



MACHAKOS UNIVERSITY

University Examinations 2022/2023 Academic Year

DEPARTMENT OF MATHEMATICS AND STATISTICS

FIRST YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE TELECOMMUNICATION AND INFORMATION
TECHNOLOGY)

BACHELOR OF SCIENCE (MATHEMATICS AND COMPUTER SCIENCE)

BACHELOR OF SCIENCE (STATISTICS AND PROGRAMMING)

BACHELOR OF SCIENCE (ACTUARIAL SCIENCE)

BACHELOR OF SCIENCE (MATHEMATICS)

BACHELOR OF EDUCATION

BACHELOR OF ARTS

SMA 160: INTRODUCTION TO PROBABILITY AND STATISTICS

DATE: 17/04/2023

TIME: 8:30 – 10:30 AM

Instructions to the Candidate:

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

QUESTION ONE (COMPULSORY)(30 MARKS)

- (a) By use of sketch diagrams, differentiate between positive skewness and negative skewness as used in Statistics. (4 marks)

- (b) Given the data set

11, 12, 14, 16, 17, 18, 18, 19, 20, 21, 21, 22, 23, 23, 24, 25, 27, 28, 29, 30,
31, 32, 32, 33, 34, 37, 38, 39, 41, 42, 44, 45, 46, 48, 49, 51, 53, 54, 56 57.

Using an interval of 10, present this data using a stem and leaf plot: (4 marks)

- (c) The data given below represents the frequency distribution of the various shoe sizes purchased from a Bata shop by 250 customers during the first quarter of the year 2022.

Size of shoes	4	5	6	7	8	9	10	11
No. of customers	10	18	42	70	63	24	15	8

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

- (i) Median;
- (ii) Mean;
- (iii) Standard deviation. (8 marks)

- (d) A study was carried out on the relationship between salary earned and the house size occupied by employed residents in Masaku Town. A random sample of 12 residents was taken, and the data relating their monthly salary in thousand Kenya shillings and the house size in hundred square feet of floor space, was recorded as shown in the table below.

Resident	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
Salary	54	75	34	70	12	57	32	15	85	26	48	42
House size	10	12	07	15	06	12	10	09	15	08	15	12

- (i) Construct a scatter diagram to present this information. (5 marks)
 - (ii) Interpret the scatter diagram constructed in (i) above. (2 marks)
- (e) The table below shows the frequency distribution of the reaction time in seconds for 50 Kenyan athletes in a training session.

Reaction time	01 - 05	06 - 10	11 - 15	16 - 20	21 - 25	26 - 30	31 - 35	36 - 40
No of athletes	3	f_1	7	9	f_2	8	6	2

Given that the median reaction time was 21 seconds. Determine each of the following:

- (i) The observed frequencies f_1 and f_2 for the reaction time; (5 marks)
- (ii) The mean reaction time. (2 marks)

QUESTION TWO (20 MARKS)

An expert in personal finance carried out a study to investigate the relationship between the monthly salary and the shillings. The data is as shown in the table below.

Employee	A	B	C	D	E	F	G	H	J	K	L	M
Salary	48	78	35	72	88	60	40	72	56	45	84	48
Savings	12	18	15	12	20	12	09	10	14	11	15	08

- (a) Compute the *Pearson's product moment* co-efficient of correlation between the salary and the sacco savings. (6 marks)
- (b) (i) Determine the *least squares regression line* of the sacco savings on salary. (6 marks)
(ii) Interpret the regression line obtained in (b) (i) above. (4 marks)
- (c) Compute the *co-efficient of determination* between the monthly salary and the monthly sacco savings, and interpret the value obtained. (4 marks)

QUESTION THREE (20 MARKS)

- (a) Differentiate between the measures of *central tendency* and the measures of *deviation* as used in statistics. (4 marks)
- (b) The table below shows the distribution of weights in kilograms of 500 adult patients who attended an out-patient clinic at a given teaching hospital in a certain week.

Weight in kgs	40 - 50	50 - 60	60 - 70	70 - 80	80 - 90	90 - 100	100 - 110	110 - 120
No. of patients	12	38	96	136	118	76	20	4

- (i) Estimate by calculation the mean, the median and the standard deviation of the weight distribution of the patients. (7 marks)
- (ii) The hospital classifies adult patients as underweight, normal weight and overweight. Below 55 kg are under-weight, between 55 and 92 kg are normal weight, while above 92 kg are over-weight or obese. Determine the proportion of each weight category. (7 marks)
- (iii) An epidemiologist classifies over-weight or obesity in a society as the top 24% of the general population in terms of adult weight. Based on this classification, determine the minimum weight for obesity. (2 marks)

QUESTION FOUR (20 MARKS)

- (a) Explain the **four** measurement scales for statistical data as outlined by Stevens (1946) giving two examples in each case. (8 marks)
- (b) An electronic monitoring device comprising a sound recorder and a surveillance camera is powered by a solar electric system comprising; a solar panel, a solar battery and a voltage inverter. In the solar electric system, the following actions are possible; the panel may be charging the battery or not; the battery state of charge may be full or moderate or low; and the inverter may be on or off.

The panel charges the battery with a probability of $\frac{2}{5}$. If the panel is charging the battery, the battery state of charge is moderate with a probability of $\frac{1}{2}$, and either full or low with equal probabilities; otherwise the battery state of charge is never full, but is moderate with a probability of $\frac{2}{3}$. The inverter goes off if the battery state of charge is low; otherwise it remains on with a probability of $\frac{5}{6}$. The monitoring device works provided the inverter is on.

- (i) Present this information in a probability tree diagram;
- (ii) Determine the probability that the monitoring device works;
- (iii) Determine the probability that the monitoring device is not working and yet the battery state of charge is not low;
- (iv) If the inverter is off, determine the probability that the panel is charging the battery. (12 marks)

QUESTION FIVE (20 MARKS)

- (a) A study was carried out to evaluate whether there is a relationship in salaries between males and females among married couples in Kenya. A random sample of 12 couples was selected, and the monthly salary in thousand Kenya shillings was recorded as shown in the table below.

Couple	A	B	C	D	E	F	G	H	J	K	L	M
Male	35	26	33	32	64	50	40	75	42	34	24	22
Female	24	24	28	27	56	52	42	70	30	32	20	18

- (i) Compute the *Spearman's rank correlation* co-efficient between the male salary and the female salary. (6 marks)
- (ii) Interpret the results obtained in (i) above. (2 marks)
- (b) Following the increase in incidence of cancer in Kenya, a national hospital has launched an intense testing for cancer. The hospital uses a diagnostic kit which is known to have a small margin of error in testing. A random sample of 860 suspected cancer patients was tested at the hospital. The result from the diagnostic testing kit was as shown in the table below:

Actual Status	Test Result	
	Positive	Negative
Cancer	452	8
No cancer	10	390

Assuming a random selection of patients from the hospital, determine the probability that:

- (i) a patient who has cancer shows a positive test result. (3 marks)
- (ii) a patient who does not have cancer shows a negative test result. (3 marks)
- (iii) a patient is misclassified by the diagnostic test. (3 marks)
- (iv) a patient actually has cancer; given that he has already tested positive for cancer. (3 marks)