



# LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

## M.Sc. DEGREE EXAMINATION – STATISTICS

THIRD SEMESTER – APRIL 2017

### ST 3817- STATISTICAL QUALITY CONTROL

Date: 28-04-2017  
09:00-12:00

Dept. No.

Max. : 100 Marks

#### PART A

Answer ALL the questions:

( 10 X 2 = 20)

- 1) Define Statistical Process Control.
- 2) Why np chart is not appropriate when sample size is varying?
- 3) What are chance and assignable causes of variation?
- 4) Define  $\beta$  risk.
- 5) Define process capability ratio.
- 6) State any two advantages of multivariate control chart.
- 7) How lots have to be chosen in acceptance sampling?
- 8) For  $p = 6$ ,  $m = 10$ ,  $n = 7$  and  $\alpha = 0.05$ , find the UCL of  $T^2$  control chart.
- 9) What is an average run length?
- 10) Define natural tolerance limits.

#### PART B

Answer any FIVE questions:

( 5 X 8 = 40)

- 11) Explain cyclic pattern, mixture, shift in process level, trend and stratification.
- 12) A TiW layer is deposited on a substance using a sputtering tool. The following table contains layer thickness measurements on 20 subgroups of four substances.

Subgroup	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
X1	45	44	45	46	44	44	44	44	44	43	44	46	45	42	41
X2	49	40	44	46	45	45	42	43	46	45	47	44	46	43	44
X3	42	44	41	48	45	40	44	41	42	43	46	45	45	44	42
X4	40	42	46	47	48	49	41	40	45	46	47	47	42	42	40

Set up a control chart for mean and range.

- 13) Briefly explain the different types of sampling plans.
- 14) For a sequential sampling plan, find the acceptance line and rejection line for the  $p_1 = 0.01$ ,  $\alpha = 0.05$ ,  $p_2 = 0.05$  and  $\beta = 0.25$  for a sample of size 50.
- 15) Suppose that we have  $p = 3$  quality characteristics and in correlation from all the 3 variables have variance unity and all pairwise correlation coefficients are 0.8, then in-control value of the process mean vector is  $\mu = (0 \ 0 \ 0)$ 
  - (a) Write the covariance matrix  $\Sigma$
  - (b) What is  $\chi^2$  control limits for  $\alpha = 0.05$
  - (c) Suppose that a sample of observations results in the standardized observation vector  $y' = [1 \ 3 \ 5]$ , calculate the value of the  $T^2$  statistics. Is an out-control signal generated?
  - (d) Calculate the diagnostic quantities  $d_i$ ,  $i = 1, 2, 3$  from equation. Does the information assist in identifying which process variables have shifted?

- 16) Explain chain sampling plan.
- 17) Write a short note on process capability analysis with attribute data.
- 18) Explain SIPOC diagram and its uses.

PART C

Answer any TWO of the following: ( 2X20 = 40)

- 19) (a) Distinguish between p and np charts. Explain the situation where p and np are applicable and how are the limits obtained for these charts. (8)
- (b) Control charts for  $\bar{X}$  and R are to be established to control the tensile strength of a metal part. Assume the tensile strength is normally distributed. Thirty samples of size n = 6 parts are collected over a period of time with the following results:  
 $\sum_{i=1}^{30} \bar{X}_i = 6000$  and  $\sum_{i=1}^{30} R_i = 150$ 
  - (i) Calculate control limits for  $\bar{X}$  and R.
  - (ii) Both charts exhibit control. The specifications on tensile strength are  $200 \pm 5$ . What are your conclusions regarding process capability?
  - (iii) For the above  $\bar{X}$  chart, find the  $\beta$ -risk when the true process mean is 199. (12)
- 20) (a) Describe the concept of Exponential Moving Average Control chart.
- (b) Suppose that a quality characteristic has a normal distribution with specification limits at  $USL = 100$  and  $LSL = 90$ . A random sample of 30 parts results in  $\bar{x} = 97$  and  $s = 1.6$
- (i) Calculate a point estimate of  $C_{pk}$  and (ii) Find a 95% confidence interval on  $C_{pk}$ .

(12+8)

21) (a) Write down the procedure of Hotelling  $T^2$  control chart.

(b) Set up a moving average control chart for the following data using  $w=4$  with target mean value as 8.02 and standard deviation of 0.05.

Observation i	1	2	3	4	5	6	7	8	9	10
$x_i$	8	8.01	8.02	8.01	8	8.01	8.06	8.07	8.01	8.04
Observation i	11	12	13	14	15	16	17	18	19	20
$x_i$	8.05	8.04	8.03	8.05	8.06	8.04	8.05	8.06	8.04	8.02

- 22) (a) Explain DMAIC.
- (b) How DMAIC problem solving process can be used to improve service quality in banking process?

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