

**B.E. PRODUCTION ENGINEERING SECOND YEAR SECOND SEMESTER EXAM  
2019**

**INSPECTION AND PRODUCT CONTROL**

Time : Three hours

Full marks: 100

**Question Number 1 is compulsory and it should be answered in continuity. Answer another three questions from the rest.**

- 1.(a) State how the concepts of 'Inspection' and 'Product Control' are correlated. (4\*10)
- (b) Describe the Indian Standard for tolerance design for shaft and hole assembly (IS 919 –1963).
- (c) The radius of curvature of a convex surface is expressed as  $R = (L - d)^2/8d$ . The errors in measurement in  $L$  and  $d$  are observed to be 1% and 2% respectively. What is the total error in the measured  $R$  value? (Given  $L = 22.5$  mm and  $d = 6$  mm)
- (d) What is process variability? How it can be minimized?
- (e) State the advantages of having a rough surface. Differentiate between  $R_z$  and  $R_{3z}$  values.
- (f) Show how the Pareto analysis is helpful in increasing quality of manufactured products from a vertical drilling process.
- (g) How a Coordinate Measuring Machine can be employed to measure the diameter of a sphere and external taper angle?
- (h) State the applications computer vision system in product control.
- (i) What is a Coordinate Measuring Machine? Classify it according to its construction and control mechanism?
- (j) What is a bearing area curve? How it can be interpreted?
2. With neat diagrams, describe the working principle of the following measuring instruments:  
(a) Mechanical-electrical comparator, (b) NPL Interferometer, (c) Plug gauge and (d) Taylor-Hobson Talysurf. (4\*5)
- 3.(a) What is SWIPE concept as used in metrology ? (5)
- (b) What are the various modes of classifying measuring instruments? Describe each mode citing suitable examples. (15)
- 4.(a) Describe various types of acceptance sampling plan as used in statistical quality control. (10)
- (b) Distinguish between clearance fit, transition fit and interference fit. (6)
- (c) Based on applicability, differentiate between p chart and c chart. (4)
- 5.(a) For a given single sampling plan,  $N = 1000$ ,  $n = 25$ ,  $c = 2$  have been given. Now, find the values of probability of acceptance, AOQ and AOQL for the lots containing 1%, 2%, 3%, 5% and 10% defective items. (10)
- (b) A textile manufacturer initiates use of a c chart to monitor the number of imperfections found in the roll of cloth. Each roll is the same length, width, weave and fiber composition. A total of 191 imperfections were found in the last 25 rolls inspected. The four highest and lowest counts were:

Count of imperfections	
Highest	Lowest
22	4
19	4
14	5
12	5

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- (i) Calculate the control limits for this process.
- (ii) Is the process in control? If not, what aimed-at values of the control limits would you recommend for the next period? (10)

6. Control charts for X-bar and R are to be established at a work station at which a hole of a certain diameter is being drilled in a part. The analyst begins by estimating the magnitude of X-bar and R. He does this by taking 25 samples of size 5, measuring the diameter of the holes contained in each sample, and calculating the sample averages and ranges. These averages and ranges are given in the following table: (20)

Sample No.	Sample average (in mm)	Sample range (in mm)
1	3.5492	0.005
2	3.5546	0.005
3	3.5488	0.009
4	3.5464	0.008
5	3.5516	0.015
6	3.5496	0.006
7	3.5496	0.007
8	3.5544	0.010
9	3.5506	0.003
10	3.5470	0.005
11	3.5534	0.008
12	3.5526	0.012
13	3.5468	0.020
14	3.5480	0.004
15	3.5488	0.008
16	3.5506	0.007
17	3.5534	0.009
18	3.5496	0.010
19	3.5608	0.011
20	3.5540	0.023
21	3.5506	0.005
22	3.5498	0.011
23	3.5476	0.006
24	3.5546	0.010
25	3.5514	0.006

- (i) Now, compute the values of 3-sigma control limits for X-bar and R charts.
- (ii) Determine the value of population standard deviation.
- (iii) What is the natural tolerance of this process?
- (iv) The specifications for the dimension under consideration are 3.5000 ± 0.0076 mm. If the individual items are normally distributed, what percentage defective output can the firm expect if the process remains in control at the present form?
- (v) What is the RPI of this process?  
(Given for  $n = 5$ ,  $d_2 = 2.326$ ,  $A_2 = 0.58$ ,  $D_4 = 2.11$ ,  $D_3 = 0$ ,  $\Phi(-2.251) = 0.0122$  and  $\Phi(1.728) = 0.9581$ )