الجامعة الوطنية
National University
Science & Technology للعلوم والتكنولوجيا
كلية عمان البحرية الدولية
International Maritime College Oman

ACADEMIC YEAR 2023 - 2024

Program	Year	Semester	Paper
PE	4	2	MAIN

MODULE NAME:	**STATISTICAL QUALITY CONTROL**		
MODULE CODE:	**TSQC**	**EXAM DATE:**	**13-05-2024**
INSTRUCTOR's NAME:	**Muhammad Javed**	**DURATION:**	**2 hrs.**

Questions to be answered on:	**Allowed tools:**	**Number of pages**
MS.Excel Workbook	Pen, Pencil & Calculator	(Incl. cover page)**:** **8**

Points of attention:

- For each question, the maximum earned points are mentioned between brackets at the end of each question.
- Write very clearly! Answers that are not readable are not marked and don't get points!
- Make sure your answers are written to the point.
- All answers should be written **in English.**
- Write all the answers in **blue or black pen only.**
- Use the **pencil** only for **diagrams & graphs.**
- Show all the calculation steps in the given space.
- When finished submit the question paper, together with the answer scripts and the signed cover page to the invigilator.
- Any cheating/copying may result in an instant failing of the examination.

		FINAL MARKS
STUDENT NAME:		**40**
STUDENT ID:		**10**

Number of answer scripts:……..…….. **Invigilator:**……..……..

Student's signature: …… **Time of receipt:**……..…..

Note: Solve the following questions on MS Excel Sheets. Save the Excel workbook with the filename format 'ID_FirstName' for example 005011-20 Sara

Question 1. **[10 Marks]**

A hard-bake process is used in conjunction with photolithography in semiconductor manufacturing. We wish to establish statistical control of the flow width of the resist in this process using x-bar and R charts. Twenty-five samples, each of size five wafers, have been taken when we think the process is in control. The interval of time between samples or subgroups is one hour. The flow width measurement data (in microns) is shown the following table.

Sample Number	1	2	3	4	5
1	1.3235	1.4128	1.6744	1.4573	1.6914
2	1.4314	1.3592	1.6075	1.4666	1.6109
3	1.4284	1.4871	1.4932	1.4324	1.5674
4	1.5028	1.6352	1.3841	1.2831	1.5507
5	1.5604	1.2735	1.5265	1.4363	1.6441
6	1.5955	1.5451	1.3574	1.3281	1.4198
7	1.6274	1.5064	1.8366	1.4177	1.5144
8	1.4190	1.4303	1.6637	1.6067	1.5519
9	1.3884	1.7277	1.5355	1.5176	1.3688
10	1.4039	1.6697	1.5089	1.4627	1.5220
11	1.4158	1.7667	1.4278	1.5928	1.4181
12	1.5821	1.3355	1.5777	1.3908	1.7559
13	1.2856	1.4106	1.4447	1.6398	1.1928
14	1.4951	1.4036	1.5893	1.6458	1.4969
15	1.3589	1.2863	1.5996	1.2497	1.5471
16	1.5747	1.5301	1.5171	1.1839	1.8662
17	1.3680	1.7269	1.3957	1.5014	1.4449
18	1.4163	1.3864	1.3057	1.6210	1.5573
19	1.5796	1.4185	1.6541	1.5116	1.7247
20	1.7106	1.4412	1.2361	1.3820	1.7601
21	1.4371	1.5051	1.3485	1.5670	1.4880
22	1.4738	1.5936	1.6583	1.4973	1.4720
23	1.5917	1.4333	1.5551	1.5295	1.6866
24	1.6399	1.5243	1.5705	1.5563	1.5530
25	1.5797	1.3663	1.6240	1.3732	1.6887

Answer the following question according to special causes.

a. Evaluate the chart for jumbling of data above or below the central line.
b. Determine trends on the chart if there are any.
c. Identify significant deviations in your chart if there are any.
d. Assess the chart for potential variation in the process if there is any.
e. Comment on the chart if more than 68% of data is in the 1-sigma?

Question 2. **[6 Marks]**

You have been asked to examine your company's travel reimbursement process. You have collected feedback about the process to identify the key issues that are creating the most variability. After collecting all the information, you count how many times specific issues were mentioned and create categories describing the issues. The results are shown in the table below.

Travel System Issues		
Issue Number	Process Issues Identified	Issue Count
1	System takes a long time to process requests	66
2	Paperwork was lost	2
3	Customer submitted duplicate requests	5
4	Initial request was submitted to the wrong person	49
5	Customer filled out form incorrectly	29
6	Customer did not provide accurate information	16
7	Customers slow or do not response to email	8
8	System timed out while processing request	12
9	Customer submitted incorrect form	6
10	Staff entered request incorrectly	7
	Total	200

a. Sort the issues based on their occurrence from highest to lowest. **(1 mark**)

b. Calculate the percentage of occurrence for each issue count relative to the total. (**1 mark)**

c. Sum up the relative frequencies as you move down the sorted list. **(1 mark**)

d. Construct the Pareto chart for better analysis of the issues. Insert a meaningful title to the chart and add all titles to axis correctly. **(2 Mark)**

e. Determine the issues that contribute significantly to the majority of the problems. **(1 mark**)

Question 3. **[6 Marks]**

A survey was taken on how much trust people place in the information they read on the Internet.

A = trust in all that they read,

M = trust in most of what they read,

H = trust in about one-half of what they read

S = trust in a small portion of what they read.

M	M	M	A	H	M	S	M	H	M
S	M	M	M	M	A	M	M	A	M
M	M	H	M	M	M	H	M	H	M
A	M	M	M	H	M	M	M	M	M

a. Construct a categorical frequency distribution for the data. **(3 Marks)**

b. Plot a pie-chart showing the percentage of the category. **(3 Marks)**

Question 4. **[6 Marks]**

A production manager at a tire manufacturing plant has inspected the number of defective products in twenty random samples with thirty observations each. Following are the number of defective tires found in each sample. Construct a p-chart for the defective product and analyse the defective product in the process.

Sample Number	Number of Defective Product	Number of Observations Sampled
1	4	30
2	3	30
3	2	30
4	3	30
5	2	30
6	4	30
7	4	30
8	3	30
9	2	30
10	3	30
11	4	30
12	3	30
13	3	30
14	2	30
15	2	30
16	3	30
17	5	30
18	4	30
19	2	30
20	2	30

Question 5. **[6 Marks]**

Three ice cream packing machines at a local ice cream Company are being evaluated for their capability. The following data are recorded,

Packing Machine	Standard Deviation
A	0.2
B	0.3
C	0.05

If specifications are set between 15.8 and 16.2 ounces, determine which of the machines are capable of producing within specifications.

Question 6. **[6 Marks]**

The average price of a personal computer (PC) is $949. If the computer prices are approximately normally distributed and standard deviation is $100,

a. What is the probability that a randomly selected PC costs at least $1200? (3 Marks)

b. The least expensive 20% of personal computers cost more than what amount? (3 Marks)

Information Sheet

1.	**P-chart**	$\text{UCL} = \bar{p} + z\sigma_p$ $\text{LCL} = \bar{p} - z\sigma_p$ where z = standard normal variable $\bar{p}$ = the sample proportion defective σ_p = the standard deviation of the average proportion defe $= \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$
2.	**X-bar chart**	Upper control limit (UCL) $= \bar{\bar{x}} + z\sigma_{\bar{x}}$ Lower control limit (LCL) $= \bar{\bar{x}} - z\sigma_{\bar{x}}$ $\sigma_{\bar{x}}$ = standard deviation of the distribution of sample means, computed as $\sigma/\sqrt{n}$ σ = population (process) standard deviation n = sample size (number of observations per sample)
3.	**R-Chart**	$\text{CL} = \bar{R}$ $\text{UCL} = D_4\,\bar{R}$ $\text{LCL} = D_3\,\bar{R}$

	Factors for X-bar chart	***Factor for R Chart***	
n	**A_2**	**D_3**	**D_4**
2	1.88	0	3.27
3	1.02	0	2.57
4	0.73	0	2.28
5	0.58	0	2.11
6	0.48	0	2.00
7	0.42	0.08	1.92
8	0.37	0.14	1.86
9	0.34	0.18	1.82
10	0.31	0.22	1.78
11	0.29	0.26	1.74
12	0.27	0.28	1.72
13	0.25	0.31	1.69
14	0.24	0.33	1.67
15	0.22	0.35	1.65
16	0.21	0.36	1.64
17	0.20	0.38	1.62
18	0.19	0.39	1.61
19	0.19	0.40	1.60
20	0.18	0.41	1.59
21	0.17	0.43	1.58
22	0.17	0.43	1.57
23	0.16	0.44	1.56
24	0.16	0.45	1.55
25	0.15	0.46	1.5