Discipline Specific Elective (DSE) Course 1b: Time Series Analysis

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Prerequisite of the course (if any)
		Lecture (45 Hours)	Tutorial (00 Hours)	Practical (30 Hours)		
DSE 1b: Time Series Analysis	**4**	**3**	**0**	**1**	**NIL**	**NIL**

Course Objectives:

- To teach the time series modelling and the concept of forecasting and future planning.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Time series analysis concepts to practical data scenarios.
- Techniques to identify and analyze trends and seasonality.
- Various time series models, including MA, AR, ARMA, and ARIMA, for data modeling.
- Time series models for effective forecasting.
- Information criteria (AIC, BIC) to select the most suitable models.
- Yule-Walker equations to analyze AR processes.
- Methods to address non-stationarity in time series data.
- The random walk model and conduct the Dickey-Fuller test for unit root analysis.

Unit I (10 Hours)

Time series as a stationary or nonstationary stochastic process, sample autocovariance function (ACVF) and autocorrelation function (ACF) at lag k, partial autocorrelation function (PACF), correlogram, lag operators and linear filters, Ergodicity and Stationarity.

Unit II (12 Hours)

Wald decomposition, Generic linear process and its ACVF, ACF. Autoregressive (AR) process, moving average (MA) process, ACF and PACF for AR and MA processes, Yule-Walker equations for AR processes.

Unit III (12 Hours)

Stationarity and invertibility conditions, ARIMA (p,d,q) model, estimation of parameters for AR, MA, ARMA and ARIMA processes, identification of processes with ACF PACF, Model estimation techniques-AIC, AICC, BIC, etc.

Unit IV (11 Hours)

Forms of non-stationarity in time series, random walk model, Dickey-Fuller test for unit root. ARCH and GARCH Processes, order identification, estimation, diagnostic.

Essential Readings:

1. Box, G.E.P., Jenkins, G.M., Reinsel, G.C., Ljung, G.M. (2015). *Time Series Analysis-Forecasting and Control*, John Wiley & Sons.
2. Brockwell, P.J. and Davies, R.A. (2009). *Introduction to Time Series and Forecasting*, Springer.

Suggested Readings:

1. Chatfield, C. (1975). *The Analysis of Time series: Theory and Practice*, Chapman & Hall.
2. Chatfield, C. (2003). *Analysis of Time Series, An Introduction*, CRC Press.
3. Jonathan, D.C. and Kung, S.C. (2008). *Series Analysis with Application in R*. Springer
4. Kendall, M. G. and Ord, J. K., *Time Series*, Edward Arnold.
5. Montgomery, D.C. and Johnson, L.A. (1977). *Forecasting and Time series Analysis*, McGraw Hill.
6. Montgomery, D.C., Jennings, C. and Kulahci, M. (2016). *Introduction to Time Series Analysis and Forecasting*, John Wiley & Sons.
7. Shumway, R.H. and Stoffer, D.S. (2017). *Time Series Analysis and Its Applications: With R Examples*, Springer.

List of Practicals:

1. Calculate and plot descriptive statistics (mean, variance, autocorrelation, partial autocorrelation), create time plots.
2. Identify potential trends and seasonality.
3. Identify potential ARIMA(p,d,q) models based on ACF/PACF plots.
4. Identify potential ARIMA(p,d,q) models based on unit root tests.
5. Compare the performance of different ARIMA models (e.g., different orders) using information criteria (AIC, BIC).
6. Implementing Dickey-Fuller (or other unit root) tests on various datasets to determine stationarity.