W1-2-60-1-6

JOMO KENYATTA UNIVERSITY

OF

AGRICULTURE AND TECHNOLOGY

UNIVERSITY EXAMINATIONS 2020/2021

THIRD YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN STATISTICS/BACHELOR OF SCIENCE IN ACTUARIAL SCIENCES/BACHELOR OF SCIENCE IN FINANCIAL ENGINEERING/ BACHELOR OF SCIENCE IN BIOSTATISTICS/ BACHELOR OF SCIENCE IN OPERATION RESEARCH / BACHELOR OF SCIENCE IN MATHEMATICS AND COMPUTER SCIENCE

STA 2301 TESTS OF HYPOTHESIS

DATE: AUGUST 2021 **TIME: 2 HOURS**

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS

QUESTION ONE (30MARKS)

a) Distinguish between statistical hypothesis and hypothesis testing as used in testing hypothesis (2 marks)

b) Define the most powerful and uniformly most powerful critical regions for testing.

$H_0 : \theta = \theta_0$ *against* $H_1 : \theta = \theta_1$ *where* θ_1 *and* θ_0 are specified values of the parameter θ. (3 marks)

c) Suppose that random variable X is randomly distributed with unknown mean, μ and variance 400. If a random sample of size 25 taken from X, find the power of test in testing $H_0 : \mu = 165$ *against* $H_1 : \mu = 162$ given the acceptance region is given by $\varpi = \{x : 161.08 \leq \overline{X} \leq 168.92\}$ (4 marks)

d) Given $X_1, X_2, \ldots, X_n$ be random sample from a population whose density is

$$f(x,0)=\begin{cases}\theta^x(1-\theta)^{1-x} & ,x=0,1\\ 0 & otherwise\end{cases}$$

Obtain the critical region for testing the hypothesis $H_0:\theta=\theta_0 \quad against \quad H_1:\theta>\theta_0 \quad where \quad \theta_0$ is a specified value (6 marks)

e) Suppose the two samples of sizes 6 and 7 respectively are randomly selected from two normally distributed populations with variances $\sigma_1^2 \quad and \quad \sigma_2^2$. Suppose we calculate S_1=4.2, S_2= 2.9. Test the hypothesis that $\sigma_1^2=\sigma_2^2$ against a two sided alternative at 5% level of significance. (2 marks)

f) Let $X_1, X_2, \ldots, X_n$ be the random sample of the size n from X which is distributed as $N(\mu,1)$. To test $H_0:\mu=\mu_0 \quad against \quad H_1:\mu=\mu_1$, we reject H_0 whenever $\overline{X}>C$. Find the value of C if n =25 and $\alpha=5\%$. (6 marks)

g) A machine fills milk bottles, the mean amount of milk in each bottle is supposed to be 32 with a standard deviation of 0.06. suppose the mean amount of milk is approximately normally distributed. To check if the machine is operating properly, 36 filled bottles will be chosen at random and the mean amount will be determined.

i. If an $\alpha=0.05$ test is used to decide whether the machine is working properly, what should the rejection criterion be? (2 marks)

ii. Find the power of the test if the true mean takes on the following values: 31.97, 31.99, 32, 32.01, and 32.03. (3 marks)

iii. Find the probability of a type II error when the true mean is 32.03. (2 mark)

QUESTION TWO (20MARKS)

a) Let $X_1, X_2, \ldots, X_m$ be m independent observations on the random variable X, distributed normally with mean μ_1 and variance σ^2. Let $Y_1, Y_2, \ldots, Y_n$ be another random sample of size n from Y, distributed normally with mean μ_2 and variance σ^2. Assuming X and Y are independent random variables, derive a test statistic for testing the hypothesis

$$H_0:\mu_1=\mu_2 \quad against \quad H_1:\mu_1\neq\mu_2$$

Take the level of significance to be the $\alpha=5\%$ (9 marks)

b) Two analysts took 10 repeated readings on the hardness of the city water. The means and variances of the readings were:

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$\mu_1 = 0.35 \quad \mu_2 = 0.53$

$\delta_1 = 0.23 \quad \delta_2 = 0.24$

	Analyst I	Analyst II
Sample mean	0.35	0.53
Sample variance	0.23	0.24

$\bar{x} = 0.35$
$\bar{y} = 0.53$
$\delta_1 = 0.23$
$\delta_2 = 0.24$

assuming normal populations with common variance, test whether these data present sufficient evidence to indicate a difference in mean hardness of the city water. Use 5% level of significance. (3 marks)

c) A study was conducted of the effects of a special class designed to aid students with verbal skills. Each child was given a verbal skills test twice, both before and after completing a 4-week period in the class. Let Y = score on exam at time 2 - score on exam at time 1. Hence, if the population mean μ for Y is equal to 0, the class has no effect, on the average. For the four children in the study, the observed values of Y are 8-5=3, 10-3=7, 5-2=3, and 7-4=3 (e.g. for the first child, the scores were 5 on exam 1 and 8 on exam 2, so Y = 8-5=3). It is planned to test the null hypothesis of no effect against the alternative hypothesis that the effect is positive, based on the following results from a computer software package:

Variable	No. of cases	Mean	Std.dev	Std.Error
Y	4	4	2.000	1.000

i. Set up the null and alternative hypotheses (2 marks)
ii. Calculate the test statistic, and indicate whether the P-value was below 0.05, based on using the appropriate table (2 marks)
iii. Make a decision, using P_value of = .05. Interpret. (2 marks)
iv. If the decision in (iii) is actually (unknown to us) incorrect, what type of error has been made? What could you do to reduce the chance of that type of error? (2 marks)

QUESTION THREE (20MARKS)

a) Consider a simple regression model

$$y_i = \alpha + \beta x_i + e_i ,$$

Where α, β are constants and $e_i \sim N(0, \sigma^2)$

Derive a test statistic for testing the hypothesis $H_0 : \beta = 0$ *against* $H_1 : \beta \neq 0$. Take the significance level to be $\alpha = 5\%$ (9 marks)

b) Test the hypothesis $H_0 : \beta = 0$ *against* $H_1 : \beta \neq 0$ at $\alpha = 5\%$ if observations are (1, 2), (3, 2), (2,10), (8, 6) (3 marks)

c) A meteorologist has measured the amount of rain in six cities for six months. She wants to know if there are different amounts of rain in the six cities. The table below shows the raw data. The distribution of the rainfall is unknown.

$T = n\frac{(n+1)}{2}$

CITY 1	CITY 2	CITY 3	CITY 4	CITY 5	CITY 6
68	100	97	65	77	112
78	60	87	55	67	110
98	68	56	75	87	73
98	65	87	66	78	108
88	56	97	65	79	78
87	79	90	50	97	64

i. Are there significant differences in the amounts of rain among the six cities? (4 marks)

ii. Write a Program in R that could carry the test in (i) above (4 marks)

QUESTION FOUR (20MARKS)

a) Let $X_1, X_2, \ldots, X_n$ be a random sample of size n from a normal population with unknown mean μ and unknown variance σ^2. Obtain the likelihood ratio critical region for testing the hypothesis

$H_0 : \sigma^2 = \sigma_O^2$ *against* $H_1 : \sigma^2 \neq \sigma_0^2$, where σ_0^2 is specified. (9 marks)

b) A random sample of n = 7 observations from a normal population produced the following measurements 4,0,6,3,3,5,7. Do the data provide sufficient evidence to indicate that $\sigma^2 < 1$? Take α to be 5%. (3 marks)

c) A forensic pathologist wants to know whether there is a difference between the rate of cooling of freshly killed bodies and those which reheated, to determine whether you can detect an attempt to mislead a Coroner about the time of death. He tested several mice for their cooling constant both when the mouse was originally killed and when after the mouse was reheated. The results are presented in the table below.

Freshly Killed	400	395	450	402	345	490	450	432	367	487		
Reheated	378	321	387	400	389	402	354	389	355	376	410	360

The distribution of the differences is unknown.

i. Is there any difference in the cooling constants between freshly killed and reheated corpses? (5 marks)

ii. Write a program in R that could carry out the test in (c_i) above (3 marks)

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OF
AGRICULTURE AND TECHNOLOGY
UNIVERSITY EXAMINATIONS 2020/2021
THIRD YEAR SECOND SEMESTER EXAMINATIONS FOR THE DEGREE OF
BACHELOR OF SCIENCE IN OPERATION RESEARCH

STA 2353: QUEUING THEORY II

DATE: AUGUST 2021 TIME: 2 HOURS

INSTRUCTIONS: Attempt section A and any other two questions in section B.

SECTION A (30 MARKS)

QUESTIONS ONE (30 MARKS)

(a) State and prove the Markovian property of interarrival times. [4 marks]

(b) In a railway marshaling yard, goods trains arrive at a rate of 30 trains per day. Assuming that the inter-arrival time follows an exponential distribution and the service time (the time taken to hump a train) distribution is also exponential with an average of 36 minutes. Calculate:

(i) Expected queue size (line length) [2 marks]

(ii) Probability that the queue size exceeds 10 [2 marks]

(iii) If the input of trains increases to an average of 33 per day, what will be the change in (i) and (ii) [3 marks]

(c) For the $M/M/c/K$ queue, calculate L, Lq, W, Wq, pk. $Pr(N \geq k)$, and $Pr(T_q \geq t)$ for $\lambda = 2/min$, $\mu = 45/h$, c = 2, K = 6, $k = 2$ and 4, and $t = 0.01$ and 0.02 h. [5 marks]

(d) A small mail order business has one telephone line and a facility for call waiting for two additional customers. Orders arrive at the rate of 1 per minute and each order requires 2 minutes and 30 seconds to take down the particulars. Model this system as an M/M/1/3 queue and answer the following questions.

(i) Find is the expected number of calls waiting in the queue and the mean wait in queue [4 marks]

(ii) Find the probability that the call has to wait for more than 1.5 minute before getting served? [3 marks]

(iii) Because of the excessive waiting time of customers, the business decides to use two telephone lines instead of one, keeping the same total capacity for the number in the system, namely 3. What improvements result in the performance measures considered under (a) and (b)? [3 marks]

(iv) Find the impact of increasing the capacity to four customers in the system? Now we have an M/M/2/4 queue. [4 marks]

QUESTIONS TWO (20 MARKS)

(a) A mechanic repairs four machines. The mean time between service requirements is 5 hours for each machine and forms an exponential distribution. The mean repair time is one hour and also follows the same distribution pattern. Machine downtime costs ksh. 25 per hour and the mechanic costs ksh. 55 per day. Determine the following:

(i) Probability that the service facility will be idle [3 marks]

(ii) Probability of various number of machines (0 through 4) to be out of order and being repaired [2 marks]

(iii) Expected number of machines waiting to be repaired, and being repaired [3 marks]

(iv) Expected downtime cost per day [2 marks]

(v) Would it be economical to engage two mechanics, each repairing only two machines? [3 marks]

(b) Given that cumulative distribution function (CDF) $W_q(t)$ of a steady state of queue wait for $M/M/1$ queue model is defined by:

$$W_q(t) = 1 - \rho e^{-\mu(1-\rho)t},\ t \geq 0$$

Obtain Laplace-Stieljes transform [7 marks]

QUESTIONS THREE (20 MARKS)

(a) Arrivals at telephone booth are considered to be Poisson with an average time of 10 minutes between one arrival and the next. The length of phone calls is assumed to be distributed exponentially, with a mean of 3 minutes.

(i) Find is the probability that a person arriving at the booth will have to wait? [2 marks]

(ii) The telephone department will install a second booth when convinced that an arrival would expect waiting for at least 3 minutes for a phone call. By how much should the flow of arrivals increase in order to justify a second booth? [4 marks]

(iii) Find the average length of the queue that forms from time to time? [3 marks]

(iv) Find the probability that it will take a customer more than 10 minutes altogether to wait for the phone and complete his call [3 marks]

(b) For the queuing model $\{(M/M/1) : (N/FCFS)\}$, the steady-state probability P_n is given by:

$$P_n = \frac{(1-p)}{1-p^{N+1}}p^n \ ; 0 \leq n \leq N,$$

(i) Obtain expressions for P_0 [4 marks]

(ii) Obtain expected number of customers in the queue and system separately [4 marks]

QUESTIONS FOUR (20 MARKS)

(a) Cars arrive at a single station carwash at the rate of 15 per hour. The automatic carwash is set to take up exactly 3 minutes. Assuming the arrivals are in a Poisson process determine

(i) The expected number of cars waiting for wash at any time [4 marks]

(ii) The expected waiting time of each automobile. [4 marks]

(b) The owner of the car-wash wants to reduce the waiting time by shortening the amount of time taken for each wash. However, a quick survey of his customers reveals that a third of his customers would like to have a longer wash. To satisfy their need he sets up two wash times, 5 and 2.5 minutes for the two groups. Both these groups will pass through the same station. With this change has he improved the situation or worsened it? Determine the expected number of cars waiting and the mean waiting time in the long run [6 marks]

(c) City Hospital's eye clinic offers free vision tests every Wednesday evening. There are three ophthalmologists on duty. A test takes, on average, 20 min, and the actual time is found to be approximately exponentially distributed around this average. Clients arrive according to a Poisson process with a mean of 6/h, and patients are taken on a first-come, first-served basis. The hospital planners are interested in knowing (1) the average number of people waiting; (2) the average amount of time a patient spends at the clinic; and (3) the average percentage idle time of each of the doctors. Thus calculate L_q, W and the percentage idle time of a server. [6 marks]

QUESTIONS FIVE (20 MARKS)

$P_0 = 1/2$ $P_1 = 1/3$ 1/6.

(a) A super market has two sales girls at the sales counters. If the service time for each customer is exponential with a mean of 4 minutes, and if the people arrive in a Poisson fashion at the rate of 10 an hour, then calculate the:

(i) probability that a customer has to wait for being served [3 marks]

(ii) expected percentage of idle time for each sales girl [2 marks]

(iii) if a customer has to wait, what is the expected length of his waiting time [3 marks]

1/6 1/9 1/6

(b) Derive the difference equations for the queuing model $(M/M/1):(\infty/FCFS)$. [2 marks]

(c) In a single server, Poisson arrival and exponential service time queuing system show that the probability P_n of n customers in steady-state satisfies the following equations: [5 marks]

$$\begin{aligned}
\lambda p_0 &= \mu p_1 && ;n=0 \\
(\lambda+\mu)p_1 &= \mu p_2 && ;n=1 \\
(\lambda+\mu)p_1 &= \mu p_{n+1} + \lambda p_{n-1} && ;n \geq 2
\end{aligned}$$

(d) At one man barber shop, customers arrive at a mean rate of 4 per hour. The customers are served at a mean rate of 5 per hour. The owner feels that service times have some unspecified positive skewed unimodal two-tailed distribution with a standard deviation of $\delta = 0.05$ hour (3 minutes).

(i) Determine the queuing characteristics for barber shop. [3 marks]

(ii) How much would the assumption of exponential service times distort these values and explain your answer [2 marks]

$L_q = \frac{1}{(S-1)!}(\lambda/\mu)^S \frac{\lambda\mu}{(S\mu-\lambda)^2}$

$L_s = L_q + \lambda/\mu$.

$W_s = W_q + 1/\mu$

$P(n \geq s) = \sum_{n=s}^{\infty} P_n = \sum \frac{1}{s!\,S^{n-1}} \lambda/\mu$

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JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

UNIVERSITY EXAMINATIONS 2020/2021

THIRD YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN OPERATIONS RESEARCH

STA 2352: DYNAMICAL SYSTEMS I

DATE: SEPTEMBER 2021 | TIME: 2 HOURS

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

Question One (Compulsory – 30 Marks)

(a) Define the following terms

i) Over-determined equations [1 Mark]

ii) Autonomous system [1 Mark]

(b) Determine the eigenvalues of $A = \begin{pmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{pmatrix}$ and hence find the eigenvector associated with the largest eigenvalue. [6 Marks]

(c) Solve the following system using Cramer's rule. [5 Marks]

$$\begin{aligned} 2x + 3y - z &= 1 \\ 4x + y - 3z &= 11 \\ 3x - 2y + 5z &= 21 \end{aligned}$$

(d) Two grocery stores in town compete for the same customers. Although a few of each stores' customers are loyal, most of them shop in both stores. After conducting a survey, the management of one of the stores has determined that 25% of the people who shop at store A this week will return to store A for their next weekly shopping while 75% will go to store B. At store B, 60% of the people will return to store B while 40% of the people will go to store A.

i) Find the transition matrix P for this problem. [2 Marks]

ii) If 4000 people shop at store A and 6000 people shop at store B this week, how many people will shop at each store next week but one? [3 Marks]

(e) Find the general solution of the homogeneous linear system given by [6 Marks]

$$\frac{d\vec{X}}{dt} = \begin{pmatrix} 5 & 4 \\ 1 & 2 \end{pmatrix} \vec{X}, \quad \text{where } \vec{X} = \begin{pmatrix} x \\ y \end{pmatrix}$$

+ - +

(f) Using Cayley-Hamilton theorem, find A^6 given $A = \begin{pmatrix} 3 & -2 \\ 1 & -1 \end{pmatrix}$ [6 Marks]

Question Two (20 Marks)

(a) A company produces computer chips, resistors and transistors. Each computer chip requires 2 units of copper, 2 units of zinc and 1 unit of glass. Each resistor requires 1 unit of copper, 3 units of zinc and 2 units of glass. Each transistor requires 3 units of copper, 2 units of zinc and 2 units of glass. Use **Gauss elimination method** to find the number of computer chips, resistors and transistors that can be produced using 85 units of copper, 105 units of zinc and 70 units of glass. [8 Marks]

(b) Find the solution of the nonhomogeneous linear system given by

$$\frac{d\vec{X}}{dt} = \begin{pmatrix} 1 & 1 \\ 0 & -1 \end{pmatrix} \vec{X} + \begin{pmatrix} t \\ 1 \end{pmatrix}, \quad \text{where } \vec{X} = \begin{bmatrix} x(t) \\ y(t) \end{bmatrix}$$

9.5 20 15 5

subject to the initial conditions $x(0) = 1$, $y(0) = 0$. [12 Marks]

Question Three (20 Marks)

(a) Apply LU decomposition to solve for x, y and z given the system below. [10 Marks]

$$\begin{array}{rcrcrcr} 2x & + & 3y & - & z & = & 2 \\ x & + & 4y & - & 2z & = & -2 \\ 4x & - & y & + & z & = & 1 \end{array}$$

(b) City A has two suburbs namely; B and C. Over the past several years, the city has experienced a population shift from the city to the suburbs in the following manner:

- ☐ Of the people living in the city, 7% migrate from A to B, 8% migrate from A to C, and 85% remain in A.
- ☐ Of the people living in suburb B, 1% migrate from B to A, 3% migrate from B to C, and 96% remain in B.
- ☐ Of the people living in suburb C, 1% migrate from C to A, 2% migrate from C to B, and 97% remain in C.

In the year 2000, the city had a population of 120000 people, suburb B had a population of 80000 people, while suburb C had a population of 50000 people. Assuming that the population in the area remains constant at 250000 people. How many people were in each of the three states in 2005? [10 Marks]

120,000
80000
50,000

Question Four (20 Marks)

(a) Find the equilibria of the two dimensional nonlinear autonomous system below and discuss their stability [12 Marks]

$$\begin{aligned} \frac{dx}{dt} &= x(y-1) \\ \frac{dy}{dt} &= 4 - x^2 - y^2 \end{aligned}$$

40%

(b) A population of 150000 consumers make the following purchases during a particular week: 35000 consumers purchase brand A, 50000 consumers purchase brand B, and 65000 consumers purchase neither brand. From a market study it is estimated that of those who purchase brand A, 80% will purchase it again next week, 15% will purchase brand B next week while 5% will purchase neither brand next week. Of those who purchase brand B, 85% will purchase it again next week, 12% will purchase brand A next week while 3% will purchase neither brand next week. Of those who purchase neither brand, 20% will purchase brand A next week, 15% will purchase brand B next week while 65% will purchase neither brand next week. If the purchasing power continues, will the market stabilize? What will be the stable distribution? [8 Marks]

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JOMO KENYATTA UNIVERSITY

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FOURTH YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN STATISTICS , BACHELOR OF SCIENCE IN BIOSTATISTICS AND BACHELOR OF SCIENCE IN MATHEMATICS AND COMPUTER SCIENCE

STA2308/STA 2208/SMA2430: DESIGN AND ANALYSIS OF EXPERIMENT I

AUGUST 2021 **TIME: 2 HOURS**

Instructions: Answer question one and any other two questions

QUESTION ONE (30 MARKS)

a) What is a designed experiment? **(2 marks)**

b) What is the result of applying experimental design technique early in process development? **(4 marks)**

c) Define and explain a factorial design of experiment. **(3 marks)**

d) Define and explain a balanced complete block design with parameters v, b, r, k, and z.

BCBD v, b, r, k.

When is a balanced complete block design symmetric? **(7 marks)**

e) Describe the fixed effects model and the random effects model for the completely randomized design. **(6 marks)**

CRD

f) Three processes A, B and C are tested to see whether their input are equivalent. The following observations of the out puts are made.

A:	10	12	13	11	10	14	15	13
B:	9	11	10	12	13			
C:	11	10	15	14	12	13		

Carry out the analysis of variance and state your conclusions using $\alpha = 1\%$ level of significance.

(8 marks) ✓

I know my work

CRD LSD RBD

BIBD

QUESTION TWO (20 MARKS)

RBD

a) An experiment was carried out on wheat with three treatments in four randomized blocks. The plan and yield per plot in kilograms are given below.

Block IA:8, C:12, B:10 Block II C:10, B:8, A:8

Block II A:6, B:9, C:10 Block IV B:10, A:8, C:9

Analyze the data and state conclusions using $\alpha = 5\%$ level of significance. **(14 marks)**

b) Explain how you would analyze data in which one observation is missing. **(6 marks)**

QUESTION THREE (20 MARKS)

a) Consider the Latin square design.

i) Write down the linear additive model for the design

ii) Write down the ANOVA table for the design

iii) When is the Latin square design better than the Completely Randomized Design? and when is it more useful than the Randomized Block Design?

(10 marks)

b) In an experiment carried out to determine the effect of nitrogen (N), phosphorus (P) and potassium(K) on potato yields ,with two levels of each fertilizer and three replicates, the treatment totals were given as follows:

I	n	p	k	np	nk	pk	npk
94	108	97	98	114	123	111	124

i) Calculate the main effects.

ii) Calculate the interaction effects

iii) Which effects are significant on the potato yield? (Use $\alpha = 0.05$ level of significance)

(10 marks)

QUESTION FOUR (20 MARKS)

Johnson and Leone (Statistics and Experimental Design in Engineering and Physical Sciences, Wiley 1977) describe an experiment to investigate warping of copper plates. The two factors studied were temperature and the copper content of the amount of warping. The data were as follows:

block

		copper content %			
		40	60	80	100
	50	17,20	16,21	24,22	28,27
Temperature ^oc	75	12,9	18,13	17,12	27,31
	100	16,12	18,21	25,23	30,23
	125	21,17	23,21	23,22	29,31

K=1

Using $\alpha = 0.01$ level of significance test for the

i) difference between the copper content

ii) difference due to temperature

iii) difference due to interactions. **(20 marks)**

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STA 2313: RESEARCH METHODOLOGY FOR STATISTICS

DATE: AUGUST 2021 TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer question ONE and any other two questions
2. All questions except one carry equal marks

This paper consists of 4 printed pages

STACS Examination Board 2020/2021

Question One (30 marks)

a. Differentiate the following terms as used in research

Correlation studies and Causal-comparative studies [2 marks]
Reliability and Validity [2 marks]
Extraneous Variable and Confounding variable [2 marks]
Theoretical Framework and Conceptual Framework [2 marks]

b. Discuss the importance of literature review in a research proposal [6 marks]

c. Arsenal Football Club has funded a project to understand Arsenal's fans perceptions' on the current management and composition of the team. Assume you are a consultant and you bid for the above project. You need to come up with a research proposal so that you can be considered for the bid. In the event you are successful, your principal data collection will be a questionnaire to a sample of only arsenal fans within your country.

Required:

i) With reasons, explain the type of research you need to conduct for the above project [2 marks]

ii) Critically discuss how you can select a sample of 3000 arsenal fans for the purpose of the study. [2marks]

iii) Discuss at least four factors or protocols highlighted within your research proposal that would lead to the successful bid of the project [4 marks]

d. Discuss the importance of referencing, citations and bibliography in research [4 marks]

e. To perform statistical analysis of data, it is important to first understand variables and what should be measured using these variables. Discuss the four levels of measurements scale used to capture data. [4 marks]

Question Two (20 marks)

a. Six third year students in JKUAT presented some research topics for consideration towards their end of semester research proposal. State and justify the type of research that each student presented.

[12 marks]

Student Name	Research Topic	
John	Students' drinking behavior and perceptions towards introducing alcohol policies on university campus in Kenya: a focus group study	appli
James	The effects of alcohol use on academic achievement in Universities	Pure quantitive
Jack	Levels and patterns of alcohol consumption among University Students in Kenya	Pure
Mary	Strategies to reduce substance and alcohol abuse among university students	applied.
Mercy	The Analysis of different variants of Whiskey consumed by Kenyan university students	Quantid
Magdalene	A cross sectional assessment of an alcohol intervention targeting young university students in Kenya	blind

b. Discuss and justify four (4) areas/ fields where blinded protocols are applied in research. [8 marks]

medicine, lectuia, Students, social life, traditions

Question Three (20 marks)

Topic

The following abstract was taken from the article by Sath et al (2020): "Prediction of new active cases of coronavirus disease (COVID-19) pandemic using multiple linear regression model"

Prediction of new active cases of coronavirus disease (COVID 19) pandemic using multiple linear regression model.

Abstract

The COVID-19 pandemic originated from the city of Wuhan of China has highly affected the health, socio-economic and financial matters of the different countries of the world. India is one of the countries which is affected by the disease and thousands of people on daily basis are getting infected. In this paper, an analysis of daily statistics of people affected by the disease are taken into account to predict the next days' trend in the active cases in Odisha as well as India. A valid global data set is collected from the WHO daily statistics and correlation among the total confirmed, active, deceased, positive cases are stated in this paper. Regression model such as Linear and Multiple Linear Regression techniques are applied to the data set to visualize the trend of the affected cases. Here a comparison of Linear Regression and Multiple Linear Regression model is performed where the score of the model R2 tends to be 0.99 and 1.0 which indicates a strong prediction model to forecast the next coming days active cases. Using the Multiple Linear Regression model as on July month, the forecast value of 52,290 active cases are predicted towards the next month of 15th August in India and 9,358 active cases in Odisha if situation continues like this way. These models acquired remarkable accuracy in COVID-19 recognition. A strong correlation factor determines the relationship among the dependent (active) with the independent variables (positive, deceased, recovered

a. Give the statement of the problem for this study main object specific obj [2 mark]
b. Formulate three specific objectives of the study [3 marks]
c. The study can be classified into at least three types of research. State and justify the different types of research that the study qualifies quantitative [6 marks]
d. Formulate three hypothesis from the study based on the abstract [3 marks]
e. Identify with reasons the type of measurement scale that can be used for both the dependent and independent variables in the study [2 marks]
f. Provide a brief critique of the abstract [4 marks]

Question Four (20 marks)

Critically discuss the ethical issues relating to

a. Research participants [10 marks]
b. The Researcher [10 marks]

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integrity
objectivity
confidentiality
Responsible publication
Avoid plagiarism / plagi
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Reliability

JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY
UNIVERSITY EXAMINATION 2020/2021 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN ACTUARIAL SCIENCE AND BACHELOR OF SCIENCE IN OPERATIONS RESEARCH

STA 2310 DECISION THEORY

DATE AUGUST, 2021 TIME 2 HOURS

Instructions i) Answer question **one** and nay other **two** questions.
ii) Strictly submit this question paper together with the answer booklet

QUESTION ONE (30 MARKS)

a) Carter Coffee is considering a number of different ways to increase the production capacity at its Capital Hills factory. They may either build a new larger facility, expand their present facility, or lease a subcontractor's facility. Based on the information provided in a recent marketing survey, the table lists the potential increase in profits (in thousands) for each decision alternative (i.e. choice), depending on the amount of demand that will possibly arise next year. Using the EMV what is the best course of action. Also, obtain the EVPI and interpret it in the light of the question. (5 marks)

	Possible Demand		
Actions	High	Moderate	Low
Build	500	250	-150
Expand	350	300	100
Lease	300	300	200
Probabilities	0.3	0.4	0.3

b) A firm manufactures three types of products. The fixed and variable costs are given below:

Product	Fixed cost	Variable cost
A	25,000	12
B	35,000	9
C	53,000	7

The likely demand of the products can either be poor (3,000 units), moderate (7,000 units) or high (11,000 units). If the sale price of each type of product is 25,

prepare the payoff matrix and obtain the optimal course of action using Laplace and the realism criterion with 40% optimism. (6 marks)

c) A cosmetic company has developed a new after-shave lotion. If the company goes into small-scale production, its annual fixed costs will be \$200,000 and it can produce the product for a variable cost of \$3 per unit. If the company goes into large-scale production, its annual fixed costs will be \$400,000 and it can produce the product for a variable cost of \$1.25 per unit. Assume that the selling price is \$7 per unit.

(i) Determine the break-even points for small scale and large-scale production. (2 marks)
(ii) If the expected sales are for 500,000 units, which production process is more profitable: small-scale or large-scale? Determine profits for both cases. (2 marks)
(iii)Find the number of units for which one would be indifferent between small-scale and largescale production. (2 marks)

0.76

d) An investment performance is significantly affected by two variables: the economic environment and whether a competing building is developed. The cash flow under the various scenarios is as follows:

Competing Building	Economic Environment		
	Good	Fair	Poor
Developed	\$250,000	\$200,000	\$150,000
Not Developed	\$2250,000	\$175,000	\$125,000

Through an assessment of the economic environment, the probability estimates for good, fair and poor economic situations are 0.2, 0.6 and 0.2 respectively. The conditional probability of whether the competing building will be built under the 3 economic conditions is estimated as follows:

Competing Building	Economic Environment		
	Good	Fair	Poor
Developed	0.8	0.5	0.2
Not Developed	0.2	0.5	0.8

What is the expected value of the investment? Hint use a decision tree. (6 marks)

e) Suppose that Mao is an expected utility maximizer, with the VNM utility function $u(w) = \ln w$, for $w > 0$.

(i) What is Mao's certainty equivalent of the following lottery: (2 marks)

Probability	0.4	0.5	0.1
Money	30	100	500

(ii) What is the risk premium Mao is willing to pay to insure against this uncertain prospect? (2 marks)

(iii)Suppose Mao has \$1,200,000 in wealth, and decides to become a backsliding oil prospector. He finds a tract of land for sale for \$1,000,000 dollars, which will produce no return at all if no oil is found, or will yield \$10,000,000 of income (net of operating expenses but not of the cost of the land) if oil is found. Let p be the probability that oil is found. Specify the two lotteries that result from the actions, "buy that land" and "not buy the land". What probability p of finding oil would make Mao exactly indifferent between buying the land and not buying the land? (3 marks)

QUESTION TWO (20 MARKS)

a) A toy manufacturer is considering a project of manufacturing a dancing doll with three different movement designs. The doll will be sold at an average of \$10. The first movement design using 'gears and levels' will provide the lowest tooling and set up cost of \$100,000 and \$5 per unit of variable cost. A second design with spring action will have a fixed cost of \$160,000 and variable cost of \$4 per unit. Yet another design with weights and pulleys will have a fixed cost of \$300,000 and variable cost \$3 per unit. The demand events that can occur for the doll and the probability of their occurrence is given below

Demand	No of units	Probability
Light	25,000	0.10
Moderate	100,000	0.70
Heavy	150,000	0.20

(i) Construct a payoffs table for the above project hence using EMV criterion, determine the optimal design (6 marks)

(ii) How much can the manufacturer afford to pay in order to obtain perfect information about the demand? (1 mark)

b) RMC Training is trying to decide if it should sell a new type of training product. The fixed costs of production is estimated to be $300,000. The product will sell for $30 with variable cost of $15. The sales director of marketing believes that sales will be normally distributed with an average of 40,000 annually, with a standard deviation of 15,000.

(i) What is the breakeven point? (2 marks)
(ii) What is the profit/loss when 60,000 units are sold? (1 mark)
(iii) How many units must be sold to earn a profit of $150,000? (1 mark)
(iv) What is the probability of selling 50,000 units or more? (2 marks)
(v) What is the probability of earning a profit of $100,000 or more? (1 mark)

c) The management of a company is faced with the problem of choosing one of three products that it wants to manufacture. The potential demand for each product may turn out to be good, moderate or poor. The probabilities for each of the states of nature were estimated as follow

	Nature of demand		
Product	Good	Moderate	Poor
X	0.70	0.20	0.10
Y	0.50	0.30	0.20
Z	0.40	0.50	0.10

The estimated profit or loss in rupees under the three states is as tabulated alongside

Product	Good	Moderate	Poor
X	30,000	20,000	10,000
Y	60,000	30,000	20,000
Z	40,000	10,000	-15,000

Prepare the expected opportunity loss table, EOL and advise the management about the choice of product. (7 marks)

QUESTION THREE (20 MARKS)

a) A man wants to invest $1 million for one year. After analyzing and evaluating numerous possibilities, he narrowed down to three alternatives namely

- A_1- invest in a guaranteed income certificate paying 10%,
- A_2- invest in a bond with a coupon value of 8% and
- A_3- invest in a portfolio of banking institution stocks.

He believes that the payoffs associated with the last 2 acts depend on a number factors such as interest rates which can either increase, stay the same or decrease. The payoffs alongside summarized the profits he would realize for the 3 investment options under each of the 3 possible events.

Investment	Interest rate			
option	Increase	Stable	Decrease	
A1-CD	$100,000	-$30,000	$150,000	50
A2- Bond	$100,000	$80,000	$90,000	87
A3- Stocks	$100,000	$180,000	$40,000	122
Probability	0.20	0.50	0.30	155

(i) Determine the optimal investment option using the EOL criterion. (5 marks)
(ii) What is the expected value of perfect information and how do you interpret it? (1 mark)

b) Suppose the investor in (a) above wishes to consult an economic analysis who, for a fee is $5,000, will forecast the behavior of interest rates for the next 12 months. The following table gives the conditional probabilities of the prediction accuracy based on the analyst's past experiences. Z_1, Z_2 and Z_3 are the forecasted states that the interest rates will increase, stay the same and decrease respectively.

Prior · likelihood
P(Si) P(Zi|Si)
0.2
0.5
0.3

Interest rate	Z_1	Z_2	Z_3
S_1-Increase	$P(Z_1\|S_1) = 0.6$	$P(Z_2\|S_1) = 0.3$	$P(Z_3\|S_1) = 0.1$
S_2-Stay the same	$P(Z_1\|S_2) = 0.1$	$P(Z_2\|S_2) = 0.8$	$P(Z_3\|S_2) = 0.1$
S_3-Decrease	$P(Z_1\|S_3) = 0.1$	$P(Z_2\|S_3) = 0.2$	$P(Z_3\|S_3) = 0.7$

(i) Obtain the posterior probabilities for the states of nature and advice the investor on whether he should consult the analyst. (12 marks)

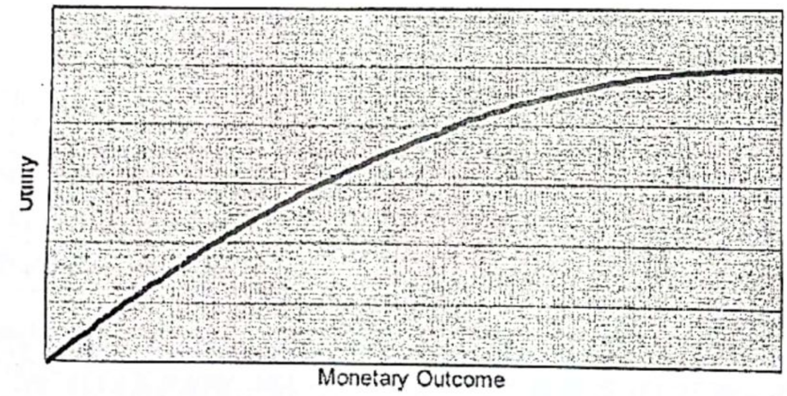
(ii) What is the efficiency of this consultancy information? (3 marks)

E

QUESTION FOUR (20 MARKS)

a) Define the term utility and distinguish between a risk averter and a risk seeker. (3 marks)

b) A decision maker's utility function is graphed below what type of decision maker does it represent and why? (1 mark)



c) Damson has a 40% chance of earning $2500/month and a 60% change of earning $1600/month. If his utility function is $u(\mathrm{w}) = w^{1/2}$

i) Verify that $u(\mathrm{w}) = w^{1/2}$ represents a risk avoider's utility function (2 marks)

ii) Find the expected earnings, the expected utility and the certainity equivalence of this Damson's gambling option. (3 marks)

d) Joan's utility function for her asset position is given by $u(\mathrm{w}) = w^{1/2}$. Currently Joan's assets consist of S10, 000 in cash and $90,000 home. During a given year there is 0.001 chance that Joan's home will be destroyed by fire or other causes. How much would Joan be willing to pay for the insurance policy that would replace her home if it was destroyed? Hint: first find the ending wealth for all possible outcomes (7 marks)

e) Compute the risk premium for I_2. In part d above $[RP(I_2) = EV(I_2) - CE(I_2)]$. In total how much would Joan be willing to pay to avoid the risk of her home being destroyed? (4 marks)

0·6( )+ 0·25(

Efficiency = $\frac{EVSI}{EVPI} \times 100$