NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech All (Other than CSE)
Course Code:	3CS106IE24
Course Title:	Time Series Analysis
Course Type:	Interdisciplinary Minor-Elective
Year of Introduction:	2024-25

L	T	Practical Component				C
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Course Learning Outcomes (CLO):

At the end of the course, the students will be able to –

1. illustrate the basics of time series data (BL2)
2. experiment with time series models and components (BL3)
3. evaluate time series analysis in practical scenarios (BL5)
4. interprete the validations of various time series models. (BL5)

Unit	Contents	Teaching Hours (Total 45)
Unit-I	**Introduction to Time Series Analysis:** Overview of time series data, Importance of time series analysis, Types of time series data patterns, Time series data visualization techniques, Sources of time series data (e.g., economic indicators, stock prices), Software tools for time series analysis (e.g., Python libraries)	05
Unit-II	**Time Series Components and Decomposition:** Understanding trend, seasonality, and noise, Decomposition methods and techniques, Identifying and handling outliers in time series data, Advanced decomposition methods (e.g., STL decomposition), Time series data transformation techniques (e.g., differencing), Practical considerations in dealing with missing data in time series	09
Unit-III	**Time Series Models** – ARIMA, Exponential Smoothing and Deep Learning Models, Introduction to ARIMA models, Components of ARIMA (p, d, q), Seasonal ARIMA (SARIMA) models, Exponential smoothing models (Simple Exponential Smoothing, Holt-Winters), Model diagnostics and parameter estimation, Forecasting with ARIMA and Exponential Smoothing models, Introduction to Simple RNN, LSTM, GRU	15
Unit-IV	**Model Evaluation and Validation:** Importance of model evaluation, Metrics for assessing time series model performance, Cross-validation techniques, Out-of-sample testing and back testing, Residual analysis, and diagnostic checks, Comparing and selecting the best-fitting models	08
Unit-V	**Applications of Time Series Analysis:** Real-world case studies, Application of time series analysis in finance, economics, and other fields, communicating results and making informed decisions, Time series analysis for anomaly detection, Ethical considerations in time series analysis (e.g., privacy concerns)	08

Self-Study:
The self-study contents will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study contents

Suggested Readings/ References:

1. Peter J. Brockwell and Richard A. Davis, Introduction to Time Series and Forecasting, Springer
2. George E. P. Box, Gwilym M. Jenkins, and Gregory C. Reinsel, Time Series Analysis: Forecasting and Control, Wiley
3. Rob J Hyndman and George Athanasopoulos, Forecasting: Principles and Practice, OTexts
4. Terence C. Mills, Applied Time Series Analysis, Academic Press

Suggested List of Experiments:

Sr. No.	Title	Hours
1	Import a time series dataset (e.g., stock prices, weather data). Explore and visualize the time series data, including trends and seasonality.	02
2	Handle missing values and outliers in the time series data. Apply differencing or other transformations to make the data stationary.	02
3	Decompose a time series into its trend, seasonality, and residual components. Visualize and interpret the decomposition results.	02
4	Fit an ARIMA model to a given time series. Based on diagnostic checks, choose the appropriate model order (p, d, q).	02
5	Extend the ARIMA modeling exercise to include seasonality (SARIMA). Evaluate and compare the performance with the non-seasonal ARIMA model.	04
6	Fit a simple exponential smoothing model to a time series. Experiment with different smoothing parameters and evaluate their impact.	04
7	Split the time series data into training and testing sets. Evaluate the performance of the chosen model using metrics like Mean Absolute Error (MAE) or Root Mean Squared Error (RMSE).	02
8	Generate forecasts using the trained time series model. Compare the forecasts with the actual values and visualize the results.	02
9	Explore more advanced forecasting techniques, such as machine learning models (e.g., LSTM for time series prediction). Compare the performance of these models with traditional time series models.	06
10	Apply time series analysis to a real-world problem or dataset of interest (e.g., financial data, energy consumption). Develop a comprehensive analysis, including data preprocessing, modeling, and interpretation.	04