# THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

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**MAIN EXAMINATION**

**SEPTEMBER –DECEMBER 2021**

**FACULTY OF SCIENCE**

**DEPARTMENT OF MATHEMATICS**

**REGULAR PROGRAMME**

**MAT 465: TIME SERIES ANALYSIS**

| | |
|---|---|
| **Date: DECEMBER 2021** | **Duration: 2 Hours** |
| **INSTRUCTIONS: Answer Question ONE and any TWO Questions** | |



Q1.

a) Define the following terms as used in time series analysis. **(8 Marks)**

i) Autoregressive process of order p $AR_{(p)}$

ii) Stationarity

iii) Strict stationarity

iv) Weak stationarity

b) Give the assumptions of stationarity. **(4 Marks)**

c) State and describe the components of time series analysis. **(8 Marks)**

d) Consider data with a linear trend that is modeled by $X_t = \beta_0 + \beta_1 t + e_t$ where $e_t$ is a stationary time series. Perform the first order differencing and show that it results to a stationary time series with no trend. **(5 Marks)**

e) The $AR_{(2)}$ process is given by

$X_t = 0.75\,X_{t-1} - 0.125\,X_{t-2} + Z_t$ Calculate the roots of the process and indicate whether the process is stationary. **(5 Marks)**

Q2.

a) Calculate the 3-year moving averages for the loans issued by cooperative banks for non farm sector based on the values given below. **(10 Marks)**

| Year | 2004−05 | 2005−06 | 2006−07 | 2007−08 | 2008−09 | 2009−10 | 2010−11 |
|---|---|---|---|---|---|---|---|
| Loan in Rupees | 41.82 | 40.05 | 39.12 | 24.72 | 26.69 | 59.66 | 23.65 |

| Year | 2011−12 | 2012−13 | 2013−14 | 2014−15 |
|---|---|---|---|---|
| Loan in Rupees | 28.36 | 33.31 | 31.60 | 36.48 |

b) Consider with a quadratic trend that is modeled by $X_t = \beta_0 + \beta_1 t + \beta_2 t^2 + s_t + e_t$ where $e_t$ is a stationary time series. Perform the second order differencing and show that it results in stationary series with no trend. **(10 Marks)**



Q3.

a) Foreigners in a certain country for 6 consecutive years are given in the table below. Use the method of least squares to calculate the trend values. **(20 Marks)**

| Year | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|
| No. of foreigners | 15 | 16 | 21 | 23 | 27 | 31 |

Q4.

a) Find the trend value by semi-average method for the following data. **(12 Marks)**

| Year | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 |
|---|---|---|---|---|---|---|---|---|
| Production in tonnes | 7.4 | 10.8 | 9.2 | 10.5 | 15.5 | 13.7 | 16.7 | 15 |

b) Show that regardless of the lag, an $AR_{(1)}$ process has mean zero by calculating the mean of the process using back substitution. **(8 Marks)**

Q5.

a) Obtain the seasonal indices for the rainfall (in mm) data in India given in the following table. **(14 Marks)**

| Quarter \Year | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|
| I | 38.2 | 38.5 | 55 | 50.5 |
| II | 166.8 | 250.9 | 277.7 | 197 |
| III | 612.6 | 773.1 | 717.8 | 706.1 |
| IV | 72.2 | 153.1 | 65.8 | 101.1 |

b) Consider the data that arise from the model $X_t = \beta_0 + \beta_1 t + \beta_2 t^2 + s_t + e_t$ which has a quadratic trend and a seasonal component with period $d$. Perform seasonal differencing to make the process stationary. **(6 Marks)**



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