

# University of Ruhuna

## Bachelor of Science (Special) Degree

### LEVEL II (Semester II) Examination-August 2017

**Subject: Statistics**

**Course Unit: MST 4144 (Time Series Analysis - Theory)**

**Answer All Questions. No. of Pagers: Three (03)**

**Time: Two (02) hours**

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(01) (a) What are the classical linear regression model assumptions? How do we violate the classical linear assumptions under the ordinary least squares (OLS)? Briefly explain.

[20 Marks]

(b) For the regression with only a constant  $Y_i = \alpha + u_i$  with  $u_i \sim \text{IID}(0, \sigma^2)$ . Prove the following properties.

(i)  $E[\hat{\alpha}_{OLS}] = \alpha$

[15 Marks]

(ii)  $\text{Var}(\hat{\alpha}_{OLS}) = \frac{\sigma^2}{n}$

[25 Marks]

(c) For the regression without a constant  $Y_i = \beta X_i + u_i$  with  $u_i \sim \text{IID}(0, \sigma^2)$ ,

(i) Derive the OLS estimator of  $\beta$  and find its expectation and variance.

[20 Marks]

(ii) What numerical properties of the OLS estimators still hold for this model?

[20 Marks]

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(02) (a) What are the practical importances of Time series analysis?

[15 Marks]

(b) Briefly explain the additive and multiplicative model selection criterion in time series analysis.

[15 Marks]

- (c) The following table gives the average quarterly prices (Rupees per kilogram) of rice for five years.

Quarter	Year				
	2012	2013	2014	2015	2016
I	16	15	17	17	18
II	21	20	24	25	26
III	9	10	13	11	14
IV	18	18	22	21	25

- (i) By assuming the suitable model (additive or multiplicative), estimate the seasonal indices for each quarter.

[15 Marks]

- (ii) Estimate the de-seasonalized series for the given data

[20 Marks]

- (iii) Estimate the trend by using the ordinary least square (OLS) method.

[20 Marks]

- (iv) Forecast the mean prices of rice for the first two quarters of the year 2017.

[15 Marks]

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- (03) (a) Briefly explain the four main types of variation in time series data with suitable examples.

[15 Marks]

- (b) Briefly explain what is meant by a time series to be stationary? If the series is non-stationary, explain the methods to convert it to be a stationary series? Explain with examples.

[25 Marks]

- (c) The following table gives data on percentage change per year for Consumer Price Index (CPI) for 10 years from 2010-2014.

Year	2010	2011	2012	2013	2014
CPI	13	24	39	65	106

- (i) Plot the data. Discuss the behavior of the time series

[10 Marks]

(ii) Fit the most suitable trend model for the given data.

[10 Marks]

(iii) Forecast the present change per year for Consumer Price Index (CPI) for years 2015 and 2016.

[20 Marks]

(iv) Discuss the cyclical variation of data using a suitable model.

Hint: Relative cyclical residual :  $\frac{Y-\bar{Y}}{\bar{Y}} \times 100$

[20 Marks]

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(04) (a) Why do we use Autoregressive Conditional Heteroscedasticity (ARCH) models for financial time series forecasting than OLS regression methods? Briefly explain.

[15 Marks]

(b) Discuss the properties of ARCH (1) and GRACH (1,1).

[15 Marks]

(c) Define the following statements

(i) The  $MA(1)$  is a weakly stationary series

[15 Marks]

(ii) AR(1) process is an infinite order MA process which is stationary if  $|\alpha| < 1$ .

[20 Marks]

(d)  $X_t = X_{t-1} + Z_t$ ; Where  $Z_t$  is purely random process with mean  $\mu$  and variance  $\sigma^2$ .

(i) Discuss the stationary and non-stationary conditions of random walk process  $X_t$

[20 Marks]

(ii) If the random walk process is non-stationary, propose a suitable method to convert it to stationary series. Discuss your results.

[15 Marks]