

Indian Statistical Institute, Bangalore  
MS (QMS) First Year  
Second Semester - Advanced Statistical Process Control

Midterm Exam  
Maximum marks: 40

Date: February 24, 2026  
Duration: 2 hours 30 minutes

1. [2 + 4 x 2 = 10]
- a) State five conditions that will be necessary conditions for controlling a product characteristic during manufacturing with a control chart.
- b) State the process control method(s) for the conditions below with justification.
- i) Quality of paint depends on the skill of the operator.
  - ii) Process average can be set by adjusting the process parameters.
  - iii) The output quality depends on the input quality of the raw material.
  - iv) The quality of the product characteristic depends on the quality of the tool condition.

2. [10]
- A printed circuit board used for different applications is produced in small batch sizes. The inspection data for the last two weeks of production is given below.

Part No.	No. of Defects									
15AZ	16	14	13	8	12	10	14	12	10	13
22BK	6	5	4	7	5	2	6	7	5	4
33HZ	22	18	17	15	20	20	18	16	10	22

Set up a suitable control chart and comment on the process.

3. [3 + 3 + 4 = 10]
- a) Define the pre-control chart limit for the characteristic ( $10 \pm 0.5 \text{ mm}$ ) when  $cp = cpx = 1.25$ .
- b) State the method for calculating the control limit when three parts are produced in short quantities with tolerance.  
( $10 \pm 0.5 \text{ mm}$ );  $12 \pm 0.06 \text{ mm}$ ;  $15 \pm 0.08 \text{ mm}$
- c) State the difference between EPC and SPC with examples.

4. [4 + 10 = 14]
- Two quantity characteristics follow Bivariate Normal Distribution. Let  $x_{ijk}$  be the  $i$ th observation of  $j$ th subgroup in the  $k$ th quantity characteristic. The mean vector and the variance covariance-matrix is estimated by using 20 subgroups of 10 samples each.

$$\bar{x} = \begin{bmatrix} 3.0 \\ 3.5 \end{bmatrix} \quad \bar{s} = \begin{bmatrix} 1.45 & 1.02 \\ 1.02 & 1.32 \end{bmatrix}$$

- a) Calculate the Phase I limit.
- b) Check whether the following sample mean vector are within control.
- i)  $[3.0, 3.7]$
  - ii)  $[2.5, 2.8]$

5.

[2 x 3 = 6]

State the control chart to be used

- a) The measurable quantity characteristic with  $Cpk = 1.8$  and any fluctuation of average is not acceptable.
- b) A packing station can fill 6 bottles at a time, with similar variation.
- c) A machine producing different components daily. The following data is collected.  
[Date \ Part No. \ No. Produced \ No. Defects]  
The machine can product five different parts, which are checked 100% for defects.