



JOMO KENYATTA UNIVERSITY
OF
AGRICULTURE AND TECHNOLOGY

University Examinations 2021/2022

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF
BACHELOR OF SCIENCE IN BIOSTATISTICS, BACHELOR OF SCIENCE IN
STATISTICS, BACHELOR OF SCIENCE IN OPERATIONS RESEARCH

STA 2402 GENERALIZED LINEAR MODELS

DATE: JULY 2022

TIME: 2 HOURS

INSTRUCTIONS: Answer question one and any other two questions

QUESTION ONE

- a) Write down the canonical form of a 2-parameter exponential dispersion family, explain all the components (3 marks)
- b) Show that the inverse-Gaussian distribution given by $f(x; \mu, \lambda) = \sqrt{\frac{\lambda}{2\pi x^3}} \exp\left(-\frac{\lambda(x-\mu)^2}{2\mu^2 x}\right)$ belongs to the exponential dispersion family, and identify the canonical link (6 marks)
- c) Let Y be a non-negative continuous random variable; write down the:
i. systematic component (1 mark)
ii. random component (1 mark)
iii. Gamma regression model (2 marks) 3
- d) Discuss overdispersion in GLMs (3 marks)
- e) Describe the parameter estimation process of a Poisson response regression model. (5 marks) 5
- f) Data were collected in a study to describe the effect of wool type (A or B) and tension (low, medium or high) on the number of warp breaks per loom. The response variable

STA 2402

was "breaks" which is a count of number of breaks. The wool "type" and "tension" are taken as predictor variables. The fitted model was:

```
Call:
glm(formula = breaks ~ wool + tension, family = poisson, data =
warpbreaks)
```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-3.6871	-1.6503	-0.4269	1.1902	4.2616

Coefficients:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	3.69196	0.04541	81.302	< 2e-16 ***
woolB	-0.20599	0.05157	-3.994	6.49e-05 ***
tensionM	-0.32132	0.06027	-5.332	9.73e-08 ***
tensionH	-0.51849	0.06396	-8.107	5.21e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

Null deviance: 297.37 on 53 degrees of freedom
Residual deviance: 210.39 on 50 degrees of freedom
AIC: 493.06

- i. Write the fitted model (2 marks)
- ii. Interpret the fitted model results (2 marks)
- iii. Discuss the goodness of fit of the model and the model variables (2 marks)
- g) Discuss the significance of generalized linear hierarchical models. (3 marks)

QUESTION TWO

- a) Define the following, as used in mixed effects modelling
 - i. Fixed effects (1 mark)
 - ii. Random effects (1 mark) 2
- b) Discuss the problems associated with hierarchical data as compared to data used in linear regression. Examples can be used. (5 marks) ✓
- c) Construct a Two-level hierarchical linear model (8 marks)
- d) State the assumptions of the model in (c) at both level one and level 2. (5 marks)

QUESTION THREE

- a) Consider a contingency table. Show that the contingency table can be written as a GLM when:
- The sample size, as well as the cell counts, are realizations of random variables. (7 marks)
 - Information is recorded on the individuals, according to the classifications, up to a certain (possibly pre-specified) sample size, and then stop, that is, when the sample size is fixed by design. (7 marks)
- b) A sample of couples was drawn and their heights taken as

		Wife		
		Tall	Medium	Short
Husband	Tall	18	28	14
	Medium	20	51	28
	Short	12	25	9

- Write a code in R to enter the data (4 marks)
- Write a code in R to perform contingency table regression (2 marks)

QUESTION FOUR

- a) Write the dispersion parameters for the following distributions
- Normal (1 mark)
 - Poisson (1 mark)
 - Gamma (1 mark)
- b) Describe the framework of parameter estimation method under regression for Binomial Data. (3 marks)
- c) Define the deviance statistic for checking model adequacy (2 marks) 2
- ~~d)~~ Derive an expression for the deviance statistics for the Binomial distribution. (6 marks) 6
- e) Discuss the response data characteristics that will lead to the choice of the following count regressions: (6 marks)
- Binomial
 - Poisson
 - ZIP
 - Negative Binomial



W1-2-60-1-6

JOMO KENYATTA UNIVERSITY

OF

AGRICULTURE AND TECHNOLOGY

UNIVERSITY EXAMINATIONS 2022/2023

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

STA 2455: ECONOMETRIC MODELS II

DATE: JULY 2022

TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer question ONE (section A) and any other two questions in section B.
 2. Be neat and show all your workings
 3. All questions except question one carry equal marks
-

This paper consists of 4 printed pages.

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SECTION A (30 MARKS)

QUESTION ONE

- State and describe the three types of data used in econometrics in estimation of the model (6 Marks)
- (a) State and describe the three types of data used in econometrics in estimation of the model (6 Marks)
- (b) What is the role of the stochastic error term u_i in regression analysis? What is the difference between the stochastic error term and the residual, \hat{u}_i ? (3 Marks)
- (c) Given the following data on Y (Personal Consumption Expenditure) and X (Gross Domestic Product, 1960–1970), both in 2000 Billions of Dollars

Year	PCE(Y)	GDP(X)
1960	1597.4	2501.8
1961	1630.3	2560.0
1962	1711.1	2715.2
1963	1781.6	2834.0
1964	1888.4	2998.6
1965	2007.7	3191.1
1966	2121.8	3399.1
1967	2185.0	3484.6
1968	2310.5	3652.7
1969	2396.4	3765.4
1970	2451.9	3771.9

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- (i) Estimate consumption function (i.e., regression line) and comment on the association between Personal Consumption Expenditure and Gross Domestic Product (5 Marks)
- (ii) Write R program that reads in the data Y and X and fit the linear regression

$$Y_t = \beta_0 + \beta_1 X_t + e_t$$

- (d) Ordinary least squares is a special case of generalized least squares. Explain. (2 Marks)
- (e) A study was conducted to determine whether the average annual salary of public school teachers differs among three geographical regions of the country - (Northern, Central and Eastern). The following regression results

$$\begin{aligned} \hat{Y}_i &= 48014.615 + 1524.099D_{2i} - 1721.027D_{3i} \\ se &= (1857.204) \quad (2363.139) \quad (2467.151) \\ t &= (25.853) \quad (0.645) \quad (-0.698) \\ pvalues &= (0.0000) \quad (0.5220) \quad (0.4888) \end{aligned}$$

where Y_i = (average) salary of public school teacher in county i , $D_{2i} = 1$ if the county is in the Eastern region = 0 otherwise and $D_{3i} = 1$ if the county is in the Northern region = 0

- (i) Interpret the estimated regression coefficients (3 Marks)
- (ii) Give the mean salary of public school teachers in the Eastern and Northern region. (2 Marks)
- (iii) Are the mean salaries in (ii.) statistically different from the mean salary of teachers in the Central region, the comparison category? Explain. (2 Marks)
- (f) There are some nonlinear regression models which are said to be intrinsically linear because they can be made linear in the parameters by a simple transformation. Apply a suitable transformation to the following nonlinear model.:

$$(t.c.f.v) Y = \frac{\beta_0}{\beta_1 + X} (B_1 + X)$$

$$(B_1 + X) Y = B_0 \quad (2 \text{ Marks})$$

SECTION B (20 MARKS EACH)

$$B_0 = \frac{X B_1 + Y}{X}$$

QUESTION TWO

- (a) In econometric modelling distinguish 'Linearity in variables' from 'Linearity in parameters' (4 Marks)
- (b) The table below shows data on 5 cars about MPG (average miles per gallons), HP (engine horsepower), VOL (cubic feet of cab space), SP (top speed, miles per hour), and WT (vehicle weight in 100lbs.).

Observation	MPG	SP	HP	VOL	WT
1	65.4	96	49	89	17.5
2	56.0	97	55	92	20.0
3	55.9	97	55	92	20.0
4	49.0	105	70	92	20.0
5	46.5	96	53	92	20.0

Consider the following model:

$$MPG_i = \beta_1 + \beta_2 SP_i + \beta_3 HP_i + u_i$$

- (i) Estimate the parameters of this model and interpret the results. Do they make economic sense? (10 Marks)
- # (ii) If heteroscedasticity is established, how would you transform the data so that in the transformed data the error variance is homoscedastic? Show the necessary calculations. (4 Marks) ✓
- (c) If you have monthly data over a number of years, how many dummy variables will you introduce to test the following hypotheses?
- (i) All the 12 months of the year exhibit seasonal patterns. (1 Mark)

- (ii) Only February, April, June, August, October, and December exhibit seasonal patterns.*
- (1 Mark)*

QUESTION THREE

- (a) Briefly describe ANOVA and ANCOVA dummy regression models. Provide mathematical formulations. (4 Marks)
- (b) From the household budget survey of 1980 of the Dutch Central Bureau of Statistics, a researcher obtained the following logit model based on a sample of 2,820 households. The purpose of the logit model was to determine car ownership as a function of (logarithm of) income. Car ownership was a binary variable: $Y = 1$ if a household owns a car, zero otherwise.

$$\begin{aligned}\hat{L}_t &= -2.77231 + 0.347582 * \ln \text{Income} \\ t &= (-3.35) \quad (4.05) \\ &= \chi^2(1df) = 16.681 \quad (P\text{value} = 0.0000)\end{aligned}$$

where \hat{L}_t = estimated logit and where $\ln \text{Income}$ is the logarithm of income. The χ^2 measures the goodness of fit of the model

- (i) Interpret the estimated logit model (3 Marks)
- (ii) From the estimated logit model, how would you obtain the expression for the probability of car ownership? (2 Marks)
- (iii) What is the probability that a household with an income of \$20,000 will own a car? And at an income level of \$25,000? (4 Marks)
- (iv) Comment on the statistical significance of the estimated logit model. (2 Marks)
- (c) State any four problems associated with the Linear probability model (LPM) (4 Marks)

QUESTION FOUR

- (a) Highlight three methods to test for omitted variables and incorrect functional form of an econometric model (3 Marks)
- (b) Briefly discuss the following panel data regression models.
- (i) Pooled OLS Regression or Constant Coefficients Model (2 Mark)
 - (ii) The fixed effects least squares dummy variable (LSDV) model (3 Marks)
 - (iii) The Random Effects Model (REM) (3 Marks)
- (c) Suppose the true model is

$$Y_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + u_i$$

but for some reason we fit the following model

$$Y_i = \alpha_1 + \alpha_2 X_{2i} + v_i$$

State the major four consequences of omitting variable X_3

(4 Marks)

- (d) In a study of the determination of prices of final output at factor cost in the United Kingdom, the following results were obtained on the basis of annual data for the period 1951-1969:

$$\widehat{PF}_t = 2.033 + 0.273W_t - 0.521X_t + 0.256M_t + 0.028M_{t-1} + 0.121PF_{t-1}$$

se = (0.992) (0.127) (0.099) (0.024) (0.039) (0.119)

$$R^2 = 0.984 \quad d = 2.54$$

where PF = prices of final output at factor cost, W = wages and salaries per employee, X = gross domestic product per person employed, M = import prices, M_{t-1} = import prices lagged 1 year, and PF_{t-1} = prices of final output at factor cost in the previous year.

"Since for 18 observations and 5 explanatory variables, the 5 percent lower and upper d values are 0.71 and 2.06, the estimated d value of 2.54 indicates that there is no positive autocorrelation." Comment. (5 Marks)



W1-2-60-1-6

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FOURTH YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR
OF SCIENCE IN OPERATION RESEARCH
STA 2455: ECONOMETRIC MODELS II

DATE: DECEMBER 2021

TIME: 2 HOURS

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY THREE QUESTIONS.

QUESTION ONE (30 MARKS)

a) Briefly explain the following concepts:

- i. Time series data
- ii. Cross sectional data
- iii. Pooled data
- iv. Panel data

[4 marks]

a) The assumptions underlying the classical linear regression model are:

- A.1 Linearity
- A.2 Full rank: $\text{rank}(X) = k$
- A.3 Errors have zero mean: $E(\varepsilon) = 0$
- A.4 Spherical errors
- A.5 The process that generates X is unrelated to the process that generates ε
- A.6 Normality of errors

Under these assumptions, estimation of the linear model by OLS is sensible. Estimation of the variance of $\hat{\beta}$ by $s^2(X'X)^{-1}$ is also sensible. For each of the assumptions listed above, explain:

- (i) how the assumption might be violated
- (ii) The implications for estimating the model by OLS

[3 Marks]

[3 Marks]

(iii) How the problem might be corrected, or how an alternative estimator might be used to correct the problem (if possible). [4 Marks]

b) A researcher is considering two regression specifications to estimate the relationship between a variable X and Y,

$$\log Y = \beta_1 + \beta_2 \log X + U \quad (\text{Equation 1})$$

$$\log \frac{X}{Y} = \alpha_1 + \alpha_2 \log X + V \quad (\text{Equation 2})$$

Where the Greek letters refer to parameters and X and Y are two random variables, which we have a random sample of size n.

i. Determine whether (Equation 2) can be represented as a restricted version of (Equation 1) [3 Marks]

ii. Using the same n observations of variable X and Y, the researcher fits two specifications using ordinary least squares (OLS). The fits are:

$$\widehat{\log Y} = \hat{\beta}_1 + \hat{\beta}_2 \log X \quad (\text{Equation 3})$$

$$\widehat{\log \frac{X}{Y}} = \hat{\alpha}_1 + \hat{\alpha}_2 \log X \quad (\text{Equation 4})$$

Using the expressions for the estimates write $\hat{\beta}_2$ in terms of $\hat{\alpha}_2$, Write $\hat{\beta}_1$ in terms of $\hat{\alpha}_1$ [2 Marks]

iii. Demonstrate that $\widehat{\log Y} - \widehat{\log X} = \widehat{\log \frac{X}{Y}}$ [3 Marks]

iv. Demonstrate that the residuals in (Equation 3) are identical to those in (Equation 4) [2 Marks]

v. Determine the relationship between the t statistic using $\hat{\beta}_2$ and the t statistic using $\hat{\alpha}_2$ [3 Marks]

vi. Explain with detailed arguments whether R^2 would be the same in the two regressions. [3 Marks]

QUESTION TWO (20 MARKS)

a) Consider the following model:

$$\hat{Y}_i = -0.261 - 2.306D_{2i} - 1.7327D_{3i} + 2.1289D_2D_{3i} + 0.8028X_i$$

$$t = (-0.2357) (-5.4873)^* (-2.1803)^* (9.9094)^*$$

$$R^2 = 0.2032, n = 528, \alpha = 0.05$$

* → indicate P value is less than 0.05

Where Y_i → hourly wage in dollar

X → education (Years of schooling)

D_2 = 1 if female, 0 if male

D_3 = 1 if non-white and non-Hispanic

= 0 if otherwise

Interpret these results

[5 Marks]

- b) Write the functional form of $E(y_i | x_i, \beta)$, the conditional mean function, that is used in each of the following [2 Marks]
- Probit model [2 Marks]
 - Logit model
- c) For the logit model, derive the marginal effect, or partial derivative $\partial E(y_i | x_i, \beta) / \partial x_{ij}$, where x_{ij} is the j^{th} element of the x_i vector [4 Marks]
- d) Suppose logit model estimation produces the following table

Variable Name	Estimated Coefficient	Standard Error	Asymptotic T-Ratio
X1	3.8	1.7	2.2
X2	-1.6	0.54	-3.0
Constant	-4.2	2.3	-1.8

- i. What is the predicted probability that $y = 1$ when $x_1 = 2$ and $x_2 = 0.5$? [2 Marks]
- ii. Compute the change in the predicted probability when x_2 increases by one unit from $x_2 = 0.5$ to $x_2 = 1.5$, holding x_1 at $x_1 = 2$. [2 Marks]
- iii. Using the derivative result from part (a) and the estimates of the above table, compute the partial derivative $\partial E(y/x_1, x_2, \beta) / \partial x_2$, at the x value given in part (i) [5 Marks]
- iv. Comment on the difference between the answers to (ii) and (iii) [2 Marks]

QUESTION THREE (20 MARKS)

Say you want to assess the importance of increasing the number of police officers on the crime rate. You have access to data at the municipality level and can estimate the equation:

$$Crime_{it} = \beta_0 + \beta_1 Police_{it} + \varepsilon_i$$

Both measures (number of crimes and number of police officers) are measured per 1000 inhabitants in each municipality.

- a) Write down the fixed effects regression model based on the regression model above. Based on this equation, describe what kind of problem you can potentially solve using fixed effects compared to the equation above? What kind of problems can a fixed effects model not solve? (5 marks)
- b) What must be true (which assumption needs to hold) in order for us to interpret the coefficient from your panel data regression as a causal relationship? Write down the equation or describe the assumption in words. (5 marks)

- c) Using yearly panel data for several time periods, the estimated coefficient on Police is -0.1 in your fixed effects specification. How do you interpret this estimate? Do you believe that this estimate has a causal interpretation? Motivate your answer. (4 marks)
- d) Suppose that around half of the municipalities in your data received central government support to increase police density at the same time period and the other half did not. Using this new information, how could you design a study to answer the question above in a causal way? Write down the equation, describe which parameter you are interested in and describe how you would show your readers that it is plausible that the most important assumption for estimating a causal effect holds. (6 marks)

QUESTION FOUR (20 MARKS)

a) Output 1

```

library(foreign)
Panel <- read.dta("http://dss.princeton.edu/training/Panel101.dta")
ols <- lm(y ~ x1, data=Panel)
summary(ols)

Call:
lm(formula = y ~ x1, data = Panel)

Residuals:
    Min      1Q      Median      3Q      Max 
-9.546e+09 -1.578e+09  1.554e+08  1.422e+09  7.183e+09 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) 1.524e+09  6.211e+08   2.454  0.0167 *  
x1          4.950e+08  7.789e+08   0.636  0.5272    
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

Residual standard error: 3.028e+09 on 68 degrees of freedom
Multiple R-squared: 0.005905, Adjusted R-squared: -0.008714
F-statistic: 0.4039 on 1 and 68 DF, p-value: 0.5272

Output 2
library(foreign)
Panel <- read.dta("http://dss.princeton.edu/training/Panel101.dta")
fixed.dum <- lm(y ~ x1 + factor(country) - 1, data=Panel)

summary(fixed.dum)

Call:
lm(formula = y ~ x1 + factor(country) - 1, data = Panel)

Residuals:

Min	1Q	Median	3Q	Max
-8.634e+09	-9.697e+08	5.405e+08	1.386e+09	5.612e+09

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
x1	2.476e+09	1.107e+09	2.237	0.02889 *
factor(country)A	8.805e+08	9.618e+08	0.916	0.36347
factor(country)B	-1.058e+09	1.051e+09	-1.006	0.31811
factor(country)C	-1.723e+09	1.632e+09	-1.056	0.29508
factor(country)D	3.163e+09	9.095e+08	3.478	0.00093 ***
factor(country)E	-6.026e+08	1.064e+09	-0.566	0.57329
factor(country)F	2.011e+09	1.123e+09	1.791	0.07821 .
factor(country)G	-9.847e+08	1.493e+09	-0.660	0.51190

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '

Residual standard error: 2.796e+09 on 62 degrees of freedom
Multiple R-squared: 0.4402, Adjusted R-squared: 0.368
F-statistic: 6.095 on 8 and 62 DF, p-value: 8.892e-06

Required:

Comment of the Model used in Output 1, Output 2 and the effect of using Model 2 on the significance of x_1 in model 2. [5 Marks]

- b) You are involved in a research and the following output is realized and you are required to make a choice between the OLS and the Fixed effects model.

#Comparing OLS vs LSDV model
#Each component of the factor variable (country) is absorbing the effects particular to each country. Predictor x_1 was not significant in the OLS model, once controlling for differences across countries, x_1 became significant in the OLS_DUM (i.e. LSDV model) #

```
#cat(apsrtable(ols, fixed.dum, model.names = c("OLS", "OLS_DUM"), Sleave=F),  
file="ols_fixed1.txt")
```

```
library(apsrtable)  
apsrtable(ols,fixed.dum, model.names = c("OLS", "OLS_DUM")) # Displays a table in Latex form
```

```
#Fixed effects: n entity-specific intercepts (using plm)  
library(plm)
```

```
fixed <- plm(y ~ x1, data=Panel, index=c("country", "year"), model="within")
summary(fixed)
# Testing for fixed effects, null: OLS better than fixed
pFtest(fixed, ols)
```

F test for individual effects

```
data: y ~ x1
F = 2.9655, df1 = 6, df2 = 62, p-value = 0.01307
alternative hypothesis: significant effects ..
```

- i) State the Null and Alternative Hypothesis [3 Marks]
- ii) From the results comment on the choice between OLS and the Fixed effects model [5 Marks]
- c)
 - i. Define a time and entity fixed model [3 Marks]
 - ii. In the output below, identify and give reasons for a choice between a time fixed effects model and fixed model [4 Marks]#Testing time-fixed effects. The null is that no time-fixed effects needed
pFtest(fixed.time, fixed)

F test for individual effects

```
data: y ~ x1 + factor(year)
F = 1.209, df1 = 9, df2 = 53, p-value = 0.3094
alternative hypothesis: significant effects
```

```
plintest(fixed, c("time"), type=("bp"))
```

Lagrange Multiplier Test - time effects (Breusch-Pagan) for balanced panels

```
data: y ~ x1
chisq = 0.16532, df = 1, p-value = 0.6843
alternative hypothesis: significant effects
```

JOMO KENYATTA UNIVERSITY
OF
AGRICULTURE AND TECHNOLOGY
BACHELOR OF OPERATIONS RESEARCH - CAT

HUMAN RESOURCE MANAGEMENT

Instructions: Attempt ALL questions

1. (a) Job analysis covers the entire domain of human resource management. Explain. (10 marks)
- (b) Explain how a firm can effectively manage the performance of its employees. (10 marks)
2. (a) Examine the activities involved in the selection of new employees from a pool of applicants. (10 marks)
- (b) Training of employees is an expense to the organization and the organization should not bother investing in it. Discuss. (10 marks)

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JOMO KENYATTA UNIVERSITY

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AGRICULTURE AND TECHNOLOGY

UNIVERSITY EXAMINATIONS 2020/2021

THIRD/FOURTH YEAR SECOND SEMESTER EXAMINATIONS FOR THE
DEGREE OF

BACHELOR OF SCIENCE IN ACTUARIAL SCIENCE, BACHELOR OF SCIENCE
IN FINANCIAL ENGINEERING, BACHELOR OF SCIENCE IN PHYSICAL
SCIENCES BACHELOR OF SCIENCE IN MATHEMATICS AND COMPUTER
SCIENCE

STA 2401: TIME SERIES ANALYSIS

DATE: AUGUST 2021

TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

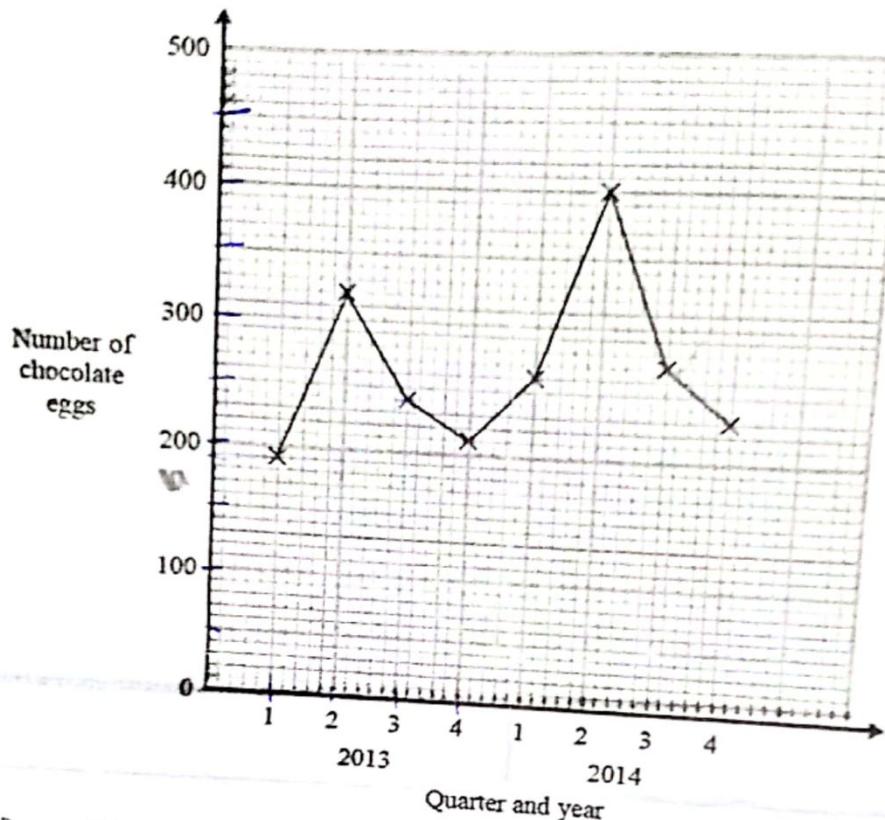
1. Answer questions ONE (section A) and any two questions in section B
 2. Be neat and show all your workings
 3. All questions except question one carry equal marks
-

This paper consists of 4 printed pages

STACS Examination board 2020/2021

SECTION AQUESTION ONE (30 MARKS)

- a) Outline and briefly explain two major reasons to record and analyze time series data. (2 marks)
- b) The time-series graph gives information about the number of chocolate eggs sold in a shop each quarter in 2013 and in 2014.



190
320
240
210
260
400
210
230

- i) Calculate the 4-point moving averages for the information in the graph. (3 marks)
- ii) Describe what the moving averages show about the trend in the number of chocolate eggs sold in the shop during this period. (1 mark)
- * Consider the following two first order moving average processes

$$A: X_t = e_t + \theta e_{t-1}$$

~~$\frac{S(n)}{S(0)}$~~

$$B: X_t = e_t + \frac{1}{\theta} e_{t-1}$$

- i) Using the autocorrelation function show that there is no unique MA process. (4 marks)
- ii) Show that model A is invertible whereas model B is not. (4 marks)
- d) State the prediction theory in finding the optimal forecast of a given time series, hence consider a process $Y_t = 0.25Y_{t-1} + Z_t$ where $\{Z_t\}$ is a purely random process. Use the prediction theory to forecast Y_{n+1} and obtain the mean squared error of the forecast. (5 marks)
- e) State the model concerned in the Box-Jenkins forecasting and give a reason why stationarity of the process is irrelevant in this procedure. (1 marks)

- f) Define spectral density function of the time series Y_t , and hence given the process

$Y_t = X_t + X_{t-1} + X_{t-2}$ where $\{X_t\}$ is a purely random process with mean 0 and variance 4, obtain the Normalized spectral density function of this process. (5 marks)

- g) Define stationarity of a time series in weak sense. Hence investigate whether the following time series is stationary in weak sense $X_t = \beta X_{t-1} + e_t$, $|\beta| < 1$ where $\{e_t\}$ is a white noise process with mean zero and variance 16. (5 marks)

SECTION B

QUESTION TWO (20 MARKS)

- a) Consider the following autoregressive process given by $x_t = \frac{7}{10}x_{t-1} + \frac{3}{20}x_{t-2} + e_t$.

Show that x_t is stationary hence find its autocorrelation function. (10 marks)

- b) Assuming a four year cycle, calculate the trend by method of moving averages from the following data in relation to production of tea in Limuru. Determine the fluctuations.

Year (20..)	01	02	03	04	05	06	07	08	09	10	11	12
Production	52	79	66	69	94	87	89	104	97	92	101	76

(8 marks)

- c) Differentiate between an autoregressive process and moving average process. (2 marks)

QUESTION THREE (20 MARKS)

- a) Calculate the cyclic variations for the following data using the ratio to trend method

Year	Q1	Q2	Q3	Q4
2010	30	40	36	34
2011	34	52	50	44
2012	40	58	54	48
2013	54	76	68	62
2014	80	92	86	82

(12 marks)

- b) Discuss the four components of a time series giving an example in each case (8 marks)

QUESTION FOUR (20 MARKS)

- a) The moving average process of order 3, MA(3) process is given by

$$y_t = e_t - \frac{1}{4}e_{t-1} + \frac{1}{5}e_{t-2} + \frac{1}{4}e_{t-3}$$

Determine the autocovariance hence autocorrelation function. (10)

- b) Outline two limitations of a moving average method in measuring the trend (2)

- c) The data below shows figures of production (in thousand tonnes) in a tea factory

Year	2008	2009	2010	2011	2012	2013
Production	68	84	91	96	90	90

- i) Fit a straight line by the method of least squares and tabulate the trend values. (6 marks)
ii) Estimate the production in 2005 and 2006. (2 marks)



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AGRICULTURE AND TECHNOLOGY

UNIVERSITY EXAMINATIONS 2021/2022

FOURTH YEAR FIRST SEMESTER EXAMINATIONS FOR THE DEGREE OF
BACHELOR OF SCIENCE IN OPERATIONS RESEARCH

STA 2401: TIME SERIES ANALYSIS

DATE: JULY/AUGUST 2022

TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer questions ONE (section A) and any two questions in section B
 2. Be neat and show all your workings
 3. All questions except question one carry equal marks
-

This paper consists of 3 printed pages

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SECTION AQUESTION ONE (30 MARKS)

- a) State the components of a time series applicable in the following cases
- The occurrence of Corona virus at Wuhan city in China.
 - Decrease of infant mortality in developing countries due to development of science and technology.
 - Increase of teachers salaries by Kenyan government.
 - Volatility of the price of petrol in Kenya. (4 marks)
- b) State and explain two main approaches to time series and the main diagnostics tools in each case. (4 marks) ✓
- c) Define a moving average process and state the importance of invertibility condition in a moving average process. Hence investigate invertibility of the following process
 $X_t = Z_t + 0.7Z_{t-1} - 0.2Z_{t-2}$ where $\{Z_t\}$ is a white noise process. (5 marks) ✓
- d) State the model concerned in the Box-Jenkins forecasting and give a reason why stationarity of the process is irrelevant in this procedure. (1 marks) ✓
- e) Use the method of three selected points $X_1 = 60$, $X_2 = 143$, and $X_3 = 251$ corresponding to times $t_1 = 2$, $t_2 = 30$, and $t_3 = 58$ to fit modified exponential curve
 $X_t = a + bC^t$ where a , b and C are constants. (6 marks) ✓
- f) Consider the process $Y_t = X_t + X_{t-1} + X_{t-2}$ where $\{X_t\}$ is a purely random process with mean 0 and variance 4. Obtain the Normalized spectral density function of this process. (5 marks) ✓
- g) Define stationarity of a time series in weak sense. Hence investigate whether the following time series is stationary in weak sense $X_t = \frac{1}{4}X_{t-1} + e_t$ where $\{e_t\}$ is a white noise process with mean zero and variance 16. (5 marks) ✗

SECTION BQUESTION TWO (20 MARKS)

- a) Consider a process given by $X_t = \frac{4}{5}X_{t-1} - \frac{16}{25}X_{t-2} + e_t$ where $\{e_t\}$ is a purely random process with mean zero and variance σ^2 . Show that the process is stationary and hence obtain its A.C.F (10 marks) ✓
- b) Establish invertibility of the following MA process $Y_t = Z_t + \frac{4}{5}Z_{t-1} - \frac{1}{5}Z_{t-2}$ where $\{Z_t\}$ is a purely random process with mean zero and variance σ^2 . Also obtain its A.C.F. ✓

QUESTION THREE (20 MARKS)

The table below shows the number of tourists in thousands arriving in Kenya between 2000 and 2004

Year	Month	Number	Year	Month	Number
2000	March	79	2001	March	130
	June	58		June	93
	September	84		September	121
	December	107		December	161
2002	March	216	2003	March	176
	June	132		June	112
	September	150		September	128
	December	163		December	142
2004	March	134	2004	2000	2001 2002 2003 2004
	June	86		June	
	September	94		September	
	December	104		December	

- i) Fit a first degree polynomial to determine the trend values. (6 marks)
- ii) Use ratio to trend method to calculate the seasonal variations. (9 marks)
- iii) Obtain the cyclic variations of the data, stating any the assumptions to be made. (5 marks)

QUESTION FOUR (20 MARKS)

- a) Obtain the spectral density function of the following process (10 marks)
 - i) A white noise process $Z_t = e_t$
 - ii) A process $X_t = Z_t + Z_{t-1} + Z_{t-2} + Z_{t-3}$ where $\{Z_t\}$ is a purely random process
- b) State the prediction theory in finding the optimal forecast of a given time series. (2 marks)
- c) Consider a process $Y_t = 0.25Y_{t-1} + Z_t$ where $\{Z_t\}$ is a purely random process. Use the prediction theory in (b) above to forecast Y_{n+3} and hence obtain the mean squared error of the forecast. (8 marks)

$$\hat{X}_t - \hat{b}\hat{t} \quad \text{or} \quad \frac{\sum X_t - b\sum t}{n}$$



W1-2-60-1-6

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UNIVERSITY EXAMINATIONS 2021/2022

FOURTH YEAR SECOND SEMESTER EXAMINATIONS FOR THE DEGREE OF
BACHELOR OF SCIENCE IN FINANCIAL ENGINEERING

STA 2422: GAME THEORY

DATE: JULY 2022

TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer question ONE (section A) and any other two questions in section B.
2. Be neat and show all your workings
3. All questions except question one carry equal marks

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SECTION A (30 MARKS)

1. (a) Define the following terms in the context of game theory
- (i) A Nash equilibrium [2 marks]
 - (ii) Game [2 marks]
 - (iii) Strongly dominant strategy [2 marks]
 - (iv) A cooperative game [2 marks]
- (b) "If a player has a dominant strategy in a simultaneous-move game, then she is sure to get her best possible outcome in any Nash equilibrium of the game." Is this statement true or false? Explain your answer and give an example of a game that illustrates your answer. [5 marks]
- (c) Let x be an unknown number and consider the matrices
- $$\begin{bmatrix} 0 & x \\ 1 & 2 \end{bmatrix} \quad \begin{bmatrix} 2 & 1 \\ x & 0 \end{bmatrix}$$
- Show that no matter what x is, each matrix has a pure saddle point. [5 marks]
- (d) Characterize the essential difference between a sequential moves game and a simultaneous move game. [3 marks]
- (e) From a game theory perspective, how would you characterize the bargaining between a student and a used car dealer? [4 marks]
- (f) Consider the following scenario: The employee (Rita) and the employer (Vanice). Rita has to choose whether to pursue training that costs \$1,000 to herself or not. Vanice has to decide whether to pay a fixed wage of \$10,000 to Rita or share the revenues of the enterprise 50:50 with Rita. The output is positively affected by both training and revenue sharing. Indeed, with no training and a fixed wage total output is \$20,000, while if either training or profit sharing is implemented the output rises to \$22,000. If both training and revenue sharing are implemented the output is \$25,000.
- i Is there any equilibrium in dominant strategies? [5 marks]
- ii Can you find the solution of the game with Iterated Elimination of Dominated Strategies?
- iii Is there any Nash equilibrium?

SECTION B (20 MARKS EACH)

2. (a) In the game rock-paper-scissors both players select one of these objects simultaneously. The rules are as follows: paper beats rock, rock beats scissors, and scissors beats paper. The losing player pays the winner \$1 after each choice of object. What is the game matrix? Find v^+ and v^- and determine whether a saddle point exists in pure strategies, and if so, find it. [5 marks]
- (b) Suppose you have an opportunity to invest in a company that is working on an important research project. If you invest, you have to put up \$1 million. If the project is successful, your \$1 million investment yields a \$6 million return, for a net return of \$5 million. If the project is unsuccessful, your return is 0, so you lose your \$1 million investment. The probability of success is 1/5.

- (i) Draw the game in extensive form including Nature as a player. [2 marks]
- (ii) Compute the expected pay-off in the event you choose to invest. Assuming you are risk neutral, do you choose to invest or not invest? [3 marks]
- (iii) Reconsider your answer to part (b) assuming you have the utility function $U(X) = \sqrt{X + 1,000,000}$, where X is your net return from the investment. Would you be willing to make the investment in this case? give a reason for your decision. [4 marks]
- (c) Consider the following bargaining problem: \$20 dollars needs to be split between Jack and Jill. Jill gets to make an initial offer. Jack then gets to respond by either accepting Jill's initial offer or offering a counter offer. Finally, Jill can respond by either accepting Jake's offer or making a final offer. If Jake does not accept Jill's final offer both Jack and Jill get nothing. Jack discounts the future at 10% (i.e. future earnings are with 10% less than current earnings while Jill discounts the future at 20%. Calculate the Nash equilibrium of this bargaining problem. [6 marks]
3. (a) In what kinds of circumstances might the Nash equilibrium concept be of limited use in predicting the outcome of a game? [4 marks] ✓
- (b) Each of two players must choose a number between 1 and 5. If a player's choice = opposing player's choice +1, she loses \$2; if a player's choice > opposing player's choice +2, she wins \$1. If both players choose the same number the game is a draw. What is the game matrix? Find v^+ and v^- and determine whether a saddle point exists in pure strategies, and if so, find it. [8 marks] ✓ 2
- (c) Suppose we have a game with matrix A and the game is modified by adding a constant C to every element of A , resulting to a new matrix $A + C$,
- Is it true that $v^+(A + C) = v^+(A) + C$ [4 marks]
 - If it happens that $v^-(A + C) = v^-(A)$, will it be true that $v^-(A + C) = v^-(A)$. [4 marks]
- ✓ (a) Describe a dominant strategy equilibrium as used in game theory [3 marks]
- (b) Consider the game represented in the table below;

		Player II	
		Swerve	Don't swerve
Player I	Swerve	0,0	-1,1
	Don't swerve	T,-1	-2,-2

Table 1: 'Chicken game' payoff matrix

- i Find all of the pure strategy Nash equilibrium strategy profiles for this game if $T > 0$. [3 marks]
- ii Find all of the pure strategy Nash equilibrium profiles for this game if $T < 0$. [3 marks]
- iii Are there any mixed-strategy Nash equilibria of the game if $T > 0$? If yes, give the equilibrium. If no explain. [4 marks]
- (c) Consider the rivalry between Airbus and Boeing to develop a new commercial jet aircraft. Suppose Boeing is ahead in the development process, and Airbus is considering whether

to enter the competition. If Airbus stays out, it earns zero profit while Boeing enjoys a monopoly and earns a profit of \$1 billion. If Airbus decides to enter and develop the rival airplane, then Boeing has to decide whether to accommodate Airbus peacefully or to wage a price war. In the event of peaceful competition, each firm will make \$300 million. If there is a price war, each will lose \$100 million because the prices of air planes will fall so low that neither firm will be able to pay off its development costs. Draw the tree for this game. Find the equilibrium.

[7 marks]



W1-2-60-1-6

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UNIVERSITY EXAMINATION 2021/2022

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR THE BACHELOR OF
SCIENCE ACTUARIAL SCIENCE

STA 2494: INVESTMENT AND ASSET MANAGEMENT

TIME: 2 HOURS

DATE: JULY 2022

INSTRUCTIONS: Attempt 3 Questions: Question One is Compulsory and any Other Two Questions

QUESTION ONE (30 Marks)

a) The Subprime Mess: An Overview

Before we look at the key players and components that led to the subprime mortgage crisis, it's important to go back a little further and examine the events that led up to it.

In early 2000, the economy was at risk of a deep recession after the dotcom bubble burst. Before the bubble burst, tech company valuations rose dramatically, as did investment in the industry. Junior companies and startups that didn't produce any revenue yet were getting money from venture capitalists, and hundreds of companies went public. This situation was compounded by the September 11 terrorist attacks in 2001. Central banks around the world tried to stimulate the economy as a response. They created capital liquidity through a reduction in interest rates. In turn, investors sought higher returns through riskier investments.

Enter the subprime mortgage. Lenders took on greater risks, too, approving subprime mortgage loans to borrowers with poor credit, no assets, and—at times—no income. These mortgages were repackaged by lenders into mortgage-backed securities (MBS) and sold to investors who received regular income payments just like coupon payments from bonds. But consumer demand drove the housing bubble to all-time highs in the summer of 2005, which ultimately collapsed the following summer.

Don't Forget the Hedge Funds

Another party added to the mess was the hedge fund industry. It aggravated the problem not only by pushing rates lower, but also by fueling market volatility that caused investor losses. The failures of a few investment managers also contributed to the problem.

To illustrate, there is a hedge fund strategy best described as credit arbitrage. It involves purchasing subprime bonds on credit and hedging the positions with credit default swaps. This amplified demand for CDOs. By using leverage, a fund could purchase many more CDOs and bonds than it could with existing capital alone, pushing subprime interest rates lower and further fueling the problem. Moreover, because leverage was involved, this set the stage for a spike in volatility, which is exactly what happened as soon as investors realized the true, lesser quality of subprime CDOs.

Because hedge funds use a significant amount of leverage, losses were amplified and many hedge funds shut down operations as they ran out of money in the face of margin calls.

The Bottom Line

There may have been a mix of factors and participants that precipitated the subprime mess, but it was ultimately human behavior and greed that drove the demand, supply, and investor appetite for these types of loans. Hindsight is always 20/20, and it is now obvious there was a lack of wisdom on the part of many. However, there are countless examples of markets lacking wisdom. It seems to be a fact of life that investors will always extrapolate current conditions too far into the future.

Required:

- i. Exound any THREE ways in which alternative investments could have averted the above crisis (6 marks)
 - ii. Discuss any THREE potential benefits that could have resulted to application of alternative investments in the above scenario (6 marks)
 - iii. Explain any channels within alternative investments that could have rescued the above crisis (6 marks)
 - iv. Explain any THREE alternative investments strategies that could help mitigate the above crisis
*Private equity funds
Real estate investments
Commodities* (6 marks)
- b) A bond was originally issued to have a life of 20 years. Its book value is 1,000 with an interest rate of 10%. If the investors required rate of return on the bond currently stands at 12%, determine the bonds current value.
$$\frac{1}{1+12\%} = \frac{1000}{1200}$$
 (6 marks) ✓

QUESTION TWO (20 Marks)

- a) Discuss the portfolio management process giving relevant examples (8 marks)
- b) Discuss diversification with respect to equity portfolio risks (6 marks)
- c) Discuss the Key asset allocation techniques for equities and bonds (8 marks)
*Strategic asset allocation
Tactical asset allocation*

QUESTION THREE (20 Marks)

- a) Highlight the contents of an investment policy statement (IPS) and prepare a sample for a hypothetical investor (10 marks)
- b) A company plans to issue 10,000 new shares each at par. The company pays a dividend of Sh 12 per share initially and growth in dividends is expected to be 5% with a cost of equity of 17.5%

Required:

- a. Compute the value of new issue of equity shares. (5 marks)
- b. If the cost of equity is 15.42% what is the current market price of an equity share. (5 marks)

QUESTION FOUR (20 Marks)

- a) Discuss any FIVE alternative portfolio investments and how to manage them (7 marks)
- b) Giving relevant examples discuss any THREE passive bond portfolio management strategies (7 marks)
- c) Describe issues in valuing and calculating returns on hedge funds (6 marks)

QUESTION FIVE (20 Marks)

- a) Giving relevant examples discuss any **FIVE** alternative investments management strategies (10 marks)
- b) Explain any **THREE** real estate valuation approaches (6 marks)
- c) Explain the portfolio approach to investments (4 marks)