(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER

MAIN EXAMINATION

FOR THE DEGREE OFBACHELOR OF SCIENCE

COURSE CODE: STA 323

COURSE TITLE: QUALITY CONTROL AND ACCEPTANCE SAMPLING

DATE: 31/08/2022   **TIME**: 2:00 PM – 4:00 PM

INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

TIME: 2 Hours

QUESTION ONE (30 MARKS)

a) Briefly describe the important steps in constructing an $\bar{x} - chart$ **[6mks]**

b) Give the three main objectives of a control chart **[3mks]**

c) What are the main applications of a control chart **[4mks]**

d) Briefly compare the single sampling plan and the double sampling plan **[2mks]**

e) Explain briefly how you use control chart for fractional defective ($p - chart$) to determine whether the process is in control or not and hence show its warning and action limit on a p-chart. (take $\alpha = 0.002$ for action limit and $\alpha = 0.05$ for warning limit) **[7mks]**

f) If n is large and p is moderately small and we let $\lambda = np$, obtain C-chart for the number of defectives per unit. (Take $\alpha = 0.001$ for action limit and $\alpha = 0.025$ for warning limit **[8mks]**

QUESTION TWO (20 MARKS)

a) A company purchases large lots of items using a single sampling plan for which $n = 4$ and $c = 0$

   i. Find the probability of acceptance of a lot in terms of proportion of defective items it contains. **[2mks]**

   ii. What is the probability of
      1. A lot containing 50% defective being accepted **[2mks]**
      2. A lot containing 10% defective being rejected **[2mks]**

   iii. Estimate the AQL (θ) corresponding to a producers risk of 5% and LTPD (θ) corresponding to consumer's risk of 10% **[3mks]**

   iv. If rectification is agreed on, find the expression for the average outgoing quality (AOQ) in terms of the incoming quality. Find AOQ if $\theta = 0.05$ **[2mks]**

   v. Calculate the average total inspection (ATI) of lots of size 100 of quality $\theta = 0.05$ **[3mks]**

b) What do you understand by the moving average chart? Explain clearly how you can use it to determine whether a system is out of control or not. **[6mks]**

QUESTION THREE (20 MARKS)

a) suppose that the mean has shifted from μ to μ^* but σ^2 remain unchanged assuming normality (take $\alpha = 0.002$)

   i. Find the probability that the process is under control for the $\bar{x} - chart$ **[4mks]**

   ii. Show that the Average Run Length function of the $\bar{x} - chart$ is given by $\frac{1}{1-P(\theta)}$. Assuming that samples taken from the process are independent, where θ is the incoming quality **[3mks]**

b) Workout the O.C curve and the ARL function for S^2-chart with upper warning limits given by $P[\sum (x_i - \bar{x})^2 > k] \leq 0.05$ and action is taken only if two consecutive values of S^2 fall beyond the upper warning limit (take $n = 12$, $\theta = \frac{\sigma^{2*}}{\sigma}$ and $\theta \rightarrow (-\infty, 0, \infty)$ **[6mks]**

c) i. Construction a sequential sampling plan from a Bernoulli population with the following values $\theta_0 = 0.02, \theta_1 = 0.08, \alpha = 0.05$ and $\beta = 0.1$ **[4mks]**

   ii. An inspector tests 40 units from a large lot. Would he have come to a decision to reject or accept the lot if he found the 10th, 18th and 23rd unit defective? **[3mks]**

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QUESTION FOUR (20 MARKS)

a) Obtain a single sampling for the proportion of defectives, fixing the producer's risk $\alpha = 0.01$ at $\theta_1 = 0.05$ and the consumer's risk $\beta = 0.1$ at $\theta_2 = 0.1$ and hence give your conclusion **[6mks]**

b) The data below are samples means and sample ranges for ten consecutive samples, each sample consisting of five measurements of a continuous random variable x. Assuming x is normally distributed plot $\bar{x} - control\ chart$ and comment on the degree of control

Sample No.	1	2	3	4	5	6	7	8	9	10
Sample mean	136.2	137.4	136.6	139.8	136.0	135.0	136.8	142.0	137.4	136.2
Sample Range	8	6	7	6	8	7	6	19	6	7

$a_n = 0.4299\ for\ n = 5$ **[7mks]**

c) When do we use S^2- chart? Explain clearly how you can use it to determine whether a system is out of control or not. If $n = 4$ and $\alpha = 0.02$, obtain its upper action and warning limits. **[7mks]**

QUESTION FIVE (20 MARKS)

a) Explain each of the following concepts
   i. Average sampling numbers [ASN] **[2mks]**
   ii. Average outgoing quality [AOQ] **[2mks]**
   iii. Acceptance Quality Level [AQL] **[2mks]**
   iv. Lot tolerance percent defective (LTPD) **[2mks]**

b) A large batch of items to be inspected using a single sampling scheme specified by the following values $n = 40$, $c = 2$, $\theta_1 = 0.02$, and $\theta_2 = 0.1$
   i. Define the operating characteristic of this sampling plan **[1mk]**
   ii. Find the probability of accepting a lot of quality $\theta = 0.05$ **[2mks]**
   iii. Find the consumer's risk and the producer's risk **[3mks]**

c) A large batch of items is to be tested by using double sampling inspection scheme specified by the following numbers $n_1 = 20$, $n_2 = 40$, $c_1 = 0$, $c_2 = c_3 = 2$
   i. Obtain an expression for the probability of accepting a batch in which the true proportion of defective is θ **[3mks]**
   ii. Obtain the value of this probability when $\theta = 0.05$ and $\theta = 0.1$ **[3mks]**