



MACHAKOS UNIVERSITY

University Examinations for 2020/2021

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

SECOND YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

BACHELOR OF SCIENCE (CIVIL ENGINEERING)

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

ECU 201: ENGINEERING MATHEMATICS VI

DATE: 16/8/2021

TIME: 8:30 – 10:30 AM

INSTRUCTIONS: Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) State any three methods of data collection giving example for each method. (3 marks)
- b) List the two methods of classifying data according to class-intervals. (2 marks)
- c) The height of water pipes feeding and emptying tanks in a given town were considered in a research. The data below shows what the researcher came up with at the end of the research exercise. What are the frequencies of each class? (2 marks)

Height (in inches)	59.5-62.5	62.5-65.5	65.5-68.5	68.5-71.5	71.5-74.5
Cumulative Frequency	5	23	65	92	100

- d) Let X be $N(2, 25)$, compute $P(-8 < X < 1)$. (3 marks)
- e) Let X be the lifetime in years of a mechanical part. Assume that X has the cdf $F_X(x) = \begin{cases} 0 & x < 0 \\ 1 - e^{-x} & 0 \leq x \end{cases}$. What is the pdf of the distribution? (2 marks)

- f) Let X have the pdf $f(x) = \begin{cases} \frac{1}{2}(x+1) & -1 < x < 1 \\ 0 & \text{elsewhere} \end{cases}$
- Obtain the expectation of X . (2 marks)
 - Obtain the variance of X . (2 marks)
- g) Three coins are tossed once. What is the sample space, S ? (1 mark)
- h) If every 11th item is systematically sampled to produce a sample size of 75 items, approximately how large is the population? (1 mark)
- i) Differentiate between random sampling and non-random sampling. (2 marks)
- j) A die is thrown six times. What is the probability of obtaining at least one six? (In such problems, with coins, cards and dice, it is always assumed that all elementary outcomes are equally likely. (2 marks)
- k) Determine the sample size needed to construct a 90% confidence Interval to estimate the population mean when $\sigma = 75$ and the margin of error equals 12. (2 marks)
- l) Suppose that X has a Poisson distribution with $\mu = 2$.
- What is the pmf of X ? (2 marks)
 - Variance of this distribution? (1 mark)
 - Compute $P(1 \leq X)$ (3 marks)

QUESTION TWO (20 MARKS)

- a) Given below are the incomes produced by two machines A and B in millions of dollars for the 10 years from 2000 to 2009.

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Machine A	47	53	52	68	51	90	74	89	83	56
Machine B	32	47	57	43	53	63	76	64	66	56

- Find the correlation coefficient for these variables. (6 marks)
- Calculate the coefficient of determination. (1 mark)
- Find the equation of the regression line. (3 marks)
- Predict the value of Machine B for a year in which the income of machine A is \$ 60 million. (1 mark)

- b) Complete the following probability distribution, and calculate its mean and standard deviation. (6 marks)

x	P(x)
0	0.28
1	0.31
2	0.19
3	
4	0.07
5	0.03
6	0.01

- c) Is the following a valid probability distribution? Explain? (2 marks)

x	P(x)
0	0.2
1	0.3
2	1.5

- d) How does sampling error occur? (1 mark)

QUESTION THREE (20 MARKS)

- a) The following are scores of 50 pupils in a test

35	60	35	30	35	45	43	69	72	10
50	30	38	30	65	45	82	40	64	58
50	45	42	59	50	55	56	15	49	95
50	48	38	60	55	50	70	61	43	90
40	40	92	30	60	50	45	37	24	17

- i. Starting with the class 10-20 make a frequency table for this data (4 marks)
- ii. Draw the histogram and frequency polygon for this data (8 marks)
- b) Using the table below;

Class	0-10	10-20	20-30	30-40	40-50	50-60
Frequency	15	13	27	29	10	3

- i. Plot a 'less than' and 'more than' ogive curve (7 marks)
- ii. Estimate the medium from the graph (1 mark)

QUESTION FOUR (20 MARKS)

- a) Let X be the number of heads (successes) in $n = 7$ independent tosses of an unbiased

coin. The pmf of X is
$$p(x) = \begin{cases} \binom{7}{x} \left(\frac{1}{2}\right)^x \left(1 - \frac{1}{2}\right)^{7-x} & x = 0, 1, 2, \dots, 7 \\ 0 & \text{elsewhere} \end{cases}$$

Find:

- i. The moment generating function of X . (3 marks)
 - ii. The mean of X . (2 marks)
 - iii. The variance of X . (3 marks)
 - iv. $P(0 \leq X \leq 1)$ (2 marks)
 - v. $P(X = 5)$ (1 mark)
- b) Let X have the discontinuous cdf $F_X(x) = \begin{cases} 0 & x < 0 \\ x/2 & 0 \leq x < 1 \\ 1 & 1 \leq x \end{cases}$. Find:
- i. $P(-1 < X \leq 1/2)$ (2 marks)
 - ii. $P(X = 1)$ (1 mark)
- c) Suppose X has the pmf $p_X(x) = \begin{cases} cx^2 & x = 1, 2, \dots, 10 \\ 0 & \text{elsewhere} \end{cases}$, obtain the value of c . (2 marks)
- d) A paint manufacturer wants to determine the average drying time of a new interior wall paint. If for 30 tests areas of equal size, he obtained a mean drying time of 66.3 minutes and a standard deviation of 8.4 minutes. Construct a 99% confidence interval for the true mean. (4 marks)

QUESTION FIVE (20 MARKS)

- a) Explain any two random sampling techniques and any two non-random sampling techniques. (8 marks)
- b) An experiment was conducted to investigate the viability of equipment designed to measure the foreign of an audio source. Three independent measurements were recorded by this equipment, they were 4.1, 5.2 and 10.2. Estimate the variance with 99% confidence interval. (6 marks)
- c) Explain the properties of a good estimator. (6 marks)