NIRMA UNIVERSITY

Institute:	Institute of Technology, School of Technology
Name of Programme:	MTech CSE (Data Science)
Course Code:	6CS380ME25
Course Title:	Multimedia and Time Series Data Analytics
Course Type:	Department Elective-II
Year of Introduction:	2025-26

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Course Learning Outcomes (CLO):

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

1. summarise the fundamental concepts of multimedia data (image, audio, video) and time series data (BL2)
2. make use of algorithms for representation, processing, and analysis of multimedia and time series data (BL3)
3. examine algorithms and models for classification, clustering, and forecasting (BL4)
4. build applications for processing multimedia and time series data using libraries and frameworks. (BL6)

Unit	Contents	Teaching Hours (Total 30)
Unit-I	**Introduction to Multimedia and Time Series Data:** Types of multimedia data: Images, audio, video, Characteristics and challenges of time series data, Applications in speech recognition, finance, healthcare, and environmental monitoring	03
Unit-II	**Fundamentals of Image, Audio, and Video Processing:** Basics of digital images: Pixels, histograms, filtering, Fundamentals of audio signals: Waveforms, spectrograms, feature extraction, Video processing: Frames, motion estimation, keyframe extraction, Tools: OpenCV, Librosa, FFmpeg	05
Unit-III	**Time Series Representation and Feature Engineering:** Time domain vs. frequency domain representation, Statistical features (mean, variance, skewness), Fourier and wavelet transforms, Autoregressive (AR), Moving Average (MA), and ARMA models	07
Unit-IV	**Machine Learning for Multimedia and Time Series Analytics:** Feature extraction and dimensionality reduction (PCA, t-SNE), Classification and clustering (SVM, k-NN, k-Means, DBSCAN), Deep learning models: CNNs for images, RNNs and LSTMs for time series, Use cases: Audio classification, image recognition, video summarization	08

Unit-V	**Forecasting and Predictive Analytics in Time Series:** Stationarity and differencing, ARIMA, SARIMA, GARCH models, Deep learning for forecasting: LSTMs, Transformer-based models, Anomaly detection in time series data	05
Unit-VI	**Applications and Case Studies:** Speech and music information retrieval, Stock market prediction, Weather and climate forecasting, Healthcare applications: ECG and EEG analysis.	02

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 content.

Suggested Readings/ References:

1. Bishop, C. M., Pattern Recognition and Machine Learning, Springer
2. Hastie, T., Tibshirani, R., & Friedman, J, The Elements of Statistical Learning, Springer
3. Box, G. E., Jenkins, G. M., Reinsel, G. C., & Ljung, G. M., Time Series Analysis: Forecasting and Control, Wiley
4. Gonzalez, R. C., & Woods, R. E., Digital Image Processing. Pearson
5. Shumway, R. H., & Stoffer, D. S., Time Series Analysis and Its Applications, Springer
6. Goodfellow, I., Bengio, Y., & Courville, A., Deep Learning, MIT Press
7. Oppenheim, A. V., & Schafer, R. W., Discrete-Time Signal Processing, Pearson
8. Müller, A. C., & Guido, S., Introduction to Machine Learning with Python, O'Reilly.

Suggested List of Experiments:

Sr. No.	Name of Experiments/Exercises	Hours
1	Image Processing basics	02
2	Audio Signal analysis and feature extraction	02
3	Video frame extraction and motion analysis	02
4	Time series data preprocessing and visualization	02
5	Statistical Analysis and Feature Engineering for Time Series	02
6	Time Series Forecasting using ARIMA	04
7	Deep Learning for Time Series Forecasting (LSTMs)	04
8	Image Classification using CNNs	04
9	Audio Classification using Machine Learning	04
10	Anomaly Detection in Time Series Data.	04