IPS Academy, Institute of Engineering & Science

(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal) Scheme Based on AICTE Flexible Curriculum

Department of Computer Science &Engineering

Bachelor of Technology (B.Tech.)

[Computer Science & Engineering (Data Science)]

VII Semester (Scheme & Syllabus)

S.No.	Course Type	Course Code	Course Title	Hrs./Week			Credits
				L	T	P	
1	PCC	DS16	Computer Vision	2	1	-	3
2	PEC	DS03	Professional Elective-III	2	1	-	3
3	PEC	DS04	Professional Elective-IV	2	1	-	3
4	IOC	–	Interdisciplinary Open Course-II	3	-	-	3
5	LC	DS16(P)	Computer Vision Lab	-	-	4	2
6	LC-PEC	DS03(P)	Elective-III Lab	-	-	2	1
7	LC-PEC	DS04(P)	Elective-IV Lab	-	-	2	1
8	PROJ	DS04	Major Project Phase-I	-	-	8	4
9	PROJ	DS05	Evaluation of Internship-II	-	-	6	3
Total Credits				9	3	22	23
				34			

Professional Elective Course (PEC) –III,DS03 (Any One Course)	Professional Elective Course (PEC) –IV,DS04 (Any One Course)	Interdisciplinary Open Course-II
(A) Mobile Application Development	(A) Cloud Computing	(A)Robotics
(B) Adversarial Machine Learning	(B) Streaming Data & Real-Time Analytics	(B)Industrial Electronics
(C) Optimization for ML	(C) Artificial Intelligence	(C) CS-01 Digital Marketing & SEO
(D) Computational Financial Modeling	(D) Deep & Reinforcement Learning	(D)3D Printing & Application

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VII Semester (Syllabus)

PCC-DS16	Computer Vision	2L:1T:0P (3 hrs)	Credits:03

Prerequisites: Basic idea of machine learning and its algorithm

Course Objective:

To gain knowledge about the vision sense of Machine Learning i.e. computer vision & to gain expertise in the various aspects of Computer Vision.

Course Contents: (40Hrs)

Module 1: (8Hrs)

Machine vision systems, introduction to low, mid and high level vision, low and mid level image processing, edge detection, image segmentation, image and texture features Camera geometry, object to image geometric transformations, orthographic and perspective view transformations, camera calibration. Introduction to OpenCV (to be contd. In Module 4).

Module 2: (8Hrs)

Real-World Applications and Industry Case Studies, Autonomous Vehicles: Perception systems for self-driving cars , Medical Imaging: AI in radiology, pathology, and ophthalmology, Surveillance and Security: Face recognition, anomaly detection,

Module 3: (8Hrs)

Machine learning for computer vision, Classification models for vision, deep learning architectures for vision, Model based recognition system Object recognition, recognition of arbitrary curved object sensed either by stereo or by range sensor, Recognition under occlusion, Aspect graph of an arbitrary 3D object viewed from different directions, Recognition of 3D objects based on 2D projections

Module 4: (8Hrs)

Generative Models for Computer Vision, Generative Adversarial Networks (GANs): DCGAN, WGAN, StyleGAN, CycleGAN, and Diffusion Models: Denoising Diffusion Probabilistic Models (DDPMs), Stable Diffusion, DALL·E, Applications of Generative Models: Image synthesis, in painting, super-resolution, deep fake generation

Module 5: (8Hrs)

Object Detection: Object Detection: R-CNN, Fast R-CNN, Faster R-CNN, YOLO, SSD, Instance and Semantic Segmentation: U-Net, DeepLab, Mask R-CNN, 3D Vision and Depth Estimation: Point clouds, 3D object detection (Point Net, Ne RF)

Course Outcome:

1. Understanding the introductory concepts of computer vision
2. Learning about Binocular vision system
3. Studying ML applications of computer vision
4. Working on image processing & functions
5. Getting to know object detection & face analysis

List of Text/ Reference Books:

1. Computer Vision: Algorithms and Applications" by Richard Szeliski
2. Multiple View Geometry in Computer Vision" by Richard Hartley and Andrew Zisserman
3. Computer Vision: A Modern Approach" by David A. Forsyth and Jean Ponce

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VII Semester (Syllabus)

PEC- DS03(A)	Mobile Application Development	2L:1T:0P (3 hrs)	Credits:03

Prerequisite: JAVA Programming

Course Objective:

The objective of this course is to help students to gain a basic understanding of Android application development and tools.

Course Contents (40Hrs)

Module 1: (8hrs)

Introduction to Android: The Android Platform, Android SDK, Eclipse Installation, Android Installation, building you First Android application, Understanding Anatomy of Android Application, Android Manifest file.

Module 2: (8hrs)

Android Application Design Essentials: Anatomy of an Android applications, Android terminologies, Application Context, Activities, Services, Intents, Receiving and Broadcasting Intents, Android Manifest File and its common settings, Using Intent Filter, Permissions.

Module 3: (8hrs)

Android User Interface Design Essentials: User Interface Screen elements, Designing User Interfaces with Layouts, Drawing and Working with Animation.

Module 4: (8hrs)

Testing Android applications: Publishing Android application, Using Android preferences, Managing Application resources in a hierarchy, working with different types of resources.

Module 5: (8hrs)

Using Common Android APIs: Using Android Data and Storage APIs, Managing data using SQLite, Sharing Data between Applications with Content Providers, Using Android Networking APIs, Using Android Web APIs, Using Android Telephony APIs, Deploying Android Application to the World.

Course Outcome:

1. Identify various concepts of mobile programming that make it unique from programming for other platforms.
2. Critique mobile applications on their design pros and cons.
3. Utilize rapid prototyping techniques to design and develop sophisticated mobile interfaces.
4. Program mobile applications for the Android operating system that use basic and advanced phone features.
5. Deploy applications to the Android marketplace for distribution.

List of Text / Reference Books:

1. Lauren Darcey and Shane Conder, "Android Wireless Application Development", Pearson Education, 2nd ed. (2011)
2. Reto Meier, "Professional Android 2 Application Development", Wiley India Pvt Ltd 3. Mark L Murphy, "Beginning Android", Wiley India Pvt Ltd3.R3. Android Application Development All in one for Dummies by Barry Burd, Edition: I

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VII Semester (Syllabus)

PEC-DS03(B)	Adversarial Machine Learning	2L: 01T: 0P (3 hrs.)	Credits:03

Prerequisite: Python & its libraries (Numpy and Pandas)

Course Objective:

This course is designed to provide knowledge regarding how the data stored in a dataset can be visualized to provide better understanding of data. Also to impart knowledge on how data impacts business decisions and how data visualization can be used in the benefit of the business.

Course Content: (40Hrs)

Module 1: **(08Hrs)**

Introduction to Adversarial Machine Learning (AML), Basic vulnerabilities associated with Machine Learning, Implementation of attacks on object detection models, Adversarial Training:, The formal approach to secure machine learning models , Strategies for training robust models against adversarial perturbations.

Module 2 **(08Hrs)**

Adversarial Attack and Defense: , Decision Time Attack and Defense –,Data Poisoning Attack and Defense , Black-box and White-box Attacks and Defenses, Generative Models in Defense Against Adversarial Attacks:, Using GANs and Variational Autoencoders (VAEs) for adversarial robustness ,Purification methods for adversarial inputs.

Module 3: **(08Hrs)**

Backdoors, Trojans, and Honeypots in Machine Learning Models:, Understanding and detecting backdoor attacks , Trojaned networks and their countermeasures ,Deploying honeypots for adversarial detection

Module 4: **(08Hrs)**

Model Inversion and Membership Inference Attacks: , Extracting private data from trained models, Membership inference attacks and privacy concerns

Module 5: **(08Hrs)**

Differential Privacy in Adversarial Defense:, Concepts of Differential Privacy in ML , Using differential privacy mechanisms to defend against adversarial attacks

Course Outcomes:

1. Getting to know the basics Adversarial Machine Learning.
2. Learning Adversarial Attack and Defense.
3. Learning Backdoors, Trojans, and Honeypots in Machine Learning Models.
4. Model Inversion and Membership Inference Attacks.
5. Learning Differential Privacy in Adversarial Defense.

List of Text/ Reference Books:

1. Authors: Yevgeniy Vorobeychik and Murat Kantarcioglu
   Publisher: Synthesis Lectures on Artificial Intelligence and Machine Learning, Morgan & Claypool Publishers Year: 2021
2. Machine Learning and Security" by Clarence Chio and David Freeman

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VII Semester (Syllabus)

PEC- DS03(C)	**Optimization for ML**	**2L:1T:0P (3 hrs)**	**Credits:03**

Prerequisites: Engineering Mathematics, Machine Learning I &II

Course Objective:
To understand the need of optimizing Machine Learning algorithms & various approaches in that direction.

Course Content: (40Hrs)

Module 1: **(08Hrs)**
Application of Continuous optimization in learning model parameters and application of discrete optimization in inference and auxiliary tasks such as feature selection, data subset selection, model compression etc.

Module 2: **(08Hrs)**
Basics of Continuous Optimization, Convexity, Gradient Descent, Projected/Proximal GD, Sub gradient Descent, Accelerated Gradient Descent, Newton & Quasi Newton, Lagrange and Fenchel Duality.

Module 3: **(08Hrs)**
Important standard classes such as linear and quadratic programming, semi definite programming, (possibly also second-order cone programming), etc., Fundamentals of discrete optimization, basic forms of combinatorial optimization (knapsack, s-t cuts/paths, matching's and mastoids).

Module 4: **(08Hrs)**
Discuss sub modular functions (DPPs) and their applications, Sub modular Functions and Applications in Machine Learning, Sub modularity and Convexity, Sub modular Minimization, Sub modular Maximization, Sub-gradient methods for non-differentiable functions.

Module 5: **(08Hrs)**
Real world applications in feature selection, summarization and diversified search, structured prediction, data subset selection and model compression.

Course Outcomes:
1. Understanding the need & application of optimization in Machine Learning.
2. Learning about the basic concepts of optimization.
3. Learning about optimization concepts with relation to programming.
4. Discussing sub modular functions & it's methods.
5. Understanding some auxiliary concepts of optimization.

List of Text/ Reference Books:

1. Convex Optimization: Algorithms and Complexity by Sébastien BubeckConvex Optimization by Stephen Boyd and Lieven Vandenberghe
2. Lectures on Modern Convex Optimization by Aharon Ben-Tal and Arkadi Nemirovski

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VII Semester (Syllabus)

PECDS03(D)	**Computational Financial Modeling**	**2L:1T:0P (3 hrs)**	**Credits:03**

Prerequisites: Knowledge of at least one of C/C++/MATLAB/R/Spreadsheets Packages, Basic knowledge of Probability, Statistics and Linear Programming.

Course objective:
The course aims to provide an introduction to Computational Financial Modeling. Fundamental concepts used in portfolio optimization, technical analysis and financial data modeling would be discussed.

Course content: (40Hrs)
Module 1: **(08Hrs)**
Markowitz Theory, Securities Portfolio Selection Model in Crisp and Fuzzy Environment.

Module 2 **(08Hrs)**
Time series models, Multivariate Volatility Models and Their Applications. Principal Component Analysis.

Module 3: **(08Hrs)**
Dow Theory, Introduction to stock analysis using different types of chart, Technical Analysis of financial markets and stock trends, Analysis of chart patterns.

Module 4: **(08Hrs)**
Index and stock tracking using soft computing techniques.

Module 5: **(08Hrs)**
Applications of CFM: Estimation of valuation of a business, Comparison of businesses, Strategic Planning: Definition & use Cost of projects, budgeting, & corporate resource allocation.

Course Outcomes:
1. Learning about financial modeling in crisp & fuzzy environment.
2. Discussing time series models.
3. Getting introduced to Dow Theory & technical analysis.
4. Understanding concepts of stock tracking using soft computing techniques.
5. Learning about the applications of CFM and its business terms.

List of Text/ Reference Books:

1. Fuzzy Portfolio Optimization, Yong Fang, Kin Lai, Kin Keung Lai, Shouyang Wang, Lecture Notes in Economics & Mathematical Systems, Volume 609, Springer, 2008. Technical Analysis of the Financial Markets, John J. Murphy, Prentice Hall Press, Jan 1999.Portfolio Selection: Efficient Diversification of Investments, Harry M. Markowitz, Markowitz, 2nd Edition, John Wiley & Sons, 1991.
2. Numerical Methods and Optimization in Finance, Manfred Gilli, DietmarMaringer, Enrico Schumann, Elsevier, 2011.

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VII Semester (Syllabus)

PEC- DS04(A)	**Cloud Computing**	**2L:1T:0P (3 hrs)**	**Credits:03**

Prerequisite: NA

Course Objective:
The objective of this course is to provide students with the comprehensive and in-depth knowledge of Cloud Computing concepts, technologies, architecture and applications.

Course Contents:(40Hrs)

Module 1: (8hrs)
Introduction of Grid and Cloud computing, characteristics, components, business and IT perspective, cloud services requirements, cloud models, Security in public model, public verses private clouds, Cloud computing platforms: Amazon EC2,Platform as Service: Google App Engine, Microsoft Azure, Utility Computing, Elastic Computing.

Module 2: (8hrs)
Cloud services- SAAS, PAAS, IAAS, cloud design and implementation using SOA, conceptual cloud model, cloud stack, computing on demand, Information life cycle management, cloud analytics, information security, virtual desktop infrastructure, storage cloud.

Module 3: (8hrs)
Virtualization technology: Definition, benefits, sensor virtualization, HVM, study of hypervisor, logical partitioning- LPAR, Storage virtualization, SAN, NAS, cloud server virtualization, virtualized data center.

Module 4: (8hrs)
Cloud security fundamentals, Vulnerability assessment tool for cloud, Privacy and Security in cloud, Cloud computing security architecture: Architectural Considerations- General Issues, Trusted Cloud computing, Secure Execution Environments and Communications, Micro architectures; Identity Management and Access control-Identity management, Access control, Autonomic Security, Cloud computing security challenges: Virtualization security management- virtual threats, VM Security Recommendations, VM- Specific Security techniques, Secure Execution Environments and Communications in cloud.

Module 5: (8hrs)
SOA and cloud, SOA and IAAS, cloud infrastructure benchmarks, OLAP, business intelligence, e-Business, ISV, Cloud performance monitoring commands, issues in cloud computing. QOS issues in cloud, mobile cloud computing, Inter cloud issues, Sky computing, Cloud Computing Platform, Oxen Cloud Platform, Eucalyptus, Open Nebula, Nimbus, Platform, Apache Virtual Computing Lab (VCL), Anomaly Elastic Computing Platform.

Course Outcome:

1. Explain the core concepts of the cloud computing paradigm
2. Demonstrate knowledge of virtualization
3. Explain the core issues of cloud computing such as security, privacy, and Interoperability.
4. Choose the appropriate technologies, algorithms, and approaches for the related issues.
5. Identify problems, and explain, analyze, and evaluate various cloud computing solutions.

List of Text/ Reference Books:

1. Dr.Kumar Saurabh, "Cloud Computing", Wiley India.
2. Ronald Krutz and Russell Dean Vines, "Cloud Security", Wiley-India.
3. Judith Hurwitz, R.Bloor, M.Kanfman, F.Halper, "Computing for Dummies", Wiley India Edition
4. Anthony T.Velte Toby J.Velte, "Cloud Computing – A Practical Approach", TMH.
5. Barrie Sosinsky, 'Cloud Computing Bible", Wiley India.

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VII Semester (Syllabus)

PEC- DS04(B)	**Streaming Data & Real- Time Analytics**	**2L:1T:0P (3 hrs)**	**Credits:03**

Prerequisite: NA

Course Objective: The course provides the foundational concepts, methods, languages, and systems for ingesting, processing, and analyzing data that flows to enable real-time decisions. The course aims to the tame velocity dimensions of Big Data without forgetting the volume and variety dimensions.

Course Contents:(40hrs)

Module 1: (8hrs)
Introduction to Streaming and Real-Time Systems Batch vs Real-Time vs Near Real-TimeProcessing, Characteristics and Use-Cases of Streaming Data, Latency, Throughput, Scalability, and Fault Tolerance, Architecture of Streaming Systems (Lambda, Kappa) ,Applications: IoT, Fraud Detection, Monitoring, etc.

Module 2: (8hrs)
Data Ingestion and Stream Processing Platforms Message Brokers: Apache Kafka, Rabbit MQ, Amazon Kinesis, Stream Processing Engines: Apache Spark Streaming, Flink, Storm ,Event Time vs Processing Time, Windowing, Triggers, and Watermarks ,Basic Operations: Map, Filter, Join, Aggregation

Module 3: (8hrs)
Real-Time Data Pipeline Architecture End-to-End Pipeline Design: Producers, Brokers, Consumers ,Stream Data Storage: Apache H Base, Cassandra, Amazon DynamoDB ,Real-Time ETL and Data Transformation, Integrating with Batch Systems and Data Lakes ,Monitoring and Logging Pipelines (e.g., Grafana, Prometheus)

Module 4: (8hrs)
Analytics on Streaming Data Stateless vs Stateful Stream Processing ,Real-Time Aggregations and Counting, Complex Event Processing (CEP) ,Machine Learning on Streaming Data (online learning, model updates),Time Series Analytics and Anomaly Detection

Module 5: (8hrs)
Deployment, Scalability, and Security Course Outcome: Scaling Stream Processing Applications, Load Balancing and Partitioning, Deploying Real-Time Systems with Docker and Kubernetes Security and Access Control in Streaming Systems, Handling Failures and Ensuring Exactly-once Semantics

Course Outcomes:

1. Understanding core concepts and use cases of data streaming:
2. Setting up and managing data ingestion:
3. Designing and implementing stream processing workflows:
4. Optimizing streaming systems for performance, scalability, and reliability:
5. Applying best practices for security and compliance:

List of Text/ Reference Books:

1. Kreps, Jay, I Love logs: Event data, stream processing, and data integration., O'Reilly Media, Inc., 2014
2. Geoff Holmes,Ricard Gavaldà,Albert Bifet, Bernhard Pfahringer, Streams: With Practical Examples in MOA, MIT Press, 2018

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VII Semester (Syllabus)

PEC-DS04(C)	**Artificial Intelligence**	**2L: 1T: 0P (3 hrs.)**	**Credits:03**

Prerequisite basic ML

Course Objective:

The main objective of this course is to understand concepts of Artificial Intelligence.

Course Contents:(40hrs)

Module 1 **(8hrs)**

Meaning and definition of artificial intelligence, Physical Symbol System Hypothesis, production systems, Characteristics of production systems; Breadth first search and depth first search techniques. Heuristic search Techniques: Hill Climbing, Iterative deepening DFS, bidirectional search. Analysis of search methods. A* algorithm, and their analysis. Introduction to Genetic Algorithms.

Module 2: **(8hrs)**

Knowledge Representation, Problems in representing knowledge, knowledge representation using propositional and predicate logic, logical consequences, syntax and semantics of an expression, semantic Tableau. Forward and backward reasoning. Proof methods, substitution and unification, conversion to clausal form, normal forms, resolution, refutation, deduction, theorem proving, inferencing, monotonic and non monotonic reasoning. Introduction to prolog.

Module 3: **(8hrs)**

Network-based representation and reasoning, Semantic networks, Conceptual Graphs, frames. Description logic (DL), concept language, reasoning using DL. Conceptual dependencies (CD), scripts, reasoning using CD. Introduction to natural language processing.

Module 4: **(8hrs)**

Adversarial search and Game theory, classification of games, game playing strategies, prisoner's Dilemma. Game playing techniques, minimax procedure, alpha-beta cut-offs. Complexity of alpha-beta search. Automated planning, classical planning problem, forward planning, partial order planning, planning with proposal logic, hierarchical task planning, multi- agent planning

Module 5: **(8hrs)**

Reasoning in uncertain environments, Fuzzy logic, fuzzy composition relation, operations on fuzzy sets. Probabilistic reasoning, Bayes theorem, construction of Bayesian networks, belief propagation. Markov processes and Hidden Markov models

Course Outcomes:

1. Describe basic concepts of AI and Heuristic search Techniques.
2. Explain Knowledge Representation, Forward and backward reasoning.
3. Explain Network-based representation and reasoning.
4. Apply Adversarial search and Game theory.
5. Analyze the Various Probabilistic Graphical Models

List of Text/ Reference Books:

1. Artificial Intelligence: Elaine Rich, Kevin Knight, Mc-GrawHill.
2. Introduction to AI & Expert System: Dan W.Patterson, PHI.
3. Artificial Intelligence by Luger (Pearson Education)
4. Russel&Norvig, Artificial Intelligence: A Modern Approach, Pearson Education

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VII Semester (Syllabus)

PEC-DS04(D)	Deep & Reinforcement Learning	2L:1T:0P (3 hrs)	Credits:03

Prerequisite: Machine Learning

Course Objective:

The objective of this course is to learn designing and implementation of deep and reinforcement learning approaches using machine learning for solving real-life problems.

Course Contents:(40hrs)

Module 1: **(8hrs)**
History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Activation functions, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, Ada Grad, RMS Prop, Adam, Eigenvalue Decomposition. Recurrent Neural Networks, Backpropagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs, Encoder Decoder Models, Attention Mechanism, Attention overimages.

Module 2: **(8hrs)**
Autoencoders and relation to PCA, Regularization in autoencoders, Denoising auto encoders, Sparse autoencoders, Contractive autoencoders, Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Batch Normalization, Instance Normalization, Group Normalization.

Module 3: **(8hrs)**
Greedy Layer wise Pre-training, Better activation functions, Better weight initialization methods, Learning Vectorial Representations Of Words, Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Recent Trends in Deep Learning Architectures.

Module 4: **(8hrs)**
Introduction to reinforcement learning(RL), Bandit algorithms – UCB, PAC, Median Elimination, Policy Gradient, Full RL & MDPs, Bellman Optimality, Dynamic Programming - Value iteration, Policy iteration, and Q-learning & Temporal Difference Methods, TemporalDifference Learning, Eligibility Traces, Function Approximation, Least Squares Methods

Module 5: **(8hrs)**
Fitted Q, Deep Q-Learning , Advanced Q-learning algorithms , Learning policies by imitating optimal controllers , DQN & Policy Gradient, Policy Gradient Algorithms for Full RL, Hierarchical RL,POMDPs, Actor-Critic Method, Inverse reinforcement learning, Maximum Entropy Deep Inverse Reinforcement Learning, Generative Adversarial Imitation Learning, Recent Trends in RL Architectures.

Course Outcomes:

1. Describe in-depth about theories, models and algorithms in machine learning.
2. Compare and contrast different learning algorithms with parameters.
3. Examine the nature of a problem at hand and find the appropriate learning algorithms and it's parameters that can solve it efficiently enough.
4. Design and implement of deep and reinforcement learning approaches for solving real-life problems.

List of Text/ Reference Books:

1. Deep Learning, An MIT Press book, Ian Goodfellow and YoshuaBengio and Aaron Courville
2. Pattern Classification- Richard O. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons Inc.
3. Reinforcement Learning: An Introduction, Sutton and Barto, 2nd Edition.
4. Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo, Eds

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VII Semester (Syllabus)

LC-PEC-DS03(P)	**Mobile Application Development**	**0L:0T:02P (2hrs.)**	**Credits:01**

Prerequisite: Mobile Application Development

Course Objective:

To provide students with practical and theoretical knowledge in mobile application development, network security, and mobile communication technologies. The course aims to build skills in secure programming, cryptographic implementation, mobile app design, and performance analysis of mobile networks.

Module 1:
To do several hands-on exercises to reinforce the students' knowledge and understanding of the various security aspects.

Module 2:
To explore the sequence of cryptographic algorithms by implementing using a programming language

Module 3:
To understand vulnerabilities and security flaws in the various applications.

Module 4:
To develop simple and location specific applications in android environment.

Module 5:
To analyse the performance of mobile networks using Network simulator.

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VII Semester (Syllabus)

Course Outcomes:

1. Have knowledge on the architecture and protocols of 2G, 3G, and 4G cellular system.
2. Deploy various protocols that support mobility at network layer and transport layer. Design and implement the user interfaces for mobile applications.
3. Design the mobile applications that are aware of the resource constraints of mobile devices.
4. Develop advanced mobile applications that access the databases and the web.

List of Text/ Reference Books:

1. Clint Smith, Daniel Collins, "Wireless Networks", Third Edition, McGraw Hill Publications, 2014.
2. Share Conder, Lauren Darcey, "Android Wireless Application Development", Volume I, Third Edition, Pearson, 2014.
3. Jochen Schiller, "Mobile Communications", Second Edition, Pearson, 2009.
4. Paul Bedell, "Cellular networks: Design and Operation – A real world Perspective", Outskirts Press,2014.
5. Zigurd Mednieks, Laird Dornin, G, Blake Meike and Masumi Android", O'Reilly, 2011.
6. Alasdair Allan, "iPhone Programming", O'Reilly, 2010.
7. Donny Wals, "Mastering iOS 12 Programming", Packt, 2018.
8. Reza B'Far, "Mobile Computing principles", Cambridge University Press, 2005.

List of Experiment:

The following exercises are based on the cryptographic algorithms. They can be implemented using any Programming Language.

1. Write a program to perform encryption and decryption using the following algorithms: (a.) Caesar cipher (b). Affine Cipher (c.) Hill Cipher (d.) Transposition Cipher.
2. Perform cryptographic attack on the cipher-text generated using any of the algorithms implemented in exercise 1.
3. Write a program to demonstrate symmetric key encryption process using DES and AES algorithm.
4. Write a program to implement RSA algorithm and demonstrate the key generation and encryption process.
5. Write a program to generate message digest for the given message using the SHA/MD5 algorithm and verify the integrity of message.
6. Write a program to sign and verify a document using DSA algorithm.
7. Perform Penetration testing on a web application to gather information about the system, then initiate XSS and SQL injection attacks using tools like kali Linux.
8. Develop a Mobile application for event handling and push notification in Android.
9. Create animations and graphical primitives in Android environment.
10. Develop a Location based services such as tracking, geofencing, and activity recognition using Google play services.
11. Develop a Mobile application for recognizing and authorizing using camera and sensors.
12. Performance analysis of various node deployment strategies in mobile environment using network simulators such as NS2/NS3/OPNET/GloMoSim/NetSim.

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VII Semester (Syllabus)

LC-PECDS03(P)	**Adversarial Machine Learning**	**0L:0T:02P (2hrs.)**	**Credits: 01**

Course Objective:
To equip students with hands-on experience in generating, defending against, and analyzing adversarial attacks on deep learning models using modern techniques. The course emphasizes practical implementation of attack/defense strategies, watermarking, and model integrity verification through cutting-edge research frameworks

Module 1:
Fast Gradient Sign Method (FGSM) Task: Implement the one-step FGSM attack to generate adversarial examples on MNIST or CIFAR-10 and measure the drop in accuracy. Task: Craft stronger, iterative $\ell\infty$ -bounded adversarial examples using PGD on a CIFAR-10 model. Analyze attack strength versus number of iterations. Framework: TensorFlow.

Module 2:
Defense-GAN (Adversarial Purification)Task: Train a GAN on clean data (e.g., MNIST). At inference, project inputs onto the GAN manifold to"purify" adversarial examples before classification.Code & Paper: Pouya Samangouei et al., "Defense-GAN: Protecting Classifiers Against Adversarial Attacks Using Generative Models," OpenReview, arXiv.

Module 3:
MagNet (Detector + Reformer)Task: Implement MagNet's autoencoder-based detectors and reformers to defend a CNN on MNIST against black-box adversarial examples (e.g., CW-L2). Task: Use the shadow-model method to build a binary classifier that, given query access to a target model, predicts if an input was in its training set.Tutorial: Nightfall AI, "Training Data Extraction Attacks: The Essential Guide

Module 4:
StegaStamp (Adversarial Watermarking)Task: Implement StegaStamp to invisibly embed a robust watermark into images that survives common adversarial perturbations and JPEG compression.Code & Paper: Jain et al., "StegaStamp: Invisible Hyperlinks in Images," CVPR 2021. GitHub.

Module 5:
Model Fingerprinting for Integrity Verification Task: Embed a subtle, model-specific perturbation ("fingerprint") during training. At test time, detect tampering or unauthorized copies by querying with fingerprint inputs. Source: Zhao et al., "Model Fingerprinting via Adversarial Examples," arXiv 2020.

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Course Outcome:

1. Implement FGSM and PGD attacks on MNIST/CIFAR -10 and analyze model robustness.
2. Train Defense-GAN to purify adversarial examples and improve classification accuracy.
3. Defend against adversarial inputs using MagNet and perform training data membership inference.
4. Apply StegaStamp to embed robust watermarks that resist adversarial perturbations.
5. Implement model fingerprinting to verify model integrity and detect unauthorized usage.

List of Text/ Reference Books:

1. Zhang et al., “Adversarial Video Hijacking: Universal Multi-Frame Attacks on Video Recognition,” ECCV 2024.
2. Ian J. Goodfellow et al., “Explaining and Harnessing Adversarial Examples,” arXiv.
3. A. Madry et al., “Towards Deep Learning Models Resistant to Adversarial Attacks,” arXiv.

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LC-PEC- DS03 (P)	Optimization for ML	0L:0T:02P (2hrs.)	Credits: 01

Prerequisites: Engineering Mathematics, Machine Learning I &II

Course Objective:

To understand the need of optimizing Machine Learning algorithms & various approaches in that direction.

Module 1:

Introduction to Machine Learning, Supervised Learning Concepts, Linear Regression, Evaluation Metrics for Regression

Module 2:

Introduction to Unsupervised Learning, Clustering Techniques, K-means Clustering, Visualization of Clusters

Module 3:

Introduction to Linear Algebra, Matrix Operations, Applications of Linear Algebra in Machine Learning

Module 4:

Introduction to Classification, Logistic Regression, Binary Classification, Multi-class Classification Evaluation Metrics for Classification

Module 5:

Introduction to Artificial Neural Networks (ANN) , Building and Training ANNs , Introduction to Gaussian Mixture Models (GMM), Comparing Clustering Techniques

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Course Outcomes:
1. Apply linear regression for predictive modeling and evaluate using regression metrics.
2. Use K-means and other clustering methods to analyze unlabeled data.
3. Apply linear algebra concepts in developing machine learning algorithms.
4. Build and evaluate classification models using logistic regression.
5. Implement ANNs and GMMs for advanced modeling and clustering comparison

List of Experiment:
1. Implement a linear regression model using python.
2. Perform K-means clustering on the Iris dataset and visualize the clusters using a scatter plot.
3. Perform basic linear algebra operations using NumPy, such as matrix multiplication and inversion.
4. Implement logistic regression for binary classification on the Iris dataset (using only two classes for simplicity).
5. Implement logistic regression for multi-class classification on the Iris dataset and evaluate its performance using a confusion matrix.
6. Demonstrate how to build a simple Artificial Neural Network (ANN) using Keras to classify image from the MNIST dataset, which contains handwritten digits from 0–9.
7. Implement K-means clustering using Python.
8. Implement naive baye's theorem to classify the English text.
9. Implement an algorithm to demonstrate the significance of genetic algorithm.
10. Implement the finite words classification system using Back-propagation algorithm.

LC-PEC- DS 03(P)	**Computational Financial Modeling**	**0L:0T:2P (2hrs.)**	**Credits: 01**

Prerequisites: Knowledge of at least one of C/C++/MATLAB/R/Spreadsheets Packages, Basic knowledge of Probability, Statistics and Linear Programming.

Course objective: The course aims to provide an introduction to Computational Financial Modeling. Fundamental concepts used in portfolio optimization, technical analysis and financial data modeling would be discussed.

Module 1:
Introduction to Financial Modeling and Markets Overview of Financial Markets and Instruments, Time Value of Money, Interest Rates, and Discounting, Introduction to Financial Modeling Concepts, Overview of Computational Tools: Excel, Python, R, MATLAB , Data Sources: Yahoo Finance, Quandl, Bloomberg (overview)

Module 2:
Stochastic Processes and Financial Time Series Random Walks and Brownian Motion, Geometric Brownian , Introduction to Ito's Lemma Stationarity and Non-stationarity, ARIMA and GARCH Models

Module 3:
Option Pricing and Derivative Modeling Introduction to Options and Derivatives, Black-Scholes Model: Assumptions and Derivation, Greeks and Sensitivity Analysis, Binomial and Trinomial Tree Models, Monte Carlo Simulation for Option Pricing

Module 4:
Portfolio Theory and Optimization Modern Portfolio Theory: Markowitz Framework, Efficient Frontier and Capital Market Line, Risk-Return Trade-off, Sharpe Ratio, Beta, and Alpha, Quadratic Programming for Portfolio Optimization

Module 5:
Risk Management and Algorithmic Trading Value at Risk (VaR) and Expected Shortfall, Backtesting and Strategy Evaluation, Overview of Algorithmic Trading Strategies,High-Frequency Data Considerations, Machine Learning Basics in Finance (Optional)

Course Outcomes:

1. Understand financial markets, instruments, and financial modeling using tools like Excel, Python, and
2. MATLAB.
3. Apply stochastic processes and time series models for financial data analysis and forecasting.
4. Implement option pricing models such as Black-Scholes, binomial trees, and Monte Carlo simulation.
5. Optimize investment portfolios using Modern Portfolio Theory and key risk-return metrics.
6. Manage financial risk and evaluate algorithmic trading strategies using backtesting techniques.

List of Experiment:

1. Setting up financial datasets using Python/Pandas
2. Basic time series visualization
3. Time series modeling using stats models or R forecast
4. Simulating stock prices using Monte Carlo
5. Implementing the Black-Scholes formula in Python/R
6. Building a binomial tree model for American options.
7. Portfolio optimization using Python (cvxpy) or R (quadprog)
8. Simulating portfolio performance with historical data
9. Implementing a basic trading strategy
10. Computing VaR and backtesting using historical simulation

List of Text/ Reference Books:

1. Investments by Zvi Bodie, Alex Kane, and Alan J. Marcus – Chapters 1–3
2. Financial Modeling by Simon Benninga – Chapters 1–2
3. Python for Finance by Yves Hilpisch – Chapters 1–2

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LC-PEC-DS04(P)	**Cloud Computing Lab**	**0L:0T:2P (2hrs.)**	**Credits:01**

Prerequisite: Cloud Computing.

Course Objective:

The objective of this course is to Gain a solid understanding of fundamental concepts in virtualization, cloud computing models (IaaS, PaaS, SaaS), and their respective benefits and trade-offs.

Module 1:

Foundations of Virtualization and Local Deployment, Introduction to Virtualization Concepts (Hypervisors, Virtual Machines, Containers) , Setting up a Virtualization Environment using VirtualBox, Setting up a Virtualization Environment using VMware Workstation/Player, Creating and Managing Virtual Machines, Basic Networking Concepts in Virtualized Environments.

Module 2:

Introduction to Cloud Platforms and Application Deployment, Overview of Major Cloud Providers (Google Cloud Platform, Microsoft Azure), Introduction to Platform as a Service (PaaS), Deploying a Simple Application on Google App Engine, Deploying a Simple Application on Microsoft Azure App Service, Understanding Cloud Deployment Models (Public, Private, Hybrid).

Module 3:

Exploring Software as a Service (SaaS) and Business Applications, Understanding the SaaS Model and its Benefits, Introduction to Salesforce Platform and its Core Features, Exploring Basic Application Development Concepts within Salesforce (e.g., Objects, Fields, Apps).

Module 4:

Infrastructure Virtualization and Storage Solutions, Introduction to Hypervisors for Enterprise Environments (VMware ESXi, Microsoft Hyper-V), Installation and Basic Configuration of a Hypervisor (Conceptual Overview and Simulated Exercises), Fundamentals of Storage Virtualization, Connecting Virtual Machines to Virtualized Storage.

Module 5:

Identity Management, Data Analysis, and Hybrid Cloud Concepts, Importance of Access Control and Identity Management, Introduction to Active Director y: Concepts and Basic Administration, Fundamentals of OLAP (Online Analytical Processing) Databases, Introduction to Platforms for Hybrid Cloud (OpenStack, Kubernetes).

Course Outcomes:

1. Demonstrate a foundational understanding of [1] virtualization
2. Deploy and manage simple applications
3. Navigate and understand the basic features and development concepts
4. Describe the fundamental principles of storage virtualization
5. Articulate the importance of access control and identity management

List of Text/ Reference Books:

1. Dr.Kumar Saurabh, “Cloud Computing”, Wiley India
2. Ronald Krutz and Russell Dean Vines, “Cloud Security”, Wiley-India.
3. Judith Hurwitz, R.Bloor, M.Kanfman, F.Halper, “Computing for Dummies”, Wiley India Edition.
4. Anthony T.Velte Toby J.Velte, “Cloud Computing – A Practical Approach”, TMH.
5. Barrie Sosinsky, ‘Cloud Computing Bible”, Wiley India.

List of Experiment

1. Setting up a basic virtualization environment using VirtualBox or VMware.
2. Deploying a simple application on Google App Engine or Microsoft Azure.
3. Implementing a simple Software as a Service (SaaS) application using a platform like
4. Salesforce or Office 365.
5. Installing and configuring a hypervisor such as VMware ESXi or Microsoft Hyper-V.
6. Configuring storage virtualization using Storage Area Networks (SAN) or Network
7. Attached Storage (NAS).
8. Implementing access control and identity management solutions using tools like Active
9. Directory or Keycloak.
10. Setting up OLAP (Online Analytical Processing) databases for business intelligence
11. analysis.
12. Investigating inter-cloud issues and experimenting with hybrid cloud deployments using platforms like OpenStack or Kubernetes.

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PEC-LC-DS 04 (P)	**Streaming Data & Real-Time Analytics**	**0L:0T:2P (2hrs.)**	**Credits: 01**

Prerequisite: Streaming Data & Real-Time Analytics

Course Objective:
This course provides a practical and conceptual foundation in real-time data streaming, covering architecture, technologies, and analytics techniques. Learners will build scalable, fault-tolerant streaming pipelines using tools like Kafka, Spark, Flink, and Kubernetes.

Module 1:
Batch vs Real-Time vs Near Real-Time Processing, Characteristics and Use-Cases of Streaming DataLatency, Throughput, Scalability, and Fault Tolerance, Architecture of Streaming Systems (Lambda, Kappa) Case studies (Uber, Twitter, Netflix real-time systems)

Module 2:
Message Brokers: Apache Kafka, RabbitMQ, Amazon Kinesis, Stream Processing Engines: Apache Spark Streaming, Flink, Storm Event Time vs Processing Time,Windowing, Triggers, and Watermarks ,Basic Operations: Map, Filter, Join, Aggregation

Module 3:
End-to-End Pipeline Design: Producers, Brokers, Consumers, Stream Data Storage: Apache HBase, Cassandra, Amazon DynamoDB , Real-Time ETL and Data Transformation ,Integrating with Batch Systems and Data Lakes Monitoring and Logging Pipelines (e.g., Grafana, Prometheus)**Case Study:** Building a real-time dashboard for sensor/IoT dataBuilding a binomial tree model for American options

Module 4:
Stateless vs Stateful Stream Processing, Real-Time Aggregations and Counting, Complex Event Processing (CEP), Machine Learning on Streaming Data (online learning, model updates),Time Series Analytics and Anomaly Detection

Module 5:
Scaling Stream Processing Applications, Load Balancing and Partitioning, Deploying Real-Time Systems with Docker and Kubernetes, Security and Access Control in Streaming Systems, Handling Failures and Ensuring Exactly-once Semantics

Course Outcomes:
1. Understanding core concepts and use cases of data streaming:
2. Setting up and managing data ingestion:
3. Designing and implementing stream processing workflows:
4. Optimizing streaming systems for performance, scalability, and reliability:
5. Applying best practices for security and compliance:

List of Experiment:

1. Compare batch vs real-time processing performance using Python
2. Analyze Netflix's real-time data architecture (written report)
3. Set up a Kafka + Spark Streaming pipeline for real-time word count.
4. Create Kafka producer and consumer using sample JSON data
5. Design a pipeline: Kafka → Spark → Cassandra → Grafana with IoT data
6. Real-time anomaly detection using River on network data
7. Rolling average & alert system with Spark Structured Streaming
8. Dockerize a Kafka-Spark pipeline
9. Deploy real-time application on Kubernetes (e.g., Minikube)
10. Set up Kafka access control (ACLs)

List of Text / Reference Books:

1. Kreps, Jay, I Love logs: Event data, stream processing, and data integration., O'Reilly Media, Inc., 2014
2. Geoff Holmes, Ricard Gavaldà, Albert Bifet, Bernhard Pfahringer MIT Press, 2018

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VII Semester (Syllabus)

LC-PEC-DS04(P)	**Artificial Intelligence Lab**	**0L:0T:2P (2hrs.)**	**Credits:01**

Course Objective:

The objective of this course is to understand different types of data structures and algorithms used in program.

Module 1:
Introduction to Prolog and AI Concepts: Overview of Prolog, Introduction to Prolog, Applications and uses of Prolog, Basic AI Concepts, Introduction to Expert Systems, AI applications in various fields

Module 2:
Syntax, Meaning of Prolog Programs, and Basic Problem Solving: Syntax and Meaning of Prolog Programs, Basic syntax and structure of Prolog programs, Data objects in Prolog, Matching in Prolog, Declarative meaning of Prolog programs, Procedural meaning of Prolog programs, Basic AI Problem Solving, Monkey and banana problem

Module 3:
Lists and Operations: Lists in Prolog, Introduction to lists, Representation of lists in Prolog, Operations on Lists, Common list operations, Example programs using lists

Module 4:
Advanced Prolog Concepts and Real-World Applications: Operators and Arithmetic, Operator notation in Prolog, Arithmetic operations in Prolog, Using Structures, Retrieving structured information from a database, Doing data abstraction, Simulating a non-deterministic automaton, Travel planning

Module 5:
Problem Solving and Control Techniques in Prolog: Complex Problems in Prolog, The eight queens' problem, Controlling Backtracking, Techniques to control backtracking in Prolog programs, Example programs illustrating backtracking control.

Course Outcomes:

1. Understand important concepts like Expert Systems, AI applications.
2. Solve basic AI based problems.
3. Define the concept of Artificial Intelligence.
4. Apply AI techniques to real-world problems to develop intelligent systems.
5. Select appropriately from a range of techniques when implementing intelligent systems.

List of Experiment:

1. Installation of gnu-prolog, Study of Prolog (gnu-prolog), its facts, and rules.
2. Write simple facts for the statements and querying it.
3. Write a program for Family-tree.
4. Write Program for Monkey-banana Problem.
5. Write a program which behaves a small expert for medical Diagnosis.
6. Write programs for computation of recursive functions like factorial Fibonacci numbers, etc.
7. Write program to solve 5-queens problem.
8. Write a Program for water jug problem.
9. Write a program for travelling salesman program.
10. Case study of standard AI programs like Mycin and AI Shell

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VII Semester (Syllabus)

LC-PEC-DS04(P)	**Deep & Reinforcement Learning**	**0L:0T:2P(2hrs.)**	**Credits: 01**

Pre-Requisite: Machine Learning.

Course Outcomes:

1. After completing the course student should be able to:
2. Describe in-depth about theories, models and algorithms in machine learning.
3. Compare and contrast different learning algorithms with parameters.
4. Examine the nature of a problem at hand and find the appropriate learning algorithms and it's parameters that can solve it efficiently enough.
5. Design and implement of deep and reinforcement learning approaches for solving real-life problems.

Course Contents:

Module 1:

History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Activation functions, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam, Eigenvalue Decomposition. Recurrent Neural Networks, Backpropagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs, Encoder Decoder Models, Attention Mechanism, Attention overimages.

Module 2:

Autoencoders and relation to PCA, Regularization in autoencoders, Denoisingautoencoder s, Sparse autoencoders, Contractive autoencoders, Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Batch Normalization, Instance Normalization, Group Normalization.

Module 3:

Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Learning Vectorial Representations Of Words, Convolutional Neural Networks, LeNet, AlexNet, ZF - Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolution al Neural Networks, Guided Backpropa gation, Deep Dream, Deep Art, Recent Trends in Deep Learning Architectures.

Module 4:

Introduction to reinforcement learning(RL), Bandit algorithms – UCB, PAC,Median Elimination, Policy Gradient, Full RL & MDPs, Bellman Optimality, Dynamic Programming - Value iteration, Policy iteration, and Q-learning & Temporal Difference Methods, Temporal-Difference Learning, Eligibility Traces, Function Approximation, Least Squares Methods

Module 5:

Fitted Q, Deep Q-Learning , Advanced Q-learning algorithms , Learning policies by imitating optimal controllers , DQN & Policy Gradient, Policy Gradient Algorithms for Full RL, Hierarchical RL,POMDPs, Actor-Critic Method, Inverse reinforcement learning, Maximum Entropy Deep Inverse Reinforcement Learning, Generative Adversarial Imitation Learning,Recent Trends in RL Architectures.

List of Text / Reference Books:

1. Deep Learning, An MIT Press book, Ian Goodfellow and YoshuaBengio and Aaron Courville
2. Pattern Classification- Richard O. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons Inc.
3. Reinforcement Learning: An Introduction, Sutton and Barto, 2nd Edition.
4. Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo, Eds

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VII Semester (Syllabus)

PROJ- DS04	Major Project-Phase -I	0L: 0T: 08P (8hrs.)	Credits:04

Course Objectives: To carry out a small scale project to develop hands-on experience of working in a project. During the course, the student will also develop knowledge of application development platforms and tools (Java /C# dotnet / Visual C++/PHP /Python or any platform of current trend). The students will learn working as a team and basic collaboration and project management skills. The student will also learn about formulating project documentations.

1. Project ideas and proposal guidance (4 hours)

2. Application development (10 hours)

1. Visual programming (object oriented)
    1. Language basics
    2. Frameworks and APIs
2. Programming basics and design patterns

3. Project management, team work and collaboration(6 hours)

1. Project management techniques
2. Collaborative development environment

4. Project guidance & Project work (20 hours)

5. Project documentation guidance (3 hours)

Course Outcome:

1. Understanding the problem identification process and design a proposal for particular problem handling.
2. Design a solution model using any programming language.
3. Learn about different types of project management techniques.
4. Develop a complete project with deployment.
5. Learn about team work and documentation process.

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VII Semester (Syllabus)

PROJ- DS05	**Evaluation of Internship-II**	**0L: 0T: 6P (6hrs.)**	**Credits: 03**

Course Outcome:

1. To explore career alternatives prior to graduation.
2. To develop communication, interpersonal and other critical skills in the job interview process.
3. To assess interests and abilities in their field of study.
4. To identify, write down, and carry out performance objectives related to their job assignment.
5. To integrate theory and practice.