

KABARAK

UNIVERSITY



EXAMINATIONS

2008/2009 ACADEMIC YEAR

**FOR THE DEGREE OF BACHELOR OF SCIENCE IN
ECONOMICS AND MATHEMATICS**

COURSE CODE: MATH 329

COURSE TITLE: *QUALITY CONTROL AND ACCEPTANCE*

STREAM: Y3S2

DAY: THURSDAY

TIME: 11.00-1.00 P.M.

DATE: 11/12/2008

INSTRUCTIONS:

- 1. Question ONE is compulsory.**
- 2. Attempt question ONE and any other TWO**

PLEASE TURN OVER

QUESTION ONE-COMPULSORY (30 marks)

- (a) Explain the meaning of the following terms as used in statistical quality control
- i. Assignable cause
 - ii. Average Run Length
 - iii. Lot Tolerance Percent Defective
 - iv. Average Outgoing Quality **(8 marks)**
- (b) Derive the expression for the 3σ control limits of a random sample x_1, \dots, x_n obtained from a random variable X, when $\delta(x_1, \dots, x_m)$ is a function of the sample and the random variable X is not from a normal distribution. **(3 marks)**
- (c) The two common charts used in manufacturing processes are \bar{x} -chart and R-charts. \bar{x} -charts detect undesirable variation in process average (μ), while R-charts detect undesirable variation in process variability (σ^2)
- i. When is the process considered to be under statistical control? **(1 mark)**
 - ii. Set up the 3σ control limits for the \bar{x} -chart when both the mean (μ) and variance (σ^2) of the population are unknown. Show clearly how to estimate the unknown population parameters. Assume normality holds. **(8 marks)**
- (d) Control charts for \bar{x} and R are maintained on a certain dimension of a manufactured part, measured in meters. The subgroup size is five. The value of \bar{x} and R are computed for each subgroup and recorded in a table as shown below.

Sample	1	2	3	4	5	6	7	8	9	10
Average (\bar{x}_i)	143.0	139.8	139.2	140.0	139.2	141.4	140.6	140.4	141.8	138.0
Range R_i	8	6	8	8	13	9	8	13	8	6

Estimate the mean (μ) and variance (σ^2) of the process assuming that it is under statistical control. Calculate the 3σ control limits for the \bar{x} and R-charts. Is the process under statistical control? **(6 marks)**
[$d_2 = 2.326$ $D_3 = 0$ $D_4 = 2.11$]

- (e) Define the following terms as used in acceptance sampling
- i. Acceptance Quality Level [AQL]
 - ii. Acceptance Outgoing Quality [AOQ] **(2 marks)**
- (f) The statistical quality control (SQC) department is a necessary component of any production process. State two major roles of this department in a production process. **(2 marks)**

QUESTION TWO (20 Marks)

- (a) When measurable characteristics are many it is uneconomical to maintain the \bar{x} charts and R-charts. Control charts for attributes are preferred which include the p-chart. The process is

considered to be under statistical control if all the samples taken from the production process have the same proportion P as the population. Let N and n be the lot size and sample size respectively.

- i. Set up the action and warning limits for p-chart for large sample size, taking $\alpha = 0.2\%$ and $\alpha = 5\%$ for the action and warning limits respectively. **(5 marks)**

- ii. Obtain the action and warning limits for a p-chart of the tube process where 100 units are inspected each day. The data for each day for tube type D is recorded in table below. **(5 marks)**

Day	1	2	3	4	5	6	7	8	9	10
Fraction defective	0.22	0.33	0.18	0.24	0.18	0.27	0.31	0.24	0.29	0.31

- (b) Determine the control limits for the number of defects per unit (c-chart) for large n and moderately small p at α level of significance? **(4 marks)**
- (c) A record was made on the number of defects found in a laboratory equipment each hour for 12 hours as shown in the following table

Hour	1	2	3	4	5	6	7	8	9	10	11	12
Number of defects	8	1	7	2	5	7	6	6	9	4	3	12

Determine the action and warning limits for the c-chart taking $\alpha = 0.2\%$ and $\alpha = 5\%$ for the action and warning limits respectively. Use normal approximation to the Poisson distribution. Is the process is under statistical control.

(6 marks)

QUESTION THREE (20 marks)

- (a) Describe the single sampling plan procedure. **(3 marks)**
- (b) A lot has the incoming quality θ and size N . A sample of size n is selected and we accept the lot if the number of defective items is less or equal to c items. Now derive the expression of operation characteristic. Further, obtain the expression of producer's risk and consumer's risk if they claim lot of quality θ_1 and θ_2 respectively. **(6 marks)**
- (c) Find the values of operating characteristic $p(\theta)$ when $\theta_2 = LTPD$ and $\theta_1 = AQL$ if the risk assumed by the producer and consumer are $\alpha = 0.05$ and $B = 0.10$ respectively. **(6 marks)**
- (d) Compute for the approximate values of the producer's and consumer's risks in a single sampling inspection plan with $[n = 6, \theta_1 = 0.2, \theta_2 = 0.2, N = \infty]$

(5 marks)

QUESTION FOUR (20 Marks)

- a) Name any two types of acceptance inspection procedures and describe them fully. **(2 marks)**
- b) Explain the following terms as used in acceptance sampling
- i. Producer's risk
 - ii. Operating Characteristics (OC) function
 - iii. Sampling by inspection **(6 marks)**
- c) A random sample of size n is selected from a normal population of mean (μ) and variance (σ^2) . Suppose the process mean (μ) has change by θ but variance unchanged. Derive the expression of the probability that the process is under control denoted by $p(\theta)$ for the \bar{x} chart, $\alpha = 0.2\%$ **(5 marks)**
- d) Sketch a graph of $p(\theta)$ against θ for part (c) above. **(3 marks)**
- e) A process is normally distributed with mean 100 and standard deviation of 5. Find probability of detecting a change of process mean to 108, using the \bar{x} -chart. ($n = 5$, $\alpha = 0.2\%$) **(4 marks)**

QUESTION FIVE (20 Marks)

- a) The following is a record of number of defects per unit in textile product **17,8,18,13,10,15,15,14,13,9,12,7,11,8,14,8,12,11,12,13** Construct a 3σ c -chart and comment on the state of the process. **(4 marks)**
- b) From a lot consisting of 2000 items a sample of size 2225 is taken. If it contains 14 or less defective then the lot is accepted, otherwise rejected.
- i. Plot the OC curve.
 - ii. Plot ASN curve.
 - iii. Hence obtain AOQL **(6 marks)**
- c) Draw the lines of rejection and acceptance. Label the regions on the graph. **(5 marks)**
- d) Determine a sequential sampling plan with the following parameters **(5 marks)**
 $\theta_0 = 0.04, \alpha = 0.02, \theta_1 = 0.2, \beta = 0.02$