MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

SECOND YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN BUILDING AND CIVIL ENGINEERING
BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING
BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING

SUPPLEMENTARY EXAMINATION

ECU 201: ENGINEERING MATHEMATICS VI

DATE: **TIME:**

INSTRUCTIONS

1. *Answer **Question 1** and any other **two** questions*
2. *You need a Scientific Calculator and Statistical Tables for this paper.*

1. (a) Explain in words the meaning of each of the following measures as used in Statistics:

   (i) mean;

   (ii) median. (4 *marks*)

   (b) With the aid of sketch diagrams, differentiate between *positive skewness* and *negative skewness* as used in Statistics. (4 *marks*)

   (c) The data given below represents the frequency distribution of sizes of shoes purchased by 250 customers in the month of December 2016.

Shoe size	4	5	6	7	8	9	10	11
No. of customers	6	16	42	64	52	36	24	10

   Determine each of the following measures about the distribution the sizes:

   (i) Median;

   (ii) Mean;

   (iii) Standard deviation. (8 *marks*)

   (d) A researcher in building construction carried out a study on the relationship between the size of a residential house and the cost of construction. After collection and analysis of the relevant data, the coefficient of correlation between the two variables was found to be $r = 0.7864$

Compute the co-efficient of determination between the size of a house and the cost of construction, and hence interpret the result obtained. (4 *marks*)

(e) A mobile phone operator in Kenya uses 10 digits to assign phone numbers to its subscribers. However, the first two digits must be 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*)

(f) A box contains 8 blue pens and 4 black pens which are identical in all aspects except colour. A customer picks 2 pens at random from the box one at a time without replacement.

(i) Present this information using a probability tree diagram. (3 *marks*)

(ii) Hence, determine the probability that all the pens picked are of different colours. (3 *marks*)

2. The table below shows the age distribution of 500 employees working at the headquarters of a county government.

Age (years)	20 - 24	25 - 29	30 - 34	35 - 39	40 - 44	45 - 49	50 - 54	55 - 59	60 - 64
No. of employees	6	20	74	96	120	92	64	24	4

(a) Estimate by calculation each of the following measures about the distribution the marks:

(i) median;

(ii) mean;

(iii) standard deviation. (10 *marks*)

(b) Due to continuous burden of the huge wage bill, it is desired to reduce the present number of employees according to the following scheme:

- To retrain the first 20% from the lower age group.
- To retain the next 45% in their current workstations.
- To transfer the next 35% to the national government.

Determine the age limits of the employees to be retained in their current workstations. (5 *marks*)

(c) Suppose the employees whose age is between 42 and 52 years are to be transferred to the national government. Determine the proportion of the employees who will be transferred. (5 *marks*)

3. A researcher in the construction industry is interested in investigating the relationship between the distance covered in transporting a construction material from the factory to the point of sale and the retail price paid for the material by the consumer. A survey was carried out in which a random sample of 10 construction

materials was taken and the distance from the factory in kilometres and the price paid for the material in thousand Kenya shillings recorded as shown below.

Material	A	B	C	D	E	F	G	H	J	K
Distance	25	20	16	24	32	18	26	14	22	12
Price	32	26	24	28	35	30	36	12	18	14

(a) (i) Compute the Pearson's product moment co-efficient of correlation between the distance covered in transporting the material from the factory and the retail price. (9 *marks*)

(ii) Interpret the result obtained in (a) (i) above. (2 *marks*)

(b) (i) Determine the least squares regression line of the retail price of material on the distance from the factory. (4 *marks*)

(ii) Interpret the regression line obtained in (b) (i) above. (3 *marks*)

(iii) Using the regression line obtained in (b)(i) above, estimate by calculation the retail price for a typical construction material which is sold 20 kilometres away from the factory. (2 *marks*)

4. (a) Outline **three** properties of the normal probability distribution curve. (3 *marks*)

(b) A market survey was conducted on the popularity of the main television channels by rural residents in Kenya with respect to watching of news. A random sample of 520 rural residents was taken from some counties and the findings of TV viewing on a certain day were as follows:

- 276 residents watched Nation
- 260 residents watched KTN
- 228 residents watched Citizen
- 120 residents watched Nation and KTN
- 108 residents watched Nation and Citizen
- 104 residents watched KTN and Citizen
- 48 residents watched all the three TV channels

(i) Present this information in a Venn diagram. (5 *marks*)

(ii) Determine the number of residents in the study who watched:

I. exactly two of the TV channels;

II. Nation or KTN but not Citizen. (4 *marks*)

(c) Observation in a certain rural region shows that not all residents who are connected to the national electricity grid have TV sets and not all residents who have TV sets are connected to the national electricity grid. After conducting a survey among a random sample of 360 residents in the region, the findings were as follows:

- 144 residents who are connected to the national electricity grid have TV sets;
- 96 residents who are connected to the national electricity grid do not have TV sets;
- 48 residents who are not connected to the national electricity grid have TV sets;
- 72 residents who are not connected to the national electricity grid do not have TV sets.

(i) Present this information in a contingency table.

(ii) A resident who is connected to the national electricity grid is selected at random, determine the probability that he has a TV set.

(iii) A resident who has a TV set is selected at random, determine the probability that he is connected to the national electricity grid. (8 *marks*)

5. (a) An electrical engineer claims that only 40% of the residential buildings in Machakos Town had the electrical installation done by a registered electrician. Assuming that this claim is true, determine the probability that among 8 such residential buildings randomly selected from Machakos Town, the following had the electrical installation done by a registered electrician:

(i) between 3 and 5 buildings inclusive;

(ii) at least 3 buildings. (8 *marks*)

(b) The operational lifespan of a given brand of a laundry machine 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 these laundry machines that will have a lifespan of between 3.8 years and 6.6 years; (5 *marks*)

(ii) If these laundry machines 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 laundry machines wants only 5% of the machines to be replaced through this warranty, determine the warranty period that should be set to achieve this. (4 *marks*)

Statistical Formulae

Mean $\bar{x} = \frac{1}{n}\sum x_i = \frac{1}{n}\sum x_i f(x_i) = \frac{\sum x_i f(x_i)}{\sum f(x_i)}$

Median $= L + \frac{i}{f}\left(\frac{1}{2}n - F_b\right)$

k th percentile $P_k = L + \frac{i}{f}\left(\frac{k}{100}n - F_b\right)$

Mode $= L + i\left(\frac{f_2}{f_2 + f_1}\right)$

$s_x = \sqrt{\frac{1}{n}\sum x^2 f(x) - \bar{x}^2} = \sqrt{\frac{\sum x^2 f(x)}{\sum f(x)} - \left(\frac{\sum x f(x)}{\sum f(x)}\right)^2}$

Pearson's product moment correlation co-efficient r

$r_{xy} = \frac{\sum xy - n\,\bar{x}\,\bar{y}}{\sqrt{\sum x^2 - n\bar{x}^2} \times \sqrt{\sum y^2 - n\bar{y}^2}} = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{n\sum x^2 - (\sum x)^2} \times \sqrt{n\sum y^2 - (\sum y)^2}}$

Spearman's rank correlation co-efficient r_R

$r_R = 1 - \frac{6\sum(R_x - R_y)^2}{n(n^2-1)} = 1 - \frac{6\sum(R_y - R_x)^2}{n(n^2-1)} = 1 - \frac{6\sum d_i{}^2}{n(n^2-1)}$

Regression co-efficient b for regression line of y on x

$b = \frac{\sum xy - n\,\bar{x}\,\bar{y}}{\sum x^2 - n\bar{x}^2} = \frac{n\sum xy - (\sum x)(\sum y)}{n\sum x^2 - (\sum x)^2}$

Regression intercept a for the regression line of y on x

$a = \bar{y} - b\,\bar{x}$

Binomial probability density function $f(x) = \binom{n}{x} p^x q^{n-x}$ for x = 0, 1, 2, 3, ……., n

Mean of x μ = E[X] = np and var (x) = npq

Poisson probability density function $f(x) = \frac{\lambda^x e^{-\lambda}}{x!}$ for x = 0, 1, 2, 3, ……., n

Mean of x μ = E[X] = np = λ and Variance of x var (x) = λ

The standardised value z for a normal random variable x: z = $\frac{x - \mu}{\sigma}$