MAASAI MARA UNIVERSITY

REGULAR UNIVERSITY EXAMINATIONS
2022/2023 ACADEMIC YEAR
THIRD YEAR SECOND SEMESTER

SCHOOL OF SCIENCE
BACHELOR OF SCIENCE IN APPLIED STATISTICS WITH COMPUTING

COURSE CODE: STA 3235-1
COURSE TITLE: QUALITATIVE CONTROL AND ACCEPTANCE SAMPLING

DATE: 20/4/2023 **TIME: 1430-1630 HRS**

INSTRUCTIONS TO CANDIDATES

1. Answer **ALL** questions from section A and any **TWO** from section B.
2. Use of sketch diagrams where necessary and brief illustrations are encouraged.
3. Read the instructions on the answer booklet keenly and adhere to them.

*This paper consists of **four** printed pages. Please turn over.*

SECTION A (20 MARKS)

QUESTION ONE (20 MARKS)

(a) A manufacturing process can be either under control or out of control. Define a process under control. **[2Mks]**

(b) What is a control chart in quality control theory? Explain the main three objectives of a control chart in controlling quality of manufactured products. **[4Mks]**

(c) In a factory where items are being produced, explain clearly how you use an x-chart to monitor a manufacturing process. If you fix α=5% for warning limits. Show clearly how you calculate the control limits. When would you take action on the process? **[5Mks]**

(d) Let N be the number of terms in a lot, n be the sample size and c be the number of defective items allowed in an acceptable lot. Describe the single acceptance sampling plan for such a lot. **[3Mks]**

(e) A process is normally distributed with mean of 1000 and standard deviation of 50. If a sample of size 5 was taken, determine the probability of detecting a change of the process mean to 1080 using a control chart at level of significance α=2%. **[3Mks]**

(f) Suppose in a single acceptance sampling inspection plan n=5, c=1, AQL=0.1 and RQL=0.3, where AQL is the average quality level. Find the risks involved and work out the average outgoing quality level (AOQL) function. **[3Mks]**

SECTION B (30 MARKS)

QUESTION TWO (15 MARKS)

a) Explain the following terms as they are used in sample acceptance

(i) Producer's and consumer's risks
(ii) Average outgoing quality (AOQ)
(iii) Acceptance quality level (AQL) **[5Mks]**

b) The following data are the $\bar{x}$ and R values for 10 subgroups each of size 5 of the depth of the anvil tip in the cap chamber of a cartridge case.

Subgroup	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
$\bar{x}$	9.3	10.6	8.7	9.1	9.7	9.3	10.2	9.7	9.2	10.14
R	1.5	3.0	2.0	2.0	2.0	1.5	3.0	2.5	2.5	4.5

Given A_n=0.4299 for n=5

(i) Calculate the upper and lower control limits for $\bar{x}$, take the level of significance α=0.01 at both ends for action and α=5% for warning. Find out the extent to which the process is under control. **[6Mks]**

(ii) Work out the oc-curve and ARL function for the $\bar{x}$-chart. Draw these curves. **[4Mks]**

QUESTION THREE (15 MARKS)

(a) Give a brief account of the theory of control charts with reference to $\bar{x}$-chart explaining clearly how to detect a process out of control. **[2Mks]**

(b) Suppose you wish to construct a control chart for the number of defects per unit, state clearly the statistical assumptions involved and give method of construction. **[3Mks]**

(c) Twelve samples each of size 100 were taken from a production of containers. The number of defective containers were as follows.

Sample number	1	2	3	4	5	6	7	8	9	10	11	12
No. of defectives	3	5	7	6	5	8	6	6	5	4	10	5

(i) From the previous experience it was known that the average fraction defective is p=5% provided the process of production is running properly. Construct a control chart for fraction defective (p-chart) choosing LCL=0, and taking level of significance of 0.1% at upper and work out ARL function. **[5Mks]**

(ii) Set up a control chart in (i) above when p is unknown. **[3Mks]**

(d) Describe the two causes of variation in quality of products produced by a manufacturing process. **[2Mks]**

QUESTION FOUR (15 MARKS)

(a) What do you understand by the terms "single acceptance sampling plan?" **[2Mks]**

(b) "The acceptance sampling plan by itself does not protect the consumer sufficiently well." Explain clearly outlining the rectification scheme. Suggest how the producer may minimize the cost of inspection. **[3Mks]**

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

(i) Find the probability of accepting a lot in terms of the proportion of defective items it contains. **[2Mks]**

(ii) What is the probability that a lot containing 50% defective items will be accepted? **[2Mks]**

(iii) What is the probability of a lot containing 10% defective items being rejected? **[2Mks]**

(d) Work out a single sampling inspection plan for the proportion of defectives (θ, say)) fixing producer's risk α=0.05 at $\theta=\theta_1$=0.01 and consumer's risk β=0.05 at $\theta=\theta_2$=0.04 using Poisson approximation. You may use the mathematical relation below. **[4Mks]**

$$c\int_n^{\infty} t^2 e^{-t}\,dt = \sum_{m=0}^{c} e^{-m}\frac{m^r}{r!}$$