List of Elective Courses Offered by B. Tech. CSE Data Science & Analytics (DSA)

Scheme

Course Code	Course Name	L	T	P	Credits
CSL472	Design Patterns	3	0	2	4
CSL473	Web and Network Data Science	3	0	0	3
CSL474	Time Series Analysis	3	0	2	4

Note: The elective courses from elective buckets of B.Tech in CSE (with specialization) can be offered to B.Tech CSE (Core) students and Vice-versa.

Syllabus

Course Code:	**CSL 472**	**Course Title:**	**Design Patterns**			
Category:	**Elective**	**Credit Assigned:**	**L**	**T**	**P**	**C**
			3	**0**	**2**	**4**
Pre-Requisite (if Any):	**None**	**Type of Course:**	**Computer Science and Engineering**			

Course Outcomes:

On successful completion of the course, students will be able to:

1. Understand the role of design patterns in software development and maintaining code quality.
2. Analyse the trade-offs of applying a design pattern to a given problem
3. Implement solutions for object creation, their structure, and interaction between objects.
4. Develop loosely coupled and scalable software solutions.

Course Contents:

Module 1: Foundations of Software Engineering & Object-Oriented Design

Software Development Lifecycle and Challenges, Need for Design Patterns, SOLID Principles - Single Responsibility, Open-Closed, Liskov Substitution, Interface Segregation, Dependency Inversion, UML Diagrams for Design Patterns - Class, Sequence, Interaction Diagrams, Introduction to Code Refactoring

Module 2: Creational Design Patterns

Implementation, Use Cases, and Examples of Factory Method Pattern , Abstract Factory Pattern, Singleton Pattern and Thread Safety Considerations, Prototype Pattern, Stepwise Object Construction using Builder Pattern.

Module 3: Structural Design Patterns

Ensuring compatibility using Adapter Pattern, Bridge Pattern, Composite Pattern, Dynamic functionality addition using Decorator Pattern, Facade Pattern to simplify Complex Interfaces, Flyweight Pattern, Controlling Object Access by Proxy Pattern

Module 4: Behavioural Design Patterns

Chain of Responsibility Pattern, Command Pattern, Interpreter Pattern, Iterator Pattern, Mediator Pattern, Memento Pattern, Observer Pattern, State Pattern, Strategy Pattern, Template Method Pattern , Visitor Pattern

Module 5: Applying Design Patterns in Real-World Scenarios

Use of Design Patterns in Large Software Systems, Design Patterns in Modern Frameworks (Spring/Django/React/Angular/.NET, etc.), Anti-patterns & Common Mistakes in Design Pattern Usage, Project: Implementing Multiple Patterns in a Real Application

Text Books:

1. "Design Patterns: Elements of Reusable Object-Oriented Software", Gamma, E., Helm, R., Johnson, R., & Vlissides, J. 1st Edition, Addison-Wesley, 1994,.
2. "Design Patterns Explained: A New Perspective on Object-Oriented Design", Shalloway, A., & Trott, J., 2nd Edition, Addison-Wesley, 2004.

Reference Books:

1. "Head First Design Patterns." Freeman, E., Freeman, B., Sierra, K., & Bates, B. , 1st Edition, 2004, O'Reilly Media.
2. "Patterns in Java", Grand, M. Volume 1, 2nd Edition, 2002, Wiley India Pvt. Ltd.

CO PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3		2	2	3	3	3	2	3
CO2	3	3	2	3	2	1			3		2	3
CO3	3	3	3	3	3				3	2	3	3
CO4	3	2	3	3	3	2		2	3	3	3	3

Note:
3: High
2: Medium
1: Low

<table>
<tr><td>Course Code:</td><td>CSL 473</td><td>Course Title:</td><td>Web and Network Data Science</td></tr>
<tr><td>Category:</td><td>Elective</td><td>Credit Assigned</td><td><table><tr><td>L</td><td>T</td><td>P</td><td>C</td></tr><tr><td>3</td><td>0</td><td>0</td><td>3</td></tr></table></td></tr>
<tr><td>Pre-Requisite (if any)</td><td>None</td><td>Type of Course</td><td>Computer Science and Engineering</td></tr>
<tr><td colspan="4">Course Outcomes:
On successful completion of the course, students will be able to:
1. Understand the fundamental concepts of web and network data.
2. Analyse structured and unstructured web data, including social media, text, and hyperlinks.
3. Learn network science techniques for analysing graph-based data.
4. Implement data mining, crawling, and extraction techniques for web data.
5. Develop applications using web data and network analytics.</td></tr>
<tr><td colspan="4">Course Contents:

Module-1: Introduction to Web and Network Data Science
Introduction to networks: nodes, edges, and graph representations, Overview of Web and Network Data Science, Web Data vs. Network Data, Sources of Web Data: Social Media, Blogs, E-commerce, Introduction to Graphs and Networks, Applications of Web and Network Analytics.

Module -2: Web Data Collection and Processing
Web Crawling Techniques, Web Scraping with BeautifulSoup & Scrapy, APIs for Web Data: Twitter, Facebook, Google, and Open Data APIs, Handling Structured and Unstructured Web Data, Text Processing & NLP Basics Tokenization, Stemming, Lemmatization Sentiment Analysis & Topic Modelling.

Module -3: Social Network Analysis (SNA)
Graph Representation of Networks, Key Network Properties: Degree, Clustering Coefficient, Path Length, Centrality Measures: Degree, Closeness, Betweenness, Eigenvector, Community Detection: Girvan-Newman, Louvain Algorithm, Case Study: Twitter/Facebook/LinkedIn Data Analysis.

Module-4: Network Models & Graph Algorithms
Random Graphs & Small-World Networks, Scale-Free Networks & Power-Law Distributions, PageRank Algorithm & Web Search, Link Prediction & Recommendation Systems, Graph Embedding & Node2Vec, Community detection algorithms (Girvan-Newman, Louvain), Network metrics and analysis.

Module-5: Advanced Web and Network Mining Techniques
Community Detection in Large Graphs, Influence Propagation & Viral Marketing, Fraud Detection using Graph Analytics, Deep Learning for Graph Data: Graph Convolutional Network (GCN),</td></tr>
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Graph Attention Network (GAT), Ethical Issues in Web and Network Data Science, Web traffic analysis and recommendation systems.

Text Book:

1. "Web and Network Data Science Modeling Techniques in Predictive Analytics", Thomas W. Miller, PearsonFT Press, 2014.

Reference Books:

1. "Web Scraping with Python", Ryan Mitchell, 2nd Edition, O'Reilly Media, 2018.
2. "Network Science", Albert Barabasi, 1st edition, Cambridge University Press, 2016.

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1		2								
CO2	2	1	2	2								
CO3	2	3	3	3								3
CO4		3	2	1	4	1						
CO5		3		1		1						

Note:
3: High
2: Medium
1: Low

Course Code:	**CSL 474**	**Course Title:**	**Time Series Analysis**
Category:	**Elective**	**Credit Assigned**	**L** **T** **P** **C** **3** **0** **2** **4**
Pre-Requisite (if Any)	**None**	**Type of Course**	**Computer Science and Engineering**

Course Outcomes:
On successful completion of the course, students will be able to:

1. Understand Time Series Fundamentals
2. Perform Time Series Preprocessing and Decomposition
3. Analyze and Model Time Series Data
4. Implement Advanced Forecasting Methods
5. Develop Practical Forecasting Solutions

Course Contents:
Module 1: Introduction to Time Series

Definition and Applications of Time Series; Components of Time Series: Trend, Seasonality, Cyclicality, and Irregularity; Time Series Data Visualization; Basic Summary Statistics and Moving Averages.

Module 2: Stationarity and Data Transformations
Definition of Stationarity; The Augmented Dickey-Fuller (ADF) and KPSS Tests; Differencing and Detrending; Log, Box-Cox, and Power Transformations.

Module 3: Time Series Decomposition
Classical Decomposition Methods such as EMD, DWT, EEMD, CEEMD etc.; Additive vs. Multiplicative Models; STL (Seasonal-Trend Decomposition using LOESS).

Module 4: ARIMA and SARIMA Models
Autoregressive (AR), Moving Average (MA), and ARMA Models; Partial and Auto-Correlation Functions (PACF & ACF); Model Selection Using Information Criteria (AIC, BIC); ARIMA (Autoregressive Integrated Moving Average); Seasonal ARIMA (SARIMA); Model Identification using Grid Search and ACF/PACF; Hands-on Forecasting with Python.

Module 5: Advanced Forecasting Techniques
Classical and Modern Forecasting Methods; Multivariate Time Series Models: Vector Autoregression (VAR), Vector Error Correction Model (VECM); Exponential Smoothing Methods (Holt-Winters, ETS); Autoregressive Conditional Models: ARCH and GARCH Models for Volatility Modeling; Regression-Based Forecasting Models; Deep Learning Models for Time Series Forecasting: Long Short-Term Memory (LSTM), GRU Networks , and Convolutional Neural Networks (CNNs); Transformer-Based Time Series Forecasting; Case Studies in Finance, Economics, and Climate Science.

Text Books:

1. "Time Series Analysis and Its Applications", Robert H. Shumway & David S. Stoffer, 4th Edition, Springer Publication, 2017.
2. "Forecasting: Principles and Practice", Rob J. Hyndman & George Athanasopoulos, 2nd Edition, O Text Publication, 2021.

Reference Books:

1. "Introduction to Time Series and Forecasting", Peter J. Brockwell & Richard A. Davis, 3rd Edition, Springer Publication, 2016.
2. "Hands-On Time Series Analysis with Python", B V Vishwas , Ashish Patel, First Edition, A Press, 2020.
3. "Deep Learning for Time Series Forecasting", Jason Brownlee, Ebook, Machine Learning Mastery, 2018.

CO PO Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1 1	PO12
CO1	3	1		2					1			2
CO2	2	1	2	2	1				1			2
CO3	2	3	3	1	2				1			2
CO4		3	2	1	1	1			1			2
CO5		3		1	1	1		2	1			2

Note:

3: High **2: Medium** **1: Low**