X/D/TY

Reg. No: 22BMM0008

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Vellore Institute of Technology

Final Assessment Test – April 2025

Course: BMEE212L - Quality Control and Improvement
Class NBR(s): 3794
Slot: B2+TB2
Time: Three Hours
Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

Answer ALL Questions
(10 X 10 = 100 Marks)

1. i) Customer tolerances for the height of a steering mechanism are 2.5±0.030m. For a product that just exceeds these limits, the cost to the customer for getting it fixed is $ 50. Ten products are randomly selected and yield the following heights (in meters): 2.48, 2.53, 2.52, 2.51, 2.54, 2.48, 2.49, 2.50, 2.55, and 2.47. Find the average loss per product item. [5]

   ii) Now the manufacturer is considering changing the production process to reduce the variability in the output. The additional cost for the new process is estimated to be $ 5.50/item. The annual production is 20,000 items. Eight items are randomly selected from the new process, yielding the following heights: 2.52, 2.51, 2.48, 2.52, 2.49, 2.50, 2.51, 2.54. Is the new process cost-efficient? If so, what is the annual savings? [5]

2. Construct a control chart for mean and the range for the following data on the basis of fuses, samples of 5 being taken every hour (each set of 5 has been arranged in ascending order of magnitude). Comment on whether the production seems to be under control.

   Assume the factor values for n = 5, $A_2 = 0.577$, $D_3 = 0$, $D_4 = 2.114$

Subgroup No.	Sample Observations (x)				
1	42	65	75	78	87
2	42	45	68	72	90
3	19	24	80	81	81
4	36	54	69	77	84
5	42	51	57	59	78
6	51	74	75	78	132
7	60	60	72	95	138
8	18	20	27	42	60
9	15	30	39	62	84
10	69	109	113	118	153
11	64	90	93	109	112
12	61	78	94	109	136

3. In the production of tyres for an automobile, the output of a given size was inspected every day before the tyres were given to finished goods stores. The number of defective tyres found on everyday inspections is summarised in the following table:

Sample Number	Number of Tyres Inspected	Number of Defective Tyres	Sample Number	Number of Tyres Inspected	Number of Defective Tyres
1	650	70	11	670	71
2	510	74	12	660	75
3	600	58	13	600	77
4	590	61	14	550	78
5	630	65	15	540	64
6	650	115	16	610	90
7	700	82	17	670	96
8	740	55	18	660	110
9	580	80	19	650	78
10	600	90	20	590	60

Calculate the average sample size and draw the appropriate p-control chart and comment on the state of the process.

4. Calculate the following for the given data:

USL = 10.050, LSL = 9.950, Estimated Mean ($\bar{x}$) = 9.999 and estimated standard deviation (σ) = 0.0165.

Capability indices Cp, Cpl, Cpu, and Cpk , as well as UNTL and LNTL. Interpret their meaning.

5. There are 3 divisions in a company that produces electric motors. One division produces the key components of electric motors such as stators, rotors, bearings, shafts and commutator, etc., second division provides assembling of these components. Quality control and testing is done in the third division. These 3 divisions are supported by one, common warehouse.

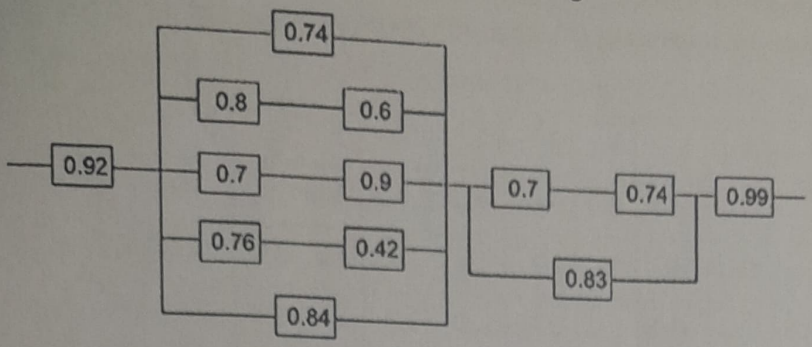
All materials, components, supplies, and tools go through the warehouse. The problem faced by the company is with delivering right material to particular working cell on time and this made the management to do something about it. Leaders from all divisions decided to run an improving project to stabilize current situation.

Defined project goal is: To improve current 1-2 hours late deliveries to be on-time, to start production.

With the goal defined, demonstrate how the DMAIC project can be launched? Give details of implementation of each phase in brief.

6. Differentiate Double, Multiple and Sequential Sampling Plans.

Reliability of individual component is shown in figure



What will be the reliatbilty of the system?

8. Explain the bathtub curve with neat sketch with respect to product life cycle.

9.a) The data in Table, represent individual observations on molecular weight taken hourly from a chemical process. The target value of percentage of calcium is 26.5 and the process standard deviation is thought to be about $\sigma = 0.089$. Set up a tabular cusum for the mean of this process. Design the cusum to quickly detect a shift of about 0.1σ in the process mean. Assume $k = 0.5618$, $K = k\sigma$ and $H = 5\sigma$.

Table. Average Percentage of Calcium for samples

Samples	Average Percentage of Calcium, x
1	25.5
2	26.0
3	26.6
4	26.8
5	27.5
6	25.9
7	27.0
8	25.4
9	26.4
10	26.3
11	26.9
12	27.8
13	26.2
14	26.8
15	26.6

OR

9.b) Set up an EWMA control chart with $\lambda = 0.25$ and $L = 3$, standard deviation is $\sigma = 1$, and the target value of the mean is $\mu_0 = 0$. The table given below shows the 'i' and 'x_i' values.

i	0	1	2	3	4	5	6	7	
x_i	-	1.0	-0.5	0.0	-0.8	-0.8	-1.2	1.5	
i	8	9	10	11	12	13	14	15	16
x_i	-0.6	1.0	-0.9	1.2	0.5	2.6	0.7	1.1	2.0

10.a) The following data shows the number of defects per lot in 15 successive lots of 5 radio sets each.

Lot Number	Number Inspected	Number of defects
1	5	3
2	5	2
3	5	1
4	5	2
5	5	6
6	5	1
7	5	3
8	5	2
9	5	0
10	5	0
11	5	0
12	5	0
13	5	0
14	5	1
15	5	2

i) Plot the u-chart based on the above data and conclude whether the process is statically controlled or not.

ii) If out of control happens, then revise the control limits for future production.

OR

As part of an overall quality improvement programme, a textile manufacturer decides to monitor the number of defects found in each inspected bolt (large bundle) of cloth. The data from 20 inspections are recorded in the table given below.

Bolt of cloth	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Number of defects	10	19	5	9	2	8	7	13	3	2
Bolt of cloth	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Number of defects	22	4	6	9	7	2	5	12	4	2

i) Calculate the control limits for this c-chart.

ii) Is the process statistically "In-control"? If not, calculate the revised control limits.

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