



MACHAKOS UNIVERSITY

University Examinations 2018/2019
SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS, STATISTICS AND ACTUARIAL SCIENCE

SECOND YEAR SPECIAL/ SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS)

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

BACHELOR OF SCIENCE (CIVIL ENGINEERING)

ECU 201: ENGINEERING MATHEMATICS VI

DATE: 23/9/2019

TIME: 2:00 – 4:00 PM

INSTRUCTIONS

*Answer Question 1 and any other **two** questions*

1. (a) The following are examples of scales used in the measurement of statistical data. Classify them into the following measurement scales: nominal, ordinal, interval and ratio:
 - sex of staff as male and female;
 - marks scored by students in an examination;
 - daily temperature in degrees Celsius at the campus weather station;
 - grades scored by students in an examination;
 - age in years of patients who attended a clinic;
 - numbers on the back of players in a football match;
 - level of customer satisfaction as low, moderate or high;
 - longitude of a place on earth surface.

(4 marks)
- (b) (i) Using sketch diagrams, differentiate between positive correlation and negative correlation as used in Statistics.

(4 marks)

(ii) Differentiate between the terms type I error and type II error as used in statistical test of hypothesis.

(2 marks)
- (c) A mobile phone operator in Kenya uses 10 digits to assign phone numbers to its subscribers. However, the first two digits must be a 0 (zero) and 2 in that order, the third digit must be one of the following: 0, 1, 2 or 4, the fourth digit can be any, the fifth digit must not be a 0 (zero). Each of the last remaining 5 can be any digit. Determine the maximum number of subscribers which can be accommodated by this system.

(4 marks)
- (d) An architect claims that only 40% of the multi-storey buildings in residential areas in Nairobi were approved by a registered engineer. Assuming that this claim is true, determine the probability that among 12 such buildings randomly selected from residential areas in Nairobi, the following were approved by a registered engineer:

- (i) exactly 3 buildings;
- (ii) between 4 and 6 inclusive;
- (iii) at least 3 buildings. (8 marks)

(e) A box contain containing ball point pens has 8 blue pens and 4 red pens which are identical in all aspects except colour. A customer picked 2 pens at random from the box one at a time without replacement.

- (i) Present this information using a probability tree diagram. (4 marks)
- (ii) Determine the probability that all the pens picked are of the same colour. (2 marks)
- (iii) Determine the probability that all the pens picked are of different colours. (2 marks)

2. A survey in electricity consumption was carried out to find out the relationship between the income of a resident and the amount of electricity consumed. A random sample of 12 residents in Machakos County was taken. The data given below shows the monthly income in thousand Kenya shillings of the residents and the monthly electricity consumption in kilowatt hours.

Resident	A	B	C	D	E	F	G	H	J	K	L	M
Income	50	60	80	70	30	60	50	25	70	65	60	40
Electricity	150	120	180	140	100	175	160	130	185	155	160	115

- (i) Determine the least squares regression line of the electricity consumption on the income of the residents. (8 marks)
- (ii) Interpret the regression line obtained in (i) above. (4 marks)
- (iii) Using the regression line obtained in (i) above, estimate by calculation the amount of electricity consumed by a typical resident whose monthly income is Ksh 62,000. (2 marks)
- (iv) The Pearson's product moment co-efficient of correlation between income and electricity consumption was computed and found to be 0.7125029735. Compute the co-efficient of determination and interpret the results. (6 marks)

3. (a) A survey on ICT usage conducted by the Ministry of Communication among a random sample of 400 residents in the Municipality of Masaku yielded the following information about ownership of ICT gadgets:

- 206 residents have a desktop computer
- 186 residents have a laptop computer
- 168 residents have an i-pad
- 86 residents have a desktop computer and a laptop computer
- 80 residents have a desktop computer and an i-pad
- 68 residents have a laptop computer and an i-pad
- 42 residents do not have any of the three ICT gadgets

- (i) Present this information in a Venn diagram. (4 marks)
- (ii) Determine the number of residents in the study who have:
 - I. Laptop computer or i-pad but not desktop computer;
 - II. Laptop computer and i-pad but not desktop computer. (4 marks)

- (b) In a certain machine, the following actions are possible; the top can blow or not; the spiggots can go up or go down or remain still; and the cum-lever can wriggle or thump. The top blows with a probability of $\frac{1}{5}$. The spiggots go up with a probability of $\frac{1}{2}$ if the top blows; otherwise they go up or go down or remain still with equal probabilities. The cum-lever wriggles if the spiggots go up; otherwise it wriggles with a probability of $\frac{1}{6}$. The machine is robust and works provided the cum-lever is thumping.

- (i) Present this information in a probability tree diagram;
- (ii) Determine the probability that the machine works;
- (iii) Determine the probability that the top blows and the cum lever wriggles;
- (iv) If the machine breaks down, determine the probability that the top is blowing. (12 marks)

4. (a) A continuous random variable x is given by the function:

$$f(x) = \begin{cases} \frac{2}{9}(9x - x^2 - 18) & \text{for } 3 \leq x \leq 6. \\ 0 & \text{otherwise} \end{cases}$$

- (i) Show that the function $f(x)$ is a probability density function (p.d.f.). (3 marks)
- (ii) Determine the *mode* and the *mean* of the random variable x in the probability distribution. (7 marks)

- (b) The operational lifespan of a given brand of desktop computers has been found to be normally distributed with a mean of 4.8 years and a standard deviation of 1.6 years.

- (i) Determine the proportion of the desktop computers that will have a lifespan of between 3.8 years and 6.6 years; (4 marks)
- (ii) If these desktop computers have a warranty period of 2 years, determine the proportion of original sales which will require replacement through this warranty. (3 marks)
- (iii) If the manufacturer of these desktop computers wants only 5% of the computers to be replaced through this warranty, determine the warranty period that should be set to achieve this. (3 marks)

5. (a) A cement factory manufactures and packages cement in bags labelled with a weight of 50 kg. The Kenya Bureau of Standards took a random sample of 625 bags from the factory and found them to have a mean weight of 49.28 kg and a standard deviation of 8 kg. Determine each of the following confidence intervals for the population mean weight for the bags of cement.

- (i) 95% confidence interval;
- (ii) 99% confidence interval. (8 marks)

- (b) A housing survey conducted by a government agency in Masaku County found out that from a random sample of 1500 houses only 1215 houses were designed by a qualified architect. Following collapse of several buildings in the country, an intensive campaign by the agency was conducted for one year. After this another random sample of 1600 houses showed that only 1258 of them were designed by a qualified architect. It is required to evaluate whether this campaign was effective in increasing the proportion of houses designed by qualified architects. Test this at the 5% level of significance. (12 marks)