

Sub: Metrology & Quality Engg.

Model Answers

Date of Exam: 22/05/2017

Q. 1. a. Surface Roughness Symbols — 5M

- Draw the various surface roughness symbols with Roughness value R_a in μm & Roughness grade number like $N_1, N_2, N_3, \dots, N_{11}, N_{12}$.

Roughness value R_a i.e. 50, 25, 12.5, 6.3, $\dots$

Symbols like 


Symbols - $2\frac{1}{2} M$

Explanation - $2\frac{1}{2} M$

Q. 1. b. Floating Carriage Micrometer — 5M

- Suitable diagram of floating carriage micrometer — 2 M
- Explanation — 3 M

Q. 1. c. Quality Cost — 5M

- Quality cost associated with preventing, detecting & remediating product issues related to Quality. — 1M
- Quality cost 4 categories
- ① Prevention Cost

ii) Appraisal cost

iii) Internal Failure cost

iv) External failure cost

(2)

Explanation of all
4 categories — 1M each

Q. 1. d. Single sampling plans

5M

Suitable explanation — $2 \frac{1}{2} M$

↓
Double sampling plans

suitable explanation — $2 \frac{1}{2} M$

Q. 2. a. Types of gauges

10M

- General explanation — 1M
- plain Plug gauges with suitable 'Go' & 'No Go' gauge with neat sketch for holes.
- plain Ring gauges with suitable 'Go' & 'No Go' gauge with neat sketch for shaft
- Rib Type Snap gauges with 'Go' & 'No Go' ends with suitable diagram.
- plate Type Snap gauges with 'Go' & 'No Go' end with suitable diagram.
- feeler gauges — suitable diagram & explanation — 2M for each type

Q.2.b. Quality Control Concept —

10M (3)

Following 10/11 points must cover with explanation.

- ① process
- ② charts
- ③ Quality Control
- ④ Quality Assurance
- ⑤ Action plan to achieve quality (PDCA cycle)
- ⑥ Factors affecting quality (9M factors)
- ⑦ Organising quality
- ⑧ planning an Organisation
- ⑨ QC Manual
- ⑩ Implementation of Quality

Explanation of above all points

1 mark for each.

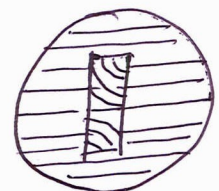
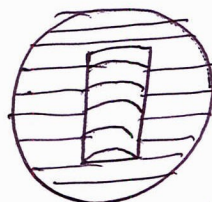
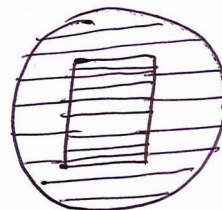
3.a. Optical Flatness Interferometer —

10M

- Construction
- Suitable diagram
- Working
- Various Fringes
- Advantages & disadvantages

2 mark for each

Q. 2.b



Various fringes

Q.3. b. Various Modern SQC Tools — [10M] (4)

- ① Pareto charts
- ② Histogram
- ③ Graph — Bar charts, Pie charts.
- ④ Scatter diagram
- ⑤ Cause & effect diagram
- ⑥ Check sheet
- ⑦ Control charts

Diagrams & Explanation of each tool
Minimum 5 must be explain — 2 Mark / each.

Q.4. a. Two wise method — [10M]

— Suitable 2 diagrams — 3M

— Equation —

$$E = T + P \quad \text{--- ⑤}$$

$$T = S - (R_1 - R_2) \quad \text{--- ⑤}$$

~~for angle~~

~~From~~ $BC = \frac{1}{2} \text{ pitch}$

$$PQ = \frac{P}{4} \cdot \cot \frac{\alpha}{2}$$

$$\therefore P = 2 \cdot AQ = 2 \left[\frac{P}{4} \cdot \cot \left(\frac{\alpha}{2} \right) - \frac{d}{2} \cdot \operatorname{cosec} \left(\frac{\alpha}{2} - 1 \right) \right]$$

$$\therefore P = \frac{P}{2} \cdot \cot \left(\frac{\alpha}{2} \right) - d \cdot \operatorname{cosec} \left(\frac{\alpha}{2} - 1 \right)$$

Equation & explanation — 7M

Q. 4. b. problem

10M (5)

$$\Sigma \bar{X} = 859.2$$

$$\Sigma R = 716$$

$$\bar{\bar{X}} = 71.6$$

$$\bar{R} = 59.67$$

— 2M

$$UCL_{\bar{X}} = 106.2$$

$$LCL_{\bar{X}} = 37.0$$

— 2M

Plot the $\bar{X}$ chart

— 2M

$$UCL_R = 125.9$$

$$LCL_R = 0$$

Plot the R chart

— 2M

From $\bar{X}$ chart, Subgroup No. 8 & 10
are out of control.

So, eliminating these 2 points.

$$\therefore \bar{X}_{\text{revised}} = 71.34$$

$$UCL_{\bar{X}_{\text{revised}}} = 105.94$$

$$LCL_{\bar{X}_{\text{revised}}} = 36.74$$

— 2M

Plot revised $\bar{X}$ chart

Q.5.a.

Terms related to surface roughness parameters.

10M

6

(i) Ra :- Arithmetical mean deviation from the mean line of profile (R_a) is defined as the avg. value of the ordinates ($y_1, y_2, \dots, y_n$) from mean line.

$$R_a = \frac{1}{n} \int_0^L |y| dx$$

$$R_a = \frac{\sum_{i=1}^n |y_i|}{n}$$

(ii) Ry :- the distance betⁿ 2 lines ||^r to the mean line touching the profile at highest points within the sampling length.

$$R_y = R_p + R_v$$

(iii) Rz :- the avg. distance betⁿ the 5 highest peaks & 5 deepest valleys.

$$R_z = \frac{(R_1 + R_3 + R_5 + R_7 + R_9) - (R_2 + R_4 + R_6 + R_8 + R_{10})}{5}$$

(iv) RMS value :- the square root of the mean of the squares of the ordinates of the surface measured from a mean line

$$\therefore \text{RMS} = \sqrt{\frac{h_1^2 + h_2^2 + h_3^2 + \dots + h_n^2}{n}}$$

Suitable diagram

2 Marks

Above 4 explanation

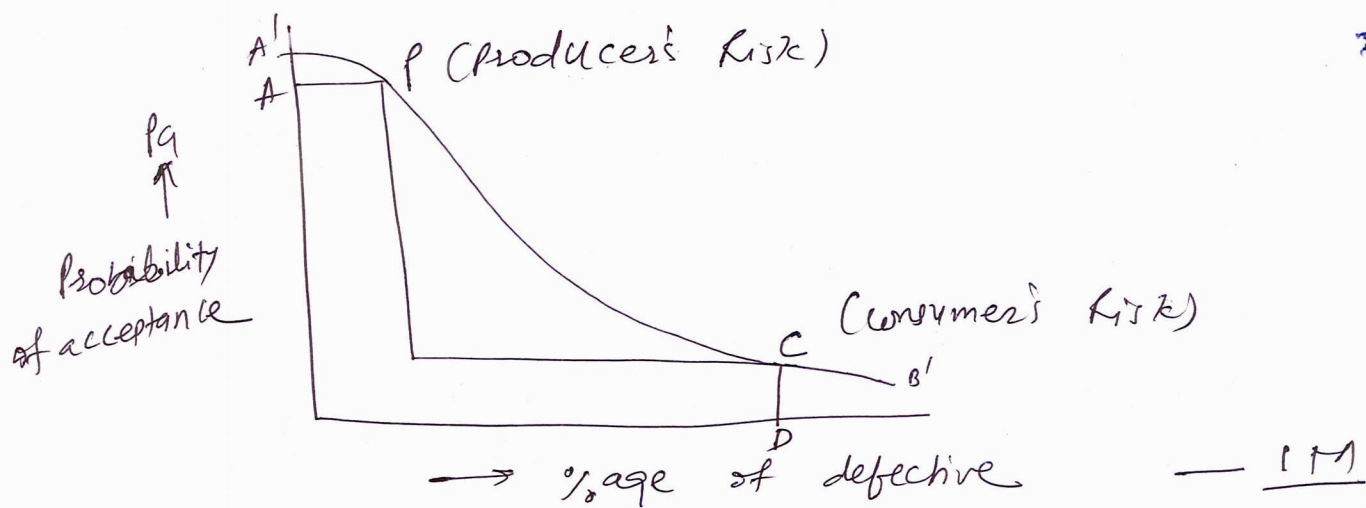
2 mark each.

Q. 5. b.

OC Curve

5M + 5M

= 10M



Explanation of OC curve curve — 4M

+

- i) AQL :- %age doesn't exceed a certain limit
- ii) Producer's Risk (α) = $\alpha = 0.05$ & $P_{0.95}$
- iii) Consumer's Risk (β) = $\beta = 0.01$ & $P_{0.10}$

Explanation of above 3 — 5M

Q. 6. a. 3-D co-ordinate measuring machine — 10M

- Construction
- Working
- Suitable diagrams
- Advantages & Disadvantages
- ~~Disadvantages~~ & applications

2 marks each

Q. 6. b. Indian standard IS 919 — SM (8)

- IS 919 for systems of limits & fits
- 20 grades of fundamental tolerance / std. tolerance
- 28 types of std. deviations.
- Capital letter A to ZC for holes
- small letter a to zc for shaft.
- 20 grades — IT0, IT01, IT1, ---- IT18
- $i_{(\text{microns})} = 0.45 \sqrt[3]{D} + 0.001 \cdot D$
where, D = Geometric mean

Q. 6. c. P-charts & np-charts — SM

- P charts & np-charts used for Yes/No type attribute data

— $p + q = 1$

If 'n' is very large then

$\sigma = \sqrt{npq}$ & mean = np.

$UCL = np + 3\sqrt{npq}$ & $LCL = np - 3\sqrt{npq}$.

This is known as np-chart where 'n' is same for all samples.

And when 'n' varies

$UCL = p + 3\sqrt{\frac{pq}{n}}$ & $LCL = p - 3\sqrt{\frac{pq}{n}}$.

This is known as p-chart.

According to statistics, limits of control charts

$UCL_p = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$ & $LCL_p = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$.

and

$UCL_{np} = n\bar{p} + 3\sqrt{n\bar{p}(1-\bar{p})}$ & $LCL_{np} = n\bar{p} - 3\sqrt{n\bar{p}(1-\bar{p})}$
— X — X — X — X —