AMRITSAR GROUP OF COLLEGES

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SYLLABUS

B. Tech. (CSE): 7th/8th SEM

7th/8th Semester	AGCS-21701: DATA SCIENCE				
Internal Marks:	**40**		**L**	**T**	**P**
External Marks:	**60**		**3**	**1**	**0**
Total Marks:	**100**		**Credits**		**4**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understanding the foundations and applications of data science
CO-2	Mastering data acquisition and preparation techniques
CO-3	Refining data for analysis and harnessing exploratory insights
CO-4	Analyzing data through probabilistic inference and statistical methods
CO-5	Evaluating and fine-tuning predictive models for real-world application
CO-6	Exploring cutting-edge trends and crafting insights through data visualization

Part	Content	CO
I	**Introduction to data science:** Evolution, need and components of data science, data science process. difference between data science and business intelligence, applications of data science in various fields. ethical issues in data science, data privacy and security, responsible data use.	CO-1
II	**Data collection**: Data collection sources, data collection methods – interviews, questionnaires, databases, web scraping, apis. **Data cleaning techniques**: Handling missing values, data transformation, data normalization and standardization.	CO-2
	Data preprocessing: Data integration – data reduction data transformation and data discretization. exploratory data analysis –basic tools (plots, graphs and summary statistics) of eda, philosophy of eda – the data science process.	CO-3
III	**Probability and statistics:** Basic probability concepts, probability distributions (normal, binomial, poisson), bayes' theorem, inferential statistics, hypothesis testing, confidence intervals. **Understanding data analytics:** Need, characteristics, descriptive (mean, median, mode, variance, and standard deviation) predictive, diagnostic, prescriptive.	CO-4
IV	**Model evaluation and validation:** Linear regression, logistic regression, decision trees, k-nearest neighbors (k-nn), clustering (k-means), model evaluation metrics (RMSE, MAE, r^2), evaluation metrics (accuracy, precision, recall, f1score), train-test split, cross-validation, overfitting and underfitting, model tuning and hyperparameter optimization.	CO-5
	Recent trends: Benefits and best practices, data visualization: introduction to data visualization, acquiring and visualizing data, applications of data visualization, data visualization tools and techniques, **Real world applications:** Object Detection, Plagiarism Detection.	CO-6

References:

- "An Introduction to Statistical Learning: with Applications in R" by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani
- "The Elements of Statistical Learning: Data Mining, Inference, and Prediction" by Trevor Hastie, Robert Tibshirani, and Jerome Friedman
- "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython" by Wes McKinney
- "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron

7th/8th Semester	AGCS-21703: DATA SCIENCE LAB				
Internal Marks:	**30**		**L**	**T**	**P**
External Marks:	**20**		**0**	**0**	**2**
Total Marks:	**50**		**Credits**		**1**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Performing manipulation of data using Pandas.
CO-2	Performing basic web scraping and apply data cleaning techniques.
CO-3	Implement Exploratory Data Analysis (EDA) and advanced visualizations using matplotlib and seaborn.
CO-4	Applying various probability concepts.
CO-5	Evaluation of supervised learning models.
CO-6	Development and execution of Data Science project

Part	Content	CO
I	Writing Python scripts for basic data manipulation tasks. Importing and exporting data with Pandas. Performing basic data manipulation operations such as filtering, sorting, and grouping.	CO-1
II	Basic web scraping with Beautiful Soup Data Cleaning: Handling missing values, Data transformation and normalization, removing duplicates and dealing with outliers.	CO-2
	Exploratory Data Analysis (EDA) • Descriptive Statistics and Visualization ◦ Calculating summary statistics (mean, median, standard deviation). ◦ Creating basic plots (histograms, box plots) with matplotlib and seaborn. • Advanced Data Visualization ◦ Creating scatter plots, line plots, and bar charts. ◦ Customizing plots (titles, labels, legends, colors).	CO-3
III	Probability and Statistics • Basic Probability ◦ Simulating coin flips and dice rolls. ◦ Calculating probabilities and visualizing probability distributions. • Inferential Statistics ◦ Performing hypothesis tests. ◦ Creating and interpreting confidence intervals.	CO-4
IV	Introduction to Machine Learning • Supervised Learning Basics ◦ Implementing linear regression with scikit-learn. ◦ Evaluating model performance (R^2, MAE, RMSE). • Classification with Logistic Regression ◦ Building a logistic regression model. ◦ Evaluating classification performance (confusion matrix, accuracy, precision, recall). • Decision Trees and k-NN ◦ Implementing decision trees and k-nearest neighbors classifiers. ◦ Visualizing decision boundaries. • Model Evaluation ◦ Performing cross-validation. ◦ Hyperparameter tuning with GridSearchCV.	CO-5

IV	Data Science Project • Defining the Problem and Collecting Data ◦ Selecting a project topic. ◦ Collecting and preparing the dataset. • Data Cleaning and EDA ◦ Cleaning the dataset. ◦ Performing exploratory data analysis and visualization.	

References:

- "An Introduction to Statistical Learning: with Applications in R" by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani
- "The Elements of Statistical Learning: Data Mining, Inference, and Prediction" by Trevor Hastie, Robert Tibshirani, and Jerome Friedman
- "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython" by Wes McKinney
- "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron

7th/8th Semester	AGCS-21702A: SOFTWARE TESTING (PEC-3)				
Internal Marks:	**40**		**L**	**T**	**P**
External Marks:	**60**		**3**	**0**	**0**
Total Marks:	**100**		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the need of software testing
CO-2	Prepare test cases for different types and levels of testing
CO-3	Verify the intended functionality of software
CO-4	Create test plan for variety of applications
CO-5	Test software for specialized environment
CO-6	Understand best practices and industry standards in testing

Part	Content	CO
I	**Introduction to Software Testing -** Importance of software testing, Objectives of testing Types- Functional vs. Non-functional testing, Manual vs. Automated testing, Black-box vs. White-box testing, Regression, Integration, System, Acceptance testing, Test Planning and strategy, Test plan components, Writing and managing test cases, Traceability matrix and Documentation.	CO-1
II	**Techniques and algorithms for functional testing-**Black box testing -Equivalence Partitioning, Boundary Value Analysis, Decision Table Testing, State Transition Testing, Use Case Testing, Exploratory Testing, Model-Based Testing, Graphs based testing- Control Flow Graph, Data Flow Graph (DFG), State Transition Testing, Finite State Machine (FSM), Control Dependency Graph (CDG), Use Case Graph, Graph Matrix Methods, structural coverage criteria, Algorithms for test case design- Random Testing, Combinatorial Testing (Pairwise Testing), Genetic Algorithms, Model-Based Testing (MBT), Constraint-Based Testing, State Transition Testing, Classification Tree Method.	CO-2
	Techniques and algorithms for structural testing - Logic based Testing with predicates, Logic coverage criteria, Path testing, Graph metrices, Loop testing, Data flow testing, Mutation Testing, Specification based Logic Coverage- Predicate coverage, Clause coverage, Combinatorial coverage, Decision Coverage, Condition Coverage, Logic Coverage on Finite State Machines (FSMs)- State Transition Coverage, Path Coverage.	CO-3
III	**Input space partitioning:** Input domain modeling, Combination strategies criteria- Selection from each partition, pairwise testing, Orthogonal Arrays, Mixed strategy testing, Syntax based testing: Coverage criteria based on syntax -Statement Coverage, Branch coverage, Condition Coverage, Multiple condition coverage, path coverage, loop coverage, Mutation testing- Primary and Secondary mutants, mutation testing process.	CO-4
IV	**Testing for specialized environment:** Testing object-oriented software, web-based systems, Agile based software	CO-5
	Emerging Trends in Testing, Industry Best Practices and Standards: AI and machine learning in testing, testing for mobile applications, Cloud-based testing, Testing standards and certifications (e.g., ISTQB), Best practices for effective testing, Emerging trends in software testing, Case studies and real-world examples	CO-6

References:

- Software Testing: Principles and Practices, Srinivasan Desikan, Pearson
- Software Testing Principles and Practices, Naresh Chauhan, Oxford University Press
- Software Testing Techniques, 2nd edition, Boris Beizer, 1990
- Software Testing and Quality Assurance: Theory and Practice by Kshirasagar Naik and Priyadarshi Tripathy, Wiley-Spektrum
- Foundations of Software Testing, Dorothy Graham, Erik van Veenendaal, Isabel Evans, and Rex Black, Cengage

7th/8th Semester	AGCS-21702B: DEEP LEARNING (PEC-3)				
Internal Marks:	**40**		**L**	**T**	**P**
External Marks:	**60**		**3**	**0**	**0**
Total Marks:	**100**		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	To understand the basic principles and mathematical foundations of deep learning.
CO-2	To learn and apply neural networks for training deep learning models.
CO-3	To apply autoencoders and generative models for suitable applications.
CO-4	To analyse regularization in deep learning approaches.
CO-5	To provide a more scalable approach to visual detection and recognition tasks using CNN.
CO-6	To understand the vanishing gradient problem present in traditional RNNs

Part	Content	CO
I	**Introduction:** Historical context and motivation for deep learning; Advantages of deep learning over machine learning, Structure and working of deep learning, Detailed explanation of Perceptron, McCulloch Pitts Neuron, Thresholding Logic, Perceptron Learning Algorithm Optimization Techniques- Optimizing logistic classifier using gradient descent, stochastic gradient descent, momentum, adaptive sub-gradient method, Batch Optimization	CO-1
II	**Neural Networks:** Layers in the neural network, Multilayer Perceptron model deep networks, Feedforward and backpropagation, regularizing a deep network, model exploration, and hyper parameter tuning.	CO-2
	Autoencoders: Undercomplete autoencoders, regularized autoencoders, sparse autoencoders, Contractive autoencoders, Principal Component Analysis (PCA) and its interpretations, Autoencoders and relation to PCA, Regularization in autoencoders, denoising autoencoders, stochastic encoders and decoders.	CO-3
III	**Regularization:** Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout.	CO-4
IV	**Convolutional Neural Networks:** Introduction to convolution neural networks: stacking, striding and pooling, applications like image, and text classification, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art.	CO-5
	Sequence Modeling: Recurrent Nets: Unfolding computational graphs, recurrent neural networks (RNNs), bidirectional RNNs, encoder-decoder sequence to sequence architectures, deep recurrent networks, LSTM networks.	CO-6

References:

- Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016
- Bunduma, N. (2017). Fundamentals of Deep Learning
- Heaton, J.(2015). Deep Learning and Neural Networks, Heaton Research Inc.
- James A Freeman, David M S Kapura, "Neural Networks Algorithms, Applications, and Programming Techniques", Addison Wesley, 2003.
- Francois Chollet, "Deep Learning with Python", Second Edition, Manning Publications, 2021.

7th/8th Semester	AGCS-21702C: COMPUTER VISION (PEC-3)				
Internal Marks:	**40**		**L**	**T**	**P**
External Marks:	**60**		**3**	**0**	**0**
Total Marks:	**100**		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Identify basic terminology and analyse the image theories.
CO-2	Study the foundation of image formation and measurement.
CO-3	Analyse the geometric and other image features and methods.
CO-4	Extract meaningful representations from high-dimensional time series data.
CO-5	Study processing and analysing discrete data of image.
CO-6	Assess the methods to solve and analyse the accuracy of the methods.

Part	Content	CO
I	**Fundamentals of Image Processing:** 2-D projective geometry, homogeneous coordinates, Projective Transformations, Invariant Properties, Duality Principle, homography, properties of homography, computer imaging systems, Components of Computer Imaging Systems, Processes in Computer Imaging Systems, Applications of Computer Imaging Systems.	CO-1
II	**Image Formation and Representation:** Image formation and sensing, Image analysis, Image pre-processing, Image Preprocessing Techniques, Edges, Importance of Edges, Edge Detection Methods Lines, Line Detection Methods, Line Representation, Segmentation, Types of Segmentation, Active contours, Split and merge, Mean shift and mode finding, Normalized cuts, Graph cuts and energy-based methods.	CO-2
	Image Transformations: Camera geometry, components of camera geometry, Stereo geometry, key concepts and components of stereo geometry, feature detection and description, feature matching and model fitting, colour processing.	CO-3
III	**Image Processing Techniques:** Range image processing, clustering and classification, dimensionality reduction and sparse representation, Morphological filtering, Fourier transform.	CO-4
IV	**Feature Extraction:** Shape, histogram, colour, spectral, texture, CVIP tools, Feature analysis, feature vectors, distance/similarity measures, data pre-processing.	CO-5
	Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians Classification: Discriminant Function, Supervised, Un-supervised, Semi- supervised. Classifiers: Bayes, KNN, ANN models. **Dimensionality Reduction:** PCA, LDA, ICA, and Non- parametric methods, Sparse representation, Recent trends in Activity Recognition, computational photography, Biometrics.	CO-6

References:

- Multiple View Geometry in Computer Vision: R. Hartley and A. Zisserman, Cambridge University Press.
- Computer Vision: Algorithms & Applications, R. Szeleski, Springer.
- Computer vision: A modern approach: Forsyth and Ponce, Pearson.

7th/8th Semester	AGCS-21702D: ADVANCED COMPUTER NETWORKS (PEC-3)				
Internal Marks:	**40**		**L**	**T**	**P**
External Marks:	**60**		**3**	**0**	**0**
Total Marks:	**100**		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Analyze some of the most advanced routing and switching techniques.
CO-2	Understand Packet classification methods and techniques for data transfer.
CO-3	Understand the architecture of SDN and NFV for security in Softwarized Networks.
CO-4	Analyze various Data Planes, P4 Switches in Programmable Networks.
CO-5	Understand the concept of Data Center Networking and its technologies used
CO-6	Understand the concept of content distribution and delivery over internet

Part	Content	CO
I	**High Performance Switching and Routing:** Introduction, performance considerations, IP address lookup, Advanced Switching Techniques, High-Speed Routing Protocols, Algorithms for IP address lookup and optimization, hardware implementation of address lookup.	CO-1
II	**Packet Classification:** Introduction to Packet Classification, Need for packet classification and methods for packet classification, Algorithms and Techniques, Quality of Service, Traffic Polishing, Traffic Shaping, Case Studies and Real-World Applications.	CO-2
	Network Softwarization: Introduction, Software Defined Networking (SDN), Architecture and Concepts, Working with Mininet, Network Function Virtualization (NFV) - Architecture and Concepts, Network Automation and Orchestration, Service Function Chaining (SFC), Security in Softwarized Networks.	CO-3
III	**Programmable Networks:** Introduction to P4, Programmable Data Planes, Smart NICS and P4 switches, Service Function Chaining (SFC), Security in Programmable Networks, Industry Standards and Protocols in P4, Case Study.	CO-4
IV	**Data Center Networking (DCN):** Introduction, Data Center Network Architectures, Data Center Network Topologies, Container Network Interfaces, Data center Network Virtualization, Software-Defined Networking (SDN) in Data Centers, Data Center Interconnect (DCI), High-Performance Networking Technologies, Network Security in Data Centers, Load Balancing and Traffic Management in DCN, Future Trends in DCN.	CO-5
	Content Distribution on the Internet: Introduction, Content Delivery Networks (CDNs), Peer-to-Peer (P2P) Networks, Internet Protocols for Content Distribution, Security in Content Distribution, Information Centric Networking- Introduction, Architectures for Information Centric Networking, Content Naming, Routing and Caching, Security in Named Data Networking.	CO-6

References:

- Information-Centric Networks: A New Paradigm for the Internet (Focus Series in Networks and Telecommunications), Gabriel M. de Brito, Pedro B. Velloso, Igor M. Moraes, Wiley-ISTE; 1st edition, 2013, ISBN: 9781848214491
- Information-Centric Networking (ICN): Content Centric Networking (CCNx) and Named Data Networking (NDN) Terminology, B. Wissingh, C. Wood, A. Afanasyev, L. Zhang, D. Oran and C. Tschudin, RFC 8793, June 2020
- Software-Defined Networks: A Systems Approach, Peterson, Cascone, O'Connor, Vachuska, and Davie, Online Free Reference Book available at https://sdn.systemsapproach.org/index.html
- Cloud Networking: Understanding Cloud-based Data Centre Networks, Gary Lee (Author), Morgan Kaufmann (Publisher), 2014, ISBN-139780128007280

7th/8th Semester	AGCS-21702E: BUSINESS INTELLIGENCE AND ANALYTICS (PEC-3)

Internal Marks:	**40**		**L**	**T**	**P**
External Marks:	**60**		**3**	**0**	**0**
Total Marks:	**100**		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the role of business intelligence and analytics in decision-making processes.
CO-2	Understand the concepts of data warehousing, data mining, and data visualization.
CO-3	Understand statistical techniques to analyze and interpret business data.
CO-4	Use BI tools to extract, transform, and load (ETL) data from various sources.
CO-5	Utilize predictive analytics techniques to forecast future trends and outcomes.
CO-6	Understand the ethical and privacy implications of using business intelligence and analytics.

Part	Content	CO
I	**Introduction to Business Intelligence:** Introduction to Business Intelligence & Analytics (BIA), drivers of BIA. Types of analytics: descriptive to prescriptive, vocabulary of business analytics. Technical architecture of BIA, fundamentals of data management, OnLine Transaction Processing (OLTP), design process of databases, Relational databases, normalization, SQL queries.	CO-1
II	**Data Warehousing:** Introduction to data warehousing concepts, Data modeling and schema design, Extract, transform, and load (ETL) processes, Data Mining and Machine Learning, Introduction to data mining techniques, Association analysis, clustering, and classification, Introduction to machine learning algorithms for BI, Data Visualization-Principles of data visualization, Choosing the right chart types, Tools for data visualization (e.g., Python, Tableau, Power BI).	CO-2
	Statistical Analysis for BI: Descriptive and inferential statistics, Hypothesis testing and confidence intervals, Regression analysis for predictive modeling	CO-3
III	**BI Tools and Software:** Overview of popular BI tools and software, Hands-on experience with a BI tool (e.g., Tableau, Power BI) to extract, transform, and load (ETL) data from various sources. Building dashboards and reports.	CO-4
IV	**Advanced Analytics Techniques:** Analytics Techniques to forecast future trends and outcomes. Time series analysis and forecasting, Text analytics and sentiment analysis, Spatial analytics and GIS integration.	CO-5
	Ethics and Privacy in BI: Ethical considerations in BI and analytics, Privacy regulations (e.g. GDPR, HIPAA), Handling sensitive data and ensuring data security. Case Studies and Applications-Real-world case studies in BI and analytics, Applications of BI across different industries.	CO-6

References:

- "Business Intelligence Guidebook: From Data Integration to Analytics" by Rick Sherman
- "The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling" by Ralph Kimball & Margy Ross
- "Data Mining: Concepts and Techniques" by Jiawei Han, Micheline Kamber, and Jian Pei
- "Building the Agile Enterprise: With Capabilities, Collaborations and Values" by Fred Cummins
- "Competing on Analytics: The New Science of Winning" by Thomas H. Davenport and Jeanne G. Harris

7th/8th Semester	AGCS-21702F: INTRODUCTION TO INTERNET OF THINGS (PEC-4)

Internal Marks:	**40**		**L**	**T**	**P**
External Marks:	**60**		**3**	**0**	**0**
Total Marks:	**100**		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the concept of IoT and its Architecture.
CO-2	Learn the function of various components and the communication modules.
CO-3	Understand the physical and application layer protocols for IoT.
CO-4	Implement the interface between hardware and Arduino board using Python Programming.
CO-5	Implementing the various python packages on Raspberry pi Board
CO-6	Analyse applications of IoT in real time scenario.

Part	Content	CO
I	**Introduction**: Characteristics of IoT, Components of IoT, Architecture of IoT, IoT Applications, Functional Blocks of an IoT Ecosystem, Sensors Classes-Vector, Scalar, Analog and Digital, Sensor Types, Actuators and its types- Hydraulic actuators, Pneumatic, Electrical actuators, Thermal actuators, Magnetic actuators and Mechanical actuators, and Smart Objects, Control Units.	CO-1
II	**Communication in IoT:** Internet based communication, IP Addressing in IoT, M2M Communication reasons, features, Six pillars of M2M, Applications and Communication modules- Bluetooth, ZigBee, GPS, GSM, Wi-Fi.	CO-2
	Techniques in IoT: Overview of RFID technology, Types of RFID tags and readers, RFID frequency bands and standards (LF, HF, UHF) HF), RFID Middleware, Applications, MQTT Architecture and operation, QoS Levels, CoAP Architecture and features, AMQ Architecture and use case,6LoWPAN in IoT, IEEE 802.15.4 features	CO-3
III	**Introduction to Arduino:** Introduction to Arduino and Arduino UNO, Pin Configuration, Installing the Software, Sketch structure, Arduino function libraries, Fundamentals of Arduino Programming. Operators in Arduino: Control Statement, Loops, Arrays, String, Math Library, Random Number, Interrupts	CO-4
IV	**Raspberry Pi and IoT:** Introduction to Raspberry, About the Raspberry pi Board: Hardware Layout, Operating Systems on Raspberry, Using GPIO pins, PiCaM, Configuring Raspberry, Programming Raspberry pi with Python Packages XML, JSON, HTTPLib, URLlib, SMTPLib,	CO-5
	IoT Applications: Smart Metering, E-health, Smart City and Home Automation, IoT in Agriculture, Automotive Applications, Smart Energy Management, Smart vehicles parking, communicating data with H/W units, mobiles, tablets.	CO-6

References:

- Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017
- Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1stEdition, VPT, 2014. (ISBN: 978-8173719547)
- Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education, 2017. (ISBN: 978-9352605224)

7th/8th Semester	AGCS-21702G: SOCIAL NETWORK ANALYSIS (PEC-4)				
Internal Marks:	**40**		**L**	**T**	**P**
External Marks:	**60**		**3**	**0**	**0**
Total Marks:	**100**		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Analyze a social network using various visualization tools.
CO-2	Illustrate large-scale network data and mechanisms used for network growth models.
CO-3	Understand the signed networks and applications of the Link Analysis
CO-4	Acquaint with the community detection and Link Prediction ways
CO-5	Examine social networks analysis and prediction using case studies.
CO-6	Apply appropriate anomaly detection and graph representation method on a network

Part	Content	CO
I	**Society & Network:** Introduction, Use of social networks, defining a network, types of networks (link-centric, node and link centric, local view, temporal view, generalization, real-world network), levels of social network analysis, graph visualization tools (web-based and standalone), applications. **Network Measures:** Network basics, node centrality, assortative, transitivity and reciprocity, similarity, degeneracy	CO-1
II	**Network Growth Models:** Properties of real-world networks, Random Network Model: Degree Distribution of Random Network, Binomial to Poisson Distribution, Evolution of a Random Network, Average Path Length, Clustering Coefficient, Random Network vs. Real-world Network, Ring Lattice Network Model, WattsStrogatz Model: Network Formation, Preferential Attachment Model: Network Formation, Degree Dynamics, Limitations of BA Model	CO-2
	Link Analysis: Application of link analysis, Signed networks: Balance Theory of Undirected Signed Networks, Status Theory of Signed Networks, Triad Balance vs Status, Strong and Weak Ties: Strength of a Tie, Triadic Closure, Dunbar Number, Local Bridges and Importance of Weak Ties, PageRank, Personalized PageRank, DivRank, SimRank, PathSim	CO-3
III	**Community Detection:** Application of community detection, types of communities, community detection methods, Disjoint Community Detection: Node-centric community detection, modularity and community detection, Overlapping Community 08 Detection: Clique Dynamics, Local Community Detection. **Link Prediction:** Applications of link prediction, Evaluating Link Prediction methods, Heuristic models, Probabilistic models, Supervised Random Walk	CO-4
IV	**Cascade Behaviours & Network Effects:** Preliminaries and Important Terminologies, Cascade Models, Probabilistic Cascades, Epidemic Models, Independent Cascade Models, Cascade Prediction.	CO-5
	Anomaly Detection in Networks: Anomaly in Static Networks: Plain and attributed networks, relational learning, Anomaly in Dynamic Networks: Preliminaries, feature and decomposition-based approaches. **Graphical Representation Learning:** Criterion of graph representation learning, pipeline, representation learning methods.	CO-6

References:

- Xiaoming Fu, Jar-Der Luo, Margarete Boos, 'Social Network Analysis Interdisciplinary Approaches and Case Studies', 1 st Edition, CRC Press, 2020.
- Dr. Krishna Raj P.M., Mr. Ankith Mohan, Dr. Srinivasa K.G, "Practical Social Network Analysis with Python (Computer Communications and Networks)", First Edition, Springer, 2019.
- John Scott, "Social Network Analysis", Fourth Edition, SAGE Publications Ltd, 2017.

7th/8th Semester	AGCS-21702H: REINFORCEMENT LEARNING (PEC-4)				
Internal Marks:	**40**		**L**	**T**	**P**
External Marks:	**60**		**3**	**0**	**0**
Total Marks:	**100**		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Gain a foundational understanding of deep reinforcement learning principles.
CO-2	Make use of various exploration and exploitation strategies.
CO-3	Understanding eligibility traces and their role in temporal difference learning.
CO-4	Delve into Bellman Optimality and its significance in reinforcement learning algorithms.
CO-5	Explore value-based reinforcement learning approaches with function approximation.
CO-6	Demonstrate various Policy based Reinforcement Learning Algorithms.

Part	Content	CO
I	**Introduction:** Reinforcement Learning, Suitability of RL, Components of Reinforcement Learning -Agent, Environment, Observations, Actions, Example-The Bandit Walk Environment, Agent-Environment interaction cycle, MDP (Markov Decision Process): The engine of the Environment-States, Actions, Transition Function, Reward Signal.	CO-1
II	**Bandit algorithms**: Median Elimination, Policy Gradient, Single-state decision problem (Multi-Armed Bandit (MAB) problem), The cost of exploration, approaches to solve MAB environments, Greedy Strategy, Random Strategy, Epsilon-Greedy Strategy, Decaying Epsilon-Greedy Strategy, Optimistic Initialization strategy, Strategic exploration, Softmax exploration strategy, Bandit algorithms – UCB, Upper confidence bound (UCB), PAC	CO-2
	Bellman Optimality and function approximation: Introduction to Bellman Optimality, Bellman Optimality Equation, Bellman Optimality in Policy Iteration and in value iteration, Least Squares Temporal Difference, Least Squares Policy Iteration.	CO-3
III	**Dynamic Programming and TD methods:** Monte Carlo Prediction (MC), First-Visit MC (FVMC), Every-Visit MC (EVMC), Temporal Difference Learning (TD), Learning to estimate from multiple steps, N-step TD learning, Forward-view TD(λ), Backward-view TD(λ), Generalized policy iteration(GPI), Monte Carlo control, SARSA: On-Policy TD control, Q-learning: Off-Policy TD control, Double Q-learning, SARSA(λ), Watkins's Q(λ). Model Based Reinforcement Learning: Dyna-Q, Trajectory sampling.	CO-4
IV	**Value Based Reinforcement Learning:** Deep reinforcement learning agents with sequential feedback, evaluative feedback, sampled feedback, Function Approximation for Reinforcement Learning- high-dimensional state and action spaces, continuous state and action spaces, state-value function and action-value function with and without function approximation, Neural Fitted Q (NFQ), Deep Q-Network (DQN), Double Deep-Q Networks (DDQN), Dueling DDQN, Prioritized Experience Replay (PER).	CO-5
	Policy Based Reinforcement Learning: Policy Gradient and Actor-Critic Methods—REINFORCE Algorithm and Stochastic Policy Search, Vanilla Policy Gradient(VPG), Asynchronous Advantage Actor-Critic (A3C), Generalized Advantage Estimation (GAE), Advantage Actor-Critic(A2C), Deep Deterministic Policy Gradient (DDPG), Twin-Delayed DDPG (TD3), Soft Actor-Critic (SAC), proximal policy optimization (PPO),representation and solution methods of POMDPs.	CO-6

References:

- Richard S. Sutton and Andrew G. Barto, Reinforcement learning: An Introduction, Second Edition, MIT Press, 2019.
- Marco Wiering, Martijn van Otterlo(Ed),Reinforcement Learning, State-of-the-Art, Adaptation, Learning, and Optimization book series, ALO, volume 12, Springer, 2012.
- 3. Keng, Wah Loon, Graesser, Laura, Foundations of Deep Reinforcement Learning: Theory and Practice in Python, Addison Wesley Data & Analytics Series, 2020.

7th/8th Semester	AGCS-21702I: OBJECT ORIENTED ANALYSIS & DESIGN USING UML (PEC-4)

Internal Marks:	**40**		**L**	**T**	**P**
External Marks:	**60**		**3**	**0**	**0**
Total Marks:	**100**		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Exploring Object-Oriented Design and Unified Modeling Language (UML).
CO-2	Understanding Use Case Diagrams and Prioritization Techniques.
CO-3	Mastering Class and Sequence Diagrams along with Advanced Concepts.
CO-4	Delving into State Chart Diagrams, Design Processes, and Anti-Patterns.
CO-5	Introduction to Design Patterns and Addressing Common Pitfalls.
CO-6	Implementing GRASP Patterns and Exploring GoF Patterns in Depth.

Part	Content	CO
I	**Introduction:** Overview of Object-Oriented Design (OOD), Key concepts of OOD: Objects, Classes, Methods, and Attributes, Benefits of OOD in software development, Comparison of OOD with Procedural Programming, Introduction to UML (Unified Modeling Language), Conceptual model of UML, building blocks of UML, Mechanisms in UML, Architecture.	CO-1
II	**Use Case Diagram:** Purpose and benefits of Use Case Diagrams, Factoring Use Cases, Use Case Guidelines, Elements of Use Case Diagrams - Actors, Use Cases, System Boundaries, Relationships in Use Case Diagrams - Include, Extend, and Generalization, Steps to create a Use Case Diagram, Example Use Case Diagrams for various systems. **Use Case Prioritization:** Discuss techniques for prioritizing use cases based on business value, risk, and feasibility, Methods for validating and verifying the correctness and completeness of use case diagrams.	CO-2
	Class Diagram and Sequence Diagrams: Purpose and structure of Class Diagrams, Elements - Classes, Attributes, Methods, Relationships, Unary and binary Associations, Aggregation, Composition, and Inheritance, Implementation of association in General Case, Qualified Association, Dependency relation, Simple Class Diagram examples. Advanced concepts in Class Diagrams, Abstract classes and interfaces, Polymorphism, Realization relationships, Multiplicity in associations, Refining and elaborating Class Diagrams with practical examples **Sequence Diagram:** Purpose of Sequence Diagrams, Synchronous and Asynchronous Messages, Creating Sequence Diagrams for system interactions.	CO-3
III	**State Chart Diagram and Design Process:** Purpose of State Chart Diagrams, States, Transitions, Events, and Actions, Initial and Final States, Guard Conditions, Practical examples of State Chart Diagrams for various scenarios, State Machine Diagrams - Features of State Machine Model, encoding a State Machine-I, encoding a State Machine -II, Interaction Diagrams. **Design Process:** Detailed steps in the design process, Requirement Analysis, System Design vs. Detailed Design, Use of UML in the design process, Case Study - Designing a software system from requirements to detailed design. common anti-patterns and pitfalls in software design, contrasting them with design patterns.	CO-4
IV	**Introduction to Design Patterns:** Importance of design patterns, Types of design patterns- Creational, Structural, Behavioral. Benefits and limitations of using design patterns.	CO-5

	GRASP Patterns and GoF Patterns: Introduction to the Gang of Four (GoF) design patterns, General Responsibility Assignment Software Patterns (GRASP), Key GRASP patterns- Information Expert, Creator, Controller, Low Coupling, High Cohesion, Applying GRASP patterns to improve software design, Pure Fabrication, Law of Demeter, Case studies and examples of GRASP patterns **GoF Pattern:** In-depth study of GoF design patterns, Creational Patterns: Singleton, Factory Method, Abstract Factory, Builder, Prototype, Structural Patterns- Adapter, Decorator, Proxy, Composite, Practical implementation and examples, Continuation of GoF design patterns, Behavioral Patterns - Strategy, Observer, Command, Template Method, State, Application and benefits of Behavioral Patterns in software design, Real-world examples and implementation strategies	CO-6

References:

- Frederick Eddy, James Rumbaugh, Michael Blaha, Willliam Premerlani, William Lorensen: Object-Oriented Modeling and Design, Pearson Education.
- James Rumbaugh, Michael R. Blaha: Object-Oriented Modeling and Design with UML, Pearson Education.
- Meilir Page-Jones: Fundamentals of Object-Oriented Design in UML, Pearson Education.
- Appling UML and Patterns: An introduction to Object – Oriented Analysis and Design and Unified Process, Craig Larman, Pearson Education.

7th/8th Semester	AGCS-21702J: FOUNDATIONS OF CRYPTOGRAPHY (PEC-4)

Internal Marks:	**40**		**L**	**T**	**P**
External Marks:	**60**		**3**	**0**	**0**
Total Marks:	**100**		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the basics paradigms and principles of Cryptography
CO-2	Understand and Implement Symmetric Key Cryptography
CO-3	Apply message authentication functions in secure communication scenario
CO-4	Understand and Implement Asymmetric Key Cryptography
CO-5	Analyze Public Key Cryptosystems
CO-6	To understand various protocols for network security to protect against the threats in the networks.

Part	Content	CO
I	**Introduction to Cryptography:** Course Overview, Symmetric-key Encryption, Historical Ciphers, Perfect Security and Its Limitations, Computational Security, Semantic Security and Pseudorandom Generators (PRGs) **Mathematical Foundations:** Number theory (modular arithmetic, prime numbers, greatest common divisor), Introduction to finite fields and groups, Basic probability theory in cryptographic contexts	CO-1
II	**Cryptosystems and Symmetric key Cryptography:** Stream Ciphers, Provably-secure Instantiation of PRG, Practical Instantiation of PRG, CPA-security and Pseudo-random Functions (PRFs), CPA-Secure Ciphers from PRF, Modes of Operations of Block Ciphers, Theoretical Constructions of Block Ciphers and Practical Constructions of Block Ciphers, DES, AES and Message Authentication Codes (MAC)	CO-2
	Cryptographic Hash Functions: Information-theoretic Secure MAC, Cryptographic Hash Functions, Ideal-Cipher Model, Davies-Meyer construction and Merkle-Damgård Paradigm Birthday Attacks on Cryptographic Hash Functions, Applications of Hash Functions, Random Oracle Model and Authenticated Encryption	CO-3
III	**Asymmetric Key Cryptography:** Generic Constructions of Authenticated Encryption Schemes, Key-exchange Problem, One-way Trapdoor Functions and Cyclic Groups Discrete-Logarithm Problem, Computational Diffie-Hellman Problem, Decisional Diffie-Hellman Problem, Elliptic-Curve Based Cryptography and Public-Key Encryption	CO-4
IV	**Public Key Cryptosystem:** El Gamal Encryption Scheme, RSA Assumption, RSA Public-key Cryptosystem, KEM-DEM Paradigm and CCA-security in the Public-key Domain, CCA-secure Public-key Hybrid Ciphers Based on Diffie-Hellman Problems and RSA-assumption	CO-5
	Digital Signature: Digital Signatures, RSA Signatures and Schnorr Identification Scheme, Schnorr Signature **Web Security:** Overview of TLS/SSL, Interactive Protocols, Firewall	CO-6

References:

- Cryptography and Network Security, William Stallings, 2nd Edition, Pearson Education Asia
- Cryptography & Network Security, Atul Kahate, TMH.
- Cryptography and Network security Principles and Practices, William Stallings, Pearson/PHI.
- Introduction to Cryptography with coding theory, Wade Trappe, Lawrence C Washington, Pearson
- Information Security, Principles, and Practice: Mark Stamp, Wiley India
- Behrouz A Ferouzan, "Cryptography and Network Security" Tata Mc Graw Hill

7th/8th Semester	AGCS-21702K: NATURAL LANGUAGE PROCESSING (PEC-4)				
Internal Marks:	**40**		**L**	**T**	**P**
External Marks:	**60**		**3**	**0**	**0**
Total Marks:	**100**		**Credits**		**3**

Course Outcomes: After studying the course, students will be able to:	
CO-1	Understand the basic principles, techniques, and applications of Natural Language Processing.
CO-2	Analyse words based on Morphology and CORPUS.
CO-3	Create CORPUS linguistics based on digestive approach.
CO-4	Use of statistical approaches to machine translation.
CO-5	Perform Part-of-speech tagging technique based on the structure of the language.
CO-6	Understand the techniques for text-based processing.

Part	Content	CO
I	**Introduction:** Basic concepts of Natural language Processing, evolution of NLP, issues and challenges in NLP, basic concepts of phases of natural language processing morphological analysis, syntactic analysis, semantic analysis, pragmatic analysis, tools and techniques used for performing these analysis, ambiguities, Types of ambiguities.	CO-1
II	**Text Preprocessing and Morphology:** Character Encoding, Word Segmentation, Sentence Segmentation, Introduction to Corpora, Corpora Analysis. Inflectional and Derivation Morphology, Morphological analysis and generation using Finite State Automata and Finite State transducer.	CO-2
	Language Modelling: Statistical Hypothesis Tests for NLP, Hypothesis testing of differences, The t Test, Pearson's chi-square test, Likelihood ratios. **Statistical Inference:** N -gram Model, Importance of order of words in text & NLP, Classification of N-gram Model, N-gram Analysis and Visualization.	CO-3
III	**Word Sense Disambiguation:** Evaluation of WSD, Approaches and Methods to Word Sense Disambiguation (WSD), Applications of Word Sense Disambiguation (WSD), Difficulties in Word Sense Disambiguation (WSD) Disambiguation based on sense, Thesaurus-based disambiguation, Disambiguation based on translations in a second-language corpus.	CO-4
IV	**Markov Model and POS Tagging:** Markov Model: Hidden Markov model, Fundamentals, Probability of properties, Parameter estimation, Variants, Multiple input observation. The Information Sources in Tagging: Markov model taggers, Viterbi algorithm, Applying HMMs to Part-of-speech tagging, Applications of Tagging.	CO-5
	Probabilistic Context Free Grammars and Probabilistic parsing: The Probability of a String, Problems with the Inside-Outside Algorithm, Parsing for disambiguation, Treebanks, Parsing models vs. language models, Phrase structure grammars and dependency, Lexicalized models using derivational histories, Dependency-based models	CO-6

References:

- Nitin Indurkhya, Fred J. Damerau "Handbook of Natural Language Processing". 2nd Edition, CRC Press,2010.
- James Allen "Natural Language Understanding". Pearson Publication 8th Edition.2012. Hobson lane Cole Howard, Hannes Hapke, "Natural Language Processing in action" MANNING Publications,2019.
- Rajesh Arumugam, Rajalingappa Shanmugamani "Hands-on natural language processing with python: A practical guide to applying deep learning architectures to your NLP application". PACKT publisher, 2018.