Course Name: **TIME SERIES**

Course Code: **STAT3002**

Number of Credits: **3**

Semester: **II**

Level: **3**

Pre-requisites: **MATH2404, STAT2001**

RATIONALE: A time series is a set of data consisting of observations made one after another in time; the observations are related and it is this feature of dependence, which any analysis must exploit. Time series is an area of statistics of enormous practical importance in finance, economics, agriculture, industry and many other fields.

COURSE DESCRIPTION: The course begins with real data, and some descriptive methods for identifying, and removing if appropriate, trend (long-term changes in level) and seasonal effects, using some very simple models. We consider moving averages and exponential smoothing, along with other approaches. This leads us in to the important concepts of stationarity and autocorrelation.
The main body of the course consists of modelling the stochastic mechanism, which gives rise to an observed series, and then using model-based forecasting procedures to predict future values of the series. Alongside real data, simulations are used extensively, as is the statistical package R/Minitab.

LEARNING OUTCOMES: At the end of the course, students will be able to:

- Demonstrate the main features of a time series data
- Define and apply basic time series concepts and terminology
- Interpret and evaluate time series models fitted by computer packages
- Formulate time series models for a given scenario
- Apply a suite of time series methods to real world problems
- Assess and validate time series models
- Test learning outcomes through written assignments

CONTENTS

Introduction: definition, notation and objectives of time series analysis; types of series; simple models and descriptive techniques:-additive, multiplicative models, trend, seasonality, cycles,

noise, fits; test for randomness; *describing serial dependence:*-autocorrelation coefficients, sample correlation function and correlogram; *describing seasonality:*-seasonal adjustment; *describing trend(smoothing):*- filters and moving averages, differencing, Slutzky-Yule effect, exponential smoothing and other methods; Operators.

Stationary Processes: strict and second-order stationarity (mean, variance, covariance); autocorrelation function, autocovariance and autocorrelation functions, partial autocorrelation function and general linear process

Models for time series: definitions and properties of the following:-

- MA:-correlogram, generating functions, invertibility
- AR:-linear difference equations, characteristic equation, stationarity, Yule-Walker and Wold equations, correlogram
- ARMA:-stationarity, invertibility, correlogram, extension to integrated processes
- ARIMA:-difference equation, general linear process, inverted form, $E\left(Y \text{ at time } t+k \mid \text{knowledge up to time } t\right)$

Model Building

- Model identification: differencing to produce stationarity, estimating the correlogram:-sampling properties of sample autocorrelation coefficients; partial autocorrelation coefficients, estimating the partial correlation function
- Model fitting: estimation of parameters:- method of moments, least squares, maximum likelihood; fitted values, residuals
- Model diagnostics: residuals analysis, principle of parsimony, AIC, BIC

Forecasting: Forecasting under fitted ARIMA models, Box-Jenkins forecasting

Financial time series: features of financial time series, ARCH(1) model

TEACHING METHODOLOGY: The course will be a mixture of lectures, tutorials and computer laboratory. The 39 contact hours is consists of: 26 hours of lectures, 8 hours of tutorial and 10 hours of supervised laboratory time. The tutorial will be interspersed with the lectures by having students discuss exercises, revise material as needed, and cover new content each day. Course materials such as exercises, assignments, solutions, etc., will be posted on the webpage http://ourvle.mona.uwi.edu/

ASSESSMENT: The course assessment entails a course- work component worth **40%** and a final exam worth **60%**. The **Final examination** will be **two hours** in length.

The Coursework element will consist of two parts:

i. Mid-term test (1 hour), worth **15%** of the student's final grade
ii. Problems papers/lab assignments, worth **25%**

REFERENCE MATERIAL

Books:

[Prescribed]

1) Jonathan, C. & Chen, K. (2010). *Time Series Analysis with Application in R (1st Edn)* Springer, ISBN: 978-1441926135

[Recommended]

2) Shumway, R. & Stoffer, D (2010). *Time Series Analysis and Its Application with R Examples (3rd Edn).* Springer, ISBN: 978-1441978646

3) Cowpertwait, P, & Metcalfe, A. (2009). *Introductory Time Series with R (1st Edn)*, Springer, ISBN:978-0387886978

4) Chatfield, C. (2003). *The Analysis of Time Series An Introduction (6th Edn)*, Chapman and Hall/CRC, ISBN:978-1584883173

5) Brockwell, P. & Davis. C. (2002). *Introduction to Time Series and Forecasting (2nd Edn)*, Springer, ISBN: 978-0387953519

On-line resources:

1. http://www.causeweb.org/resources/: Supplementary material, including datasets
2. http://www.r-project.org/: software download and documentation
3. Internet Google the topics