b) Ishekawa diagram

c) Defect concentration diagram d) Pareto chart

5) For a centered process _____

a) $C_p = C_{pk}$ b) $C_p < C_{pk}$ c) $C_p > C_{pk}$ d) none of these

P.T.O.

B) Fill in the blanks :

1) Tabular method is used to implement _____ chart.

2) Six-sigma quality performance produces _____ PPM defective.

3) Usually 2 σ limits are called _____

4) CUSUM and EWMA charts are developed specially for detecting _____ shifts efficiently.

5) Variation due to _____ causes cannot be identified and removed from the process.

C) State whether the following statements are **true** or **false** :

1) EWMA chart cannot be used with individual measurement.

2) OC curve displays the discriminatry power of the sampling plan.

3) Type II error occurs when a bad lot is accepted.

4) Normality of quality characteristic is not essential to find confidence interval for C_p. **(5+5+4)**

2. a) Define :

i) Type I error

ii) Type II error

iii) OC function

relative to control chart.

b) Write short note on the following :

i) Moving range (MR) control chart.

ii) PDCA cycle. **(6+8)**

3. a) Discuss various steps involved in the construction of $\bar{X}$ and R charts.

b) What is an EWMA control chart ? Explain the procedure of obtaining control limits for the same. **(7+7)**

4. a) Discuss a nonparametric control chart based on a sign test to monitor location of a process.

b) Discuss in detail np chart. Obtain the OC function of the same. **(7+7)**

5. a) Define process capability indices :

   i) C_p ii) C_{pk}.

   Stating the underlying assumptions, show that

   $\Phi(-3C_{pk}) \leq P \leq 2\Phi(-3C_{pk})$

   b) Explain DMAIC cycle of six-sigma methodology with an example. **(7+7)**

6. a) Describe double sampling plan for attributes. Derive the expressions for its OC and ASH functions.

   b) Explain the association between testing of hypothesis problem and implementation of the control charts. **(7+7)**

7. a) Explain in detail the development and implementation of Hotelling's T^2 chart.

   b) Explain the variable sampling plan when upper specification is given with known standard deviation. **(7+7)**

SLR-VB – 17

Seat No.	

M.Sc. (Part – II) (Semester – IV) Examination, 2014
STATISTICS (Paper – XVII)
Industrial Statistics

Day and Date : Thursday, 24-4-2014 Total Marks : 70
Time : 3.00 p.m. to 6.00 p.m.

Instructions *: 1) Attempt **five** questions.*
*2) Q. No. **1** and Q. No. **2** are **compulsory**.*
*3) Attempt **any three** from Q. No. **3** to Q. No. **7**.*
*4) Figures to the **right** indicate **full** marks.*

1. A) Select the correct alternative :

1) Quality is inversely proportional to _____
a) Variability b) Cost c) Method d) Time

2) Warning limits increase _____
a) Probabilities of both true and false alarm
b) Probability of only false alarm
c) Probability of only true alarm
d) None

3) C_p _____ C_{pk}.
a) $\leq$ b) $\geq$ c) $<$ d) $>$

4) _____ is helpful in searching the root-cause of a problem.
a) Flow chart b) Control chart
c) Check sheet d) Fishbone diagram

5) CUSUM and EWMA charts are developed specially for detecting _____ shifts efficiently.
a) Small b) Large
c) Both small and large d) None of a), b) and c) **(1×5)**

B) Fill in the blanks :

1) Shewhart control charts are relatively less sensitive to _____ shifts.

2) C_p increases as variability _____

3) _____ control relies on inspectors.

P.T.O.

4) The relationship between C_p and the probability of nonconformance p is _____

5) In _____ control, no changes are made in process settings. **(1×5)**

C) State **true** or **false** :

1) In product control quality is achieved through detection.

2) $C_p = 1$ corresponds to nonconforming 27 ppm.

3) The adoption of 3σ-limits in Shewhart control chart is based on no assumption regarding the distribution of the control statistic.

4) PDCA cycle may require several iterations for solving a quality problem. **(1×4)**

2. a) i) Give any two definitions of quality.

ii) Describe types of variability. **(3+3)**

b) Write short notes on the following :

i) Process capability index C_{pm}.

ii) Sequential sampling plans. **(4+4)**

3. a) Describe construction, operation and the underlying statistical principle of $\overline{X}$ and R charts.

b) Define statistical quality control. Describe product control and process control. **(7+7)**

4. a) Obtain an unbiased estimator and confidence interval for process capability index C_p based on sample of size n drawn on the quality characteristic.

b) Describe construction and operation of tabular CUSUM chart for monitoring process mean. **(7+7)**

5. a) Describe briefly the seven SPC tools.

b) Describe single attribute sampling inspection plan based on hypergeometric distribution. **(7+7)**

6. a) Define process capability index C_{pk} with the necessary underlying assumptions, if any. State and prove its relationship with the probability of nonconformance.

b) Describe sampling inspection plan by variables when both lower and upper specification limits are given and the standard deviation is known. **(7+7)**

7. a) Describe construction, operation and the underlying statistical principle of Hotelling's T^2 chart.

b) Describe six-sigma methodology. **(7+7)**

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SLR-BP – 493

Seat No.	

M.Sc. (Part – II) (Semester – IV) Examination, 2015
STATISTICS (Paper – XVII)
Industrial Statistics

Day and Date : Saturday, 18-4-2015 Total Marks : 70
Time : 3.00 p.m. to 6.00 p.m.

Instructions *: 1) Attempt* ***five*** *questions.*
2) Q. No. ***(1)*** *and Q. No.* ***(2)*** *are* ***compulsory****.*
3) Attempt ***any three*** *from Q. No.* ***(3)*** *to Q. No.* ***(7)****.*
4) Figures to the ***right*** *indicate* ***full*** *marks.*

1. A) Select the correct alternative :

1) Quality is inversely proportional to _____
a) Variability b) Cost c) Method d) Time

2) _____ variability is unavoidable.
a) Chance-cause
b) Assignable cause
c) Both chance and assignable cause
d) None of chance and assignable cause

3) C_p _____ C_{pk}.
a) $\leq$ b) $\geq$ c) < d) >

4) _____ is not the dimension of quality.
a) Aesthetics b) Features c) Durability d) Cost

5) The probability of false alarm for $\overline{X}$ chart with 3σ limits is _____
a) 0.027 b) 0.27 c) 0.0027 d) 0.0027% **(1×5)**

B) Fill in the blanks :

1) CUSUM and EWMA control charts are the better alternatives to _____ charts for detecting small shifts in process parameters.

2) The formula for C_{pk} is _____

3) S chart is preferred over R chart if the sample size is _____

4) The process capability index _____does not have interpretation in terms of the probability of nonconformance.

5) The SPC tool _____visualizes the most significant problem to be worked out first. **(1×5)**

P.T.O.

C) State **true** or **false** :

1) Product control relies on inspectors.

2) False alarm is the indication of in-control state of a process when it is really out-of-control.

3) The process capability index C_{pk} does not take into account location of the process mean.

4) PDCA cycle may require several iterations for solving a quality problem. **(1×4)**

2. a) i) Describe types of variability.

ii) Describe curtailed and semi-curtailed sampling plans. **(3+3)**

b) Write short notes on the following :

i) Cause and effect diagram.

ii) Process capability index C_{pm}. **(4+4)**

3. a) Define statistical quality control. Describe product control and process control.

b) Define the process capability index C_{pk}. State and prove the relation between C_{pk} and the probability of nonconformance associated with it. **(7+7)**

4. a) Describe construction, operation and the underlying statistical principle of p chart.

b) Describe construction and operation of EWMA control chart for monitoring process mean. **(7+7)**

5. a) Define process capability index. Define index C_p with the necessary underlaying assumptions. What is its interpretation ?

b) Describe the DIMAC cycle. **(7+7)**

6. a) Describe single attribute sampling inspection plan based on hypergeometric distribution.

b) Describe sampling inspection plan by variables when both lower and upper specification limits are given and the standard deviation is known. **(7+7)**

7. a) Describe construction, operation and the underlying statistical principle of Hotelling's T^2 chart.

b) Describe six-sigma methodology. **(7+7)**

SLR-MB – 639

Seat No.	

M.Sc. (Part – II) (Semester – IV) Examination, 2016
STATISTICS (Paper – XVII) (Old CGPA)
Industrial Statistics

Day and Date : Friday, 1-4-2016 Total Marks : 70
Time : 2.30 p.m. to 5.00 p.m.

Instructions : *1) Attempt **five** questions.*
*2) Q. No. **1** and Q. No. **2** are **compulsory**.*
*3) Attempt **any three** from Q. No. **3** to Q. No. **7**.*
*4) Figures to the **right** indicate **full** marks.*

1. A) Select the correct alternative :

1) _____ is helpful in searching the root-cause of a problem.
   a) Flow chart b) Control chart
   c) Check sheet d) Fish bone diagram

2) CUSUM and EWMA charts are developed specially for detecting _____ shifts efficiently.
   a) small b) large
   c) both small and large d) none of a), b) and c)

3) C_p _____ C_{pm}.
   a) $\leq$ b) $\geq$ c) $<$ d) $>$

4) Generally, in process control cost of production is _____ as compared to that in product control.
   a) high b) low
   c) almost the same d) exactly the same

5) Control chart is _____ tool.
   a) on-line process control b) off-line process control
   c) product control d) both process and product control **(1×5)**

B) Fill in the blanks :

1) In _____ control, no changes are made in process settings.
2) The formula for C_{pm} is _____
3) S chart is preferred over *R* chart if the sample size is _____
4) The probability of false alarm for $\overline{X}$ chart with 3σ control limits is _____
5) The process capability index C_p increases as variability _____ **(1×5)**

P.T.O.

C) State **true** or **false** :

1) In product control quality is achieved through prevention.

2) PDCA cycle may require several iterations for solving a quality problem.

3) C_{pm} gives more importance to the change in process mean than to the change in process variability.

4) Quality is a multidimensional entity. **(1×4)**

2. a) i) Explain interpretation of $\overline{X}$ and *R* control charts.

ii) Describe the weakness of process capability index C_p. **(3+3)**

b) Write short notes on the following :

i) Process control.

ii) Sequential sampling plans. **(4+4)**

3. a) Describe briefly the seven SPC tools.

b) Describe six-sigma methodology. **(7+7)**

4. a) Explain statistical basis and operation of a Shewchart control chart.

b) Describe construction and operation of tabular CUSUM chart for monitoring process mean. **(7+7)**

5. a) Define index C_{pk} with the necessary underlying assumptions. State and prove its relationship with the probability of nonconformance.

b) Describe construction, operation and the underlying statistical principle of Hotelling's T^2 chart. **(7+7)**

6. a) Describe single attribute sampling inspection plan based on Poisson distribution.

b) Describe sampling inspection plan by variables when lower specification limit is given and the standard deviation is not known. **(7+7)**

7. a) Explain the algorithm for simulation of $\overline{X}$ and *R* charts for evaluating their performances.

b) Describe the DIMAC cycle. **(7+7)**

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SLR-MM – 523

Seat No.	

M.Sc. (Part – II) (Semester – III) Examination, 2015
STATISTICS (Paper – XIII)
Planning and Analysis of Industrial Experiments (New CGPA)

Day and Date : Friday, 20-11-2015 Total Marks : 70

Time : 2.30 p.m. to 5.00 p.m.

Instructions : *1) Attempt **five** questions.*
*2) Q. No. (**1**) and Q. No. (**2**) are **compulsory**.*
*3) Attempt **any three** from Q. No. (**3**) to Q. No. (**7**).*
*4) Figures to the **right** indicate **full** marks.*

1. A) Choose the correct alternative : **5**

1) Smaller the experimental error _____ efficient the design.
   a) less b) more
   c) not d) none of the above

2) If AB and BC are confounded with incomplete block in 2^n experiment, then automatically confounded effect is
   a) ABC b) AC c) A d) B

3) The degrees of freedom corresponding to error in single replicate design is
   a) 0 b) 1
   c) 2 d) None of above

4) Confounding is necessary to reduce
   a) Block size b) No. of blocks
   c) No. of factors d) All of above

5) Fractional factorial experiment reduces
   a) factors b) levels of factors
   c) both a) and b) d) neither a) nor b)

P.T.O.

B) Fill in the blanks : **5**

1) In factorial experiment one can estimate _____ and _____ effects.

2) The shortest word length in defining relation is called as _____

3) Variables which are hard to control are called _____

4) In 3^3 experiment with factors A, B and C the interaction AB has _____ d.f.

5) Preferably _____ interaction is chosen for confounding.

C) State whether the following statements are **true** or **false** : **4**

1) In 2^3 design, generally we choose ABC as confounding factor.

2) Experimental error is due to experimenter's mistake.

3) For 2^k design the complete model would contain 2^{k-2} effects.

4) In Response Surface Study the factors must be quantitative.

2. a) Define with one example : **6**

i) Minimum aberration design.

ii) Resolution of factorial design.

b) Write short notes on the following : **8**

i) Yates table for 2^3 factorial experiments.

ii) Central Composite Design.

3. a) Describe the random effect model of one-way classification.

b) Describe Taguchi arrays. **(7+7)**

4. a) Explain $\frac{1}{4}$ fraction of 2^k design with suitable example.

b) Write down lay-out of 2^4 confounded design with higher order interaction is confounded. **(8+6)**

5. a) Explain advantages and disadvantages of confounding.

b) Explain partial confounding with illustration. **(7+7)**

6. a) Explain Response Surface methodology.

   b) Define :

      i) Principle fraction

      ii) Aliases sets

      iii) Clearly estimate effects. **(7+7)**

7. a) Explain analysis of 2^n factorial experiment in 'r' replicates.

   b) Describe basic principles of Design of Experiments. **(7+7)**

SLR-BP – 493

Seat No.	

M.Sc. (Part – II) (Semester – IV) Examination, 2015
STATISTICS (Paper – XVII)
Industrial Statistics

Day and Date : Saturday, 18-4-2015 Total Marks : 70
Time : 3.00 p.m. to 6.00 p.m.

Instructions *: 1) Attempt* ***five*** *questions.*
2) Q. No. ***(1)*** *and Q. No.* ***(2)*** *are* ***compulsory****.*
3) Attempt ***any three*** *from Q. No.* ***(3)*** *to Q. No.* ***(7)****.*
4) Figures to the ***right*** *indicate* ***full*** *marks.*

1. A) Select the correct alternative :

1) Quality is inversely proportional to _____
a) Variability b) Cost c) Method d) Time

2) _____ variability is unavoidable.
a) Chance-cause
b) Assignable cause
c) Both chance and assignable cause
d) None of chance and assignable cause

3) C_p _____ C_{pk}.
a) $\leq$ b) $\geq$ c) < d) >

4) _____ is not the dimension of quality.
a) Aesthetics b) Features c) Durability d) Cost

5) The probability of false alarm for $\overline{X}$ chart with 3σ limits is _____
a) 0.027 b) 0.27 c) 0.0027 d) 0.0027% **(1×5)**

B) Fill in the blanks :

1) CUSUM and EWMA control charts are the better alternatives to _____ charts for detecting small shifts in process parameters.

2) The formula for C_{pk} is _____

3) S chart is preferred over R chart if the sample size is _____

4) The process capability index _____does not have interpretation in terms of the probability of nonconformance.

5) The SPC tool _____visualizes the most significant problem to be worked out first. **(1×5)**

P.T.O.

C) State **true** or **false** :

1) Product control relies on inspectors.

2) False alarm is the indication of in-control state of a process when it is really out-of-control.

3) The process capability index C_{pk} does not take into account location of the process mean.

4) PDCA cycle may require several iterations for solving a quality problem. **(1×4)**

2. a) i) Describe types of variability.

ii) Describe curtailed and semi-curtailed sampling plans. **(3+3)**

b) Write short notes on the following :

i) Cause and effect diagram.

ii) Process capability index C_{pm}. **(4+4)**

3. a) Define statistical quality control. Describe product control and process control.

b) Define the process capability index C_{pk}. State and prove the relation between C_{pk} and the probability of nonconformance associated with it. **(7+7)**

4. a) Describe construction, operation and the underlying statistical principle of p chart.

b) Describe construction and operation of EWMA control chart for monitoring process mean. **(7+7)**

5. a) Define process capability index. Define index C_p with the necessary underlaying assumptions. What is its interpretation ?

b) Describe the DIMAC cycle. **(7+7)**

6. a) Describe single attribute sampling inspection plan based on hypergeometric distribution.

b) Describe sampling inspection plan by variables when both lower and upper specification limits are given and the standard deviation is known. **(7+7)**

7. a) Describe construction, operation and the underlying statistical principle of Hotelling's T^2 chart.

b) Describe six-sigma methodology. **(7+7)**