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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	PCC	CL16	Advanced Machine Learning	3	-	-	3
2.	PCC	CL17	Deep Learning	3	-	-	3
3.	PEC	CL03	Elective-III	3	-	-	3
4.	PEC	CL04	Elective-IV	3	-	-	3
5.	LC	CL16 (P)	Advanced Machine Learning Lab			2	1
6.	LC-PEC	CL03 (P)	Elective-III Lab	-	-	2	1
7.	PROJ	CL05	Project-III	-	-	8	4
8.	PROJ	CL06	Evaluation of Internship-II			4	2
Total Academic Engagement and Credits				12	0	16	20
				28			

Electives-III	Electives-IV
(A) Cloud Computing	(A) Mining of Massive Datasets
(B) Internet of Things	(B) Pattern Recognition
(C) Android Development	(C) Foundations of Cyber Physical Systems
(D) AI in Healthcare	(D) Semantic Web & Ontologies

IPS Academy, Institute of Engineering & Science

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Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

PCC-CL16	Advanced Machine Learning	3L: 0T:0P (3hrs.)	Credits:03

Prerequisite: Machine Learning Basics.

Course Objective:

This course will educate students on advanced machine learning principles, examine the application of ML in massive-scale automation, and allow students to implement algorithms for real-world applications.

Course Contents: (40 hrs.)

Module 1: **(08 hrs.)**

Artificial Neural Network, Recurrent Neural Networks: RNN, Bidirectional RNN, Encoder-Decoder Sequence to sequence architecture, Deep Recurrent Networks, Recursive Neural Networks, The Long Short Term Memory and other Gated RNNs, Optimization for Long Term Dependencies.

Module 2: **(08 hrs.)**

Decision Trees: Representing concepts as decision trees, Recursive induction of decision trees, best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity, Over-fitting, noisy data, and pruning.

Module 3: **(08 hrs.)**

Introduction to reinforcement learning (RL), Reinforcement Learning, RL-framework, MDP, Bellman equations, Value Iteration and Policy Iteration, Actor-critic model, Q-learning, SARSA, Bandit algorithms – UCB, PAC, Median Elimination, Policy Gradient, Full RL & MDPs, Bellman Optimality.

Module 4: **(06 hrs.)**

Reinforcement learning through feedback network, function approximation. Ensemble Methods: Bagging, boosting, stacking and learning with ensembles, Random Forest.

Module 5: **(10 hrs.)**

Dynamic Programming - Value iteration, Policy iteration, and Q-learning & Temporal Difference Methods, Temporal-Difference Learning, Eligibility Traces, Function Approximation, Least Squares Methods, Fitted Q, Deep Q-Learning, Advanced Q-learning algorithms, Inverse reinforcement learning, Deep Inverse Reinforcement Learning, Generative Adversarial Imitation Learning, Recent Trends in RL Architectures.

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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

Course Outcomes:

1. Understand the significance of multi-layer perceptrons and the back propagation algorithm for learning network parameters.
2. Analyze concepts represented by decision trees and their recursive induction.
3. Implement Random Forest algorithms for classification and regression tasks.
4. Apply Q-learning and SARSA algorithms for solving reinforcement learning problems.
5. Apply function approximation methods and eligibility traces to handle large state spaces.

List of Text / Reference Books:

1. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer-Verlag NewYork Inc., 2nd Edition, 2011.
2. Tom M. Mitchell, “Machine Learning”, McGraw Hill Education, First edition, 2017.
3. Jeeva Jose, Introduction to Machine Learning, Khanna Book Publishing 2020.
4. Rajiv Chopra, Machine Learning, Khanna Book Publishing 2021.
5. Ethem Apaydin, Introduction to Machine Learning, 2e. The MIT Press, 2010.
6. Reinforcement Learning: An Introduction, Sutton and Barto, 2nd Edition.
7. Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo, Eds

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Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

PCC-CL17	Deep Learning	3L: 0T:0P (3hrs.)	Credits:03

Pre requisite(s): Basics of Machine Learning, Knowledge of Linear Algebra will be helpful.

Course Objectives:

On completion of the course students will acquire the knowledge of applying Deep Learning techniques to solve various real life problems.

Course Contents: (40 Hours)

Module 1: **(06 hrs)**

Introduction to Deep Learning, Bayesian Learning, Decision Surfaces, Linear Classifiers, Linear machines with Hinge Loss.

Module 2: **(08 hrs)**

Optimization Techniques, Gradient Descent, Batch Optimization, Introduction to Neural Network, Multilayer Perceptron, Back Propagation Learning.

Module 3: **(08 hrs)**

Unsupervised Learning with Deep Neural Network, Auto-Encoders, Convolutional Neural Network(CNN), Building Blocks of CNN, Transfer Learning.

Module 4: **(08 hrs)**

Revisiting Gradient Descent, Momentum Optimizer, RMSProp, Adam, Effective training in Deep Net-early stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization.

Module 5: **(10 hrs)**

Recent Trends in Deep Learning Architectures, Residual Network, Skip Connection Network, Fully Connected CNN, Classical Supervised Tasks with Deep Learning, Image Denoising, Semantic Segmentation, Object Detection, LSTM Networks

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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

Course Outcomes:

After completion of the course the student will be able to

1. Understand the fundamentals of Deep Learning, including its historical context and key concepts.
2. Apply optimization techniques such as Gradient Descent and Batch Optimization in the context of machine learning algorithms.
3. Implement Autoencoders and understand their role in dimensionality reduction and feature learning.
4. Implement Momentum Optimizer, RMSProp, and Adam optimization algorithms.
5. Analyze the role of Long Short-Term Memory (LSTM) networks in sequence modeling tasks.

Reference Books:

1. Deep Learning- Ian Goodfelllow, Yoshua Benjio, Aaron Courville, The MIT Press.
2. Pattern Classification- Richard O. Duda, Peter E. Hart, David G. Stork, Wiley India.
3. Neural Networks and Deep Learning by Charu C. Aggarwal, Springer.
4. Programming PyTorch for Deep Learning by Ian Pointer.
5. Deep Learning: Foundations and Concepts by Christopher Bishop and Hugh Bishop, Springer.

IPS Academy, Institute of Engineering & Science

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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

PEC-CL03(A)	Cloud Computing	3L: 0T:0P (3hrs.)	Credits:03

Prerequisite: Computer Network.

Course Objective:

The objective of this course is to provide students with the comprehensive and in-depth knowledge of CloudComputing concepts, technologies, architecture and applications.

Course Contents: (40 Hours)

Module 1: **(08 hrs)**

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, ElasticComputing.

(06 hrs)

Module 2:

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.

(06 hrs)

Module 3:

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: **(10 hrs)**

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: **(10 hrs)**

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, Xen Cloud Platform, Eucalyptus, OpenNebula, Nimbus, TPlatform, Apache Virtual Computing Lab (VCL), Anomaly Elastic Computing Platform.

IPS Academy, Institute of Engineering & Science

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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

Course Outcomes:

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 Books/ 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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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

PEC-CL03(B)	Internet of Things	3L: 0T:0P (3hrs.)	Credits:03

Prerequisite: NA

Course Objective:

The objective of this course is to provide an understanding of the technologies and the standards relating to the Internet of Things and to develop skills on IoT technical planning.

Course Contents: (40 Hours)

Module 1: **(06 hrs)**

IoT definition, Characteristics, IoT conceptual and architectural framework, Physical and logical design of IoT, IoT enablers, Modern day IoT applications, M2M communications, IoT vs. M2M, IoT vs. WoT, IoT reference architecture, IoT Network configurations, IoT LAN, IoT WAN, IoT Node, IoT Gateway, IoT Proxy, IPv4 vs. IPV6.

Module 2: **(10 hrs)**

Sensor, Basic components and challenges of a sensor node, Sensor features, Sensor resolution; Sensor classes: Analog, Digital, Scalar, Vector Sensors; Sensor Types, bias, drift, Hysteresis error, quantization error; Actuator; Actuator types: Hydraulic, Pneumatic, electrical, thermal/magnetic, mechanical actuators, soft actuators.

Module 3: **(08 hrs)**

Basics of IoT Networking, IoT Components, Functional components of IoT, IoT service oriented architecture, IoT challenges, 6LowPAN, IEEE 802.15.4, ZigBee and its types, RFID Features, RFID working principle and applications, NFC (Near Field communication), Bluetooth, Wireless Sensor Networks and its Applications.

Module 4: **(10 hrs)**

MQTT, MQTT methods and components, MQTT communication, topics and applications, SMQTT, CoAP, CoAP message types, CoAP Request-Response model, XMPP, AMQP features and components, AMQP frametypes.

Module 5: **(06 hrs)**

IoT Platforms, Arduino, Raspberry Pi Board, Other IoT Platforms; Data Analytics for IoT, Cloud for IoT, Cloud storage models & communication APIs, IoT case studies.

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

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

Course Outcomes:

1. Understand Internet of Things and its hardware and software components.
2. Interface I/O devices, sensors & communication modules.
3. Analyze data from various sources in real-time and take necessary actions in an intelligent Pattern.
4. Remotely monitor data and control devices.
5. Develop real life IoT based projects.

List of Text Books/ Reference Books:

1. Vijay Madisetti, Arshdeep Bahga," Internet of Things, A Hands-on Approach", University Press.
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
4. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi.
5. Adrian McEwen, "Designing the Internet of Things", Wiley.
6. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill.
7. Cuno Pfister, "Getting Started with the Internet of Things", O Reilly Media.

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 -AIML

Bachelor of Technology (B.Tech.)

Semester VII

PEC-CL03(C)	Android Development	3L: 0T:0P (3hrs.)	Credits:03

Pre requisite(s): Core java

Course Objectives:

After successfully completed the course, the learner will be able to use the development tools in the Android development environment.

Course Contents: (36 Hours)

Module 1: **(06 hrs)**

Android Software Development, building a sample Android application using Android Studio, android Project Structure, Android Manifest File and its common settings, Activities, Services, Intents.

Module 2: **(08 hrs)**

Permissions, Application resources, Basic User Interface Screen elements, Designing User Interfaces with Layouts, Using Content Providers, Handling Persisting Data.

Module 3: **(08 hrs)**

JSON Web Service, Gallery, drawing 2D and 3D Graphics and Multimedia, Drawing and Working with Animation.

Module 4: **(08 hrs)**

Networking, Telephony and Location, Android Networking, Web and Telephony API, Search, Location and Mapping, Communication, Identity, Sync and social media.

Module 5: **(06 hrs)**

Sensor and Hardware Programming, Publishing Android Application, Study of Various App Stores.

IPS Academy, Institute of Engineering & Science

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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

Course Outcomes:

After completion of the course the student will be able to:

1. Understand the fundamentals of Android development, including the Android Project Structure and the role of the Android Manifest File.
2. Demonstrate an understanding of permissions management within Android applications.
3. Retrieve and parse data from JSON Web Services in Android applications.
4. Implement features related to telephony and location, including integration with location-based services and mapping.
5. Understand the process of publishing Android applications to the Google Play Store or other distribution platforms.

Reference Books:

1. Headfirst Android Development by Dawn Griffiths.
2. Android App Development for Dummies by Michael Burton.
3. Android App Development for Beginners by David H. Rogers.
4. Android 9 for Developers: The Complete Guide by Charles-William Ebersole.

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

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

PEC-CL03(D)	AI in Healthcare	3L: 0T:0P (3hrs.)	Credits:03

Prerequisite: Introduction to AI

Course Objective:

Students will gain knowledge on how AI is revolutionizing medicine by acquiring hands-on experience in using machine learning to solve real-world medical issues.

Course Content: (40 Hours)

Module 1: **(08 hrs.)**

Disease detection with computer vision Medical Image Diagnosis, Eye Disease and Cancer Diagnosis, Building and Training a Model for Medical Diagnosis, Training, prediction, and loss, Image Classification and Class Imbalance, Generating More Samples, Model Testing.

Module 2: **(10 hrs.)**

Evaluating models Sensitivity, Specificity, and Evaluation Metrics, Accuracy in terms of conditional probability, Confusion matrix, ROC curve and Threshold Image segmentation on MRI images Medical Image Segmentation, MRI Data and Image Registration, Segmentation, 2D U-Net and 3D U-Net Data augmentation and loss function for segmentation, Different Populations and Diagnostic Technology, External validation.

Module 3: **(10 hrs.)**

Linear prognostic models Medical Prognosis, Atrial fibrillation, Liver Disease Mortality, Risk of heart disease, Evaluating Prognostic Models, Concordant Pairs, Risk Ties, Permissible Pairs. Prognosis with Tree-based models Decision trees for prognosis, fix overfitting, Different distributions,Missing Data example, Imputation.

Module 4: **(06 hrs.)**

Survival Models and Time Survival Model, Survival function, collecting time data, estimating the survival function. Build a risk model using linear and tree-based models Hazard Functions, Relativerisk, Individual vs. baseline hazard, Survival Trees, Nelson Aalen estimator.

Module 5: **(06 hrs.)**

Medical Treatment Effect Estimation Analyze data from a randomized control trial, Average treatment effect, Conditional average treatment effect, T-Learner, S-Learner, C-forbenefit.

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 -AIML

Bachelor of Technology (B.Tech.)

Semester VII

Course Outcomes:

1. Understand the application of computer vision in medical image diagnosis.
2. Evaluating Models for Medical Image Segmentation.
3. Building Prognostic Models with Linear and Tree-Based Methods.
4. Building Survival Models with Linear and Tree-Based Methods.
5. Medical Treatment Effect Estimation using Observational and Randomized Data.

List of Text Books/ Reference Books:

1. Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again, Eric Topol, Basic Books, 1st edition 2019.
2. Machine Learning and AI for Healthcare: Big Data for Improved Health Outcomes, Arjun Panesar, Apress, 1st ed. Edition, 2019.
3. Artificial Intelligence in Healthcare, 2020, ISBN 978-0- 12-818438 Elsevier Inc

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 -AIML

Bachelor of Technology (B.Tech.)

Semester VII

PEC-CL04(A)	Mining of Massive Datasets	3L: 0T:0P (3hrs.)	Credits:03

Prerequisite(s): Nil

Course Objectives:

This course introduces key data mining techniques for extracting valuable insights from large datasets, emphasizing their use in modern industry applications. Students will learn foundational algorithms such as association rules, classification, clustering, sequence mining, and data preprocessing through an interdisciplinary approach involving databases, machine learning, and algorithms.

Course Contents: (36 Hours)

Module 1: **(06 hrs)**

Introduction to Data Mining, Frequent Itemsets, Association Rules, Apriori Algorithm, FP-Growth Algorithm.

Module 2: **(08 hrs)**

Near Neighbor Search in High Dimensional Data, Curse of Dimensionality, Locality Sensitive Hashing (LSH), Hash Functions, Approximate Nearest Neighbor Search

Module 3: **(08 hrs)**

Dimensionality Reduction, Principal Component Analysis (PCA), Singular Value Decomposition (SVD), Feature Selection, Noise Reduction.

Module 4: **(06 hrs)**

Recommendation Systems, Collaborative Filtering, Content-based Filtering, Clustering, K-means, Hierarchical Clustering, DBSCAN.

Module 5: **(08 hrs)**

Classification, Decision Trees, Support Vector Machines (SVM), Neural Networks, Mining the Web, Web Content Mining, Web Structure Mining, Web Usage Mining.

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 -AIML

Bachelor of Technology (B.Tech.)

Semester VII

Course Outcomes:

After completion of the course the student will be able to

1. Understand the fundamental principles of frequent item sets and association rules and their applications.
2. Apply Locality Sensitive Hashing to perform efficient approximate nearest neighbor searches in high-dimensional data.
3. Analyze the impact of dimensionality reduction techniques on data quality and mining tasks.
4. Create effective recommendation and clustering models for personalized insights and pattern discovery.
5. Evaluate classification and web mining techniques to develop systems that extract actionable knowledge from web data.

Recommended Books:

1. "Introduction to Information Retrieval" by Manning, Raghavan and Schutze, Cambridge University Press
2. "Search Engines: Information Retrieval in Practice" by W. Bruce Croft, D. Metzler, T. Strohman, Pearson.
3. "Information Retrieval: Implementing and Evaluating Search Engines" by Stefan Büttcher, Charles L. A. Clarke and Gordon V. Cormack, MIT Press.

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 -AIML

Bachelor of Technology (B.Tech.)

Semester VII

PEC-CL04(B)	Pattern Recognition	3L: 0T:0P (3hrs.)	Credits:03

Prerequisite:

Course Objective:

The objective of this course is to learn the fundamentals of pattern recognition and its relevance to classical and modern problems.

Course Content: (40 Hours)

Module 1: **(08 hrs.)**

Introduction – Definitions, data sets for Pattern, Application Areas and Examples of pattern recognition, Design principles of pattern recognition system, Classification and clustering, supervised Learning, unsupervised learning and adaptation, Pattern recognition approaches, Decision Boundaries, Decision region, Metric spaces, distances.

(10 hrs.)

Module 2:

Classification: introduction, application of classification, types of classification, decision tree, naïve Bayes, logistic regression, support vector machine, random forest, K Nearest Neighbor Classifier and variants, Efficient algorithms for nearest neighbor classification, Different Approaches to Prototype Selection, Combination of Classifiers, Training set, test set, standardization and normalization.

(10 hrs.)

Module 3:

Different Paradigms of Pattern Recognition, Representations of Patterns and Classes, Unsupervised Learning & Clustering: Criterion functions for clustering, Clustering Techniques: Iterative square -error partitional clustering – K means, hierarchical clustering, Cluster validation.

Module 4: **(06 hrs.)**

Introduction of feature extraction and feature selection, types of feature extraction, Problem statement and Uses, Algorithms - Branch and bound algorithm, sequential forward / backward selection algorithms, (l, r) algorithm.

Module 5: **(06 hrs.)**

Recent advances in Pattern Recognition, Structural PR, SVMs, FCM, Soft computing and Neuro-fuzzy techniques, and real-life examples, Histograms rules, Density Estimation, Nearest Neighbor Rule, Fuzzy classification.

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 -AIML

Bachelor of Technology (B.Tech.)

Semester VII

Course Outcomes:

1. Understand the concept of a pattern and the basic approach to the development of pattern recognition
2. Acquire the knowledge of classification, its types and normalization.
3. Understand unsupervised learning & clustering in pattern recognition.
4. Understand the basic methods of feature extraction, feature evaluation, and data mining.
5. Understand soft computing and fuzzy classification for recent advancements in pattern recognition.

List of Text Books/ Reference Books:

1. Richard O. Duda, Peter E. Hart and David G. Stork, “Pattern Classification”, 2nd Edition, John Wiley, 2006.
2. C.M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2009.
3. S. Theodoridis and. Koutroumbas, “Pattern Recognition”, 4th Edition, academic Press, 2009.
4. Robert Schalk off, “pattern Recognition: statistical, structural and neural approaches”, John Wiley & sons, Inc, 2007.

IPS Academy, Institute of Engineering & Science

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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

PEC-CL04(C)	Foundation of Cyber Physical System	3L: 0T:0P (3hrs.)	Credits:03

Prerequisite: NIL

Objective:

The objective of this course is to Analyze the performance of embedded processing, memory, bus efficiencies, real time operating system performance.

Course Contents: (40 Hours)

Module 1: **(10 hrs)**

Fundamentals of - Cyber Physical Systems: Cyber-Physical Systems (CPS) in the real world Basic principles of design and validation of CPS, Industry 4.0 AutoSAR, IIOT implications, Building Automation, Medical CPS.

(08 hrs)

Module 2:

Platform Components for Cyber Physical Systems: CPS HW platforms - Processors, Sensors, Actuators CPS Network - Wireless Hart, CAN, Automotive Ethernet Scheduling Real Time CPS tasks: Table-driven and Event driven schedulers Hybrid schedulers.

Module 3: **(6 hrs)**

Principles of Dynmical Systems: Dynamical Systems and Stability Controller Design Techniques Performance under Packet drop and Noise.

Module 4: **(10 hrs)**

CPS implementation issues: From features to automotive software components Mapping software components to ECUs CPS Performance Analysis: Effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion Building real-time networks for CPS.

Module 5: **(06 hrs)**

Intelligent CPS: Safe Reinforcement Learning: Robot motion control, Autonomous Vehicle control Gaussian Process Learning: Smart Grid Demand Response, Building Automation.

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 -AIML

Bachelor of Technology (B.Tech.)

Semester VII

Course Outcomes:

1. To understand the concept of cyber physical systems' characteristics, requirements and architecture.
2. Understand the fundamentals of microprocessor and micro-controller families and their architecture.
3. To provide the students with some knowledge and analysis skills associated with the principles of memory organization and bus structure of cyber physical systems.
4. To develop the student's ability to understand the concepts of cyber physical system software with special emphasis on real time operating system and particularly real time job scheduling.
5. To provide the students with some basic knowledge of power aware architecture & hardware software co design.

List of Text Books / Reference Books:

1. Suh, Sang C., U. John Tanik, John N. Carbone, and Abdullah Eroglu, eds. Applied cyber-physical systems. Springer New York, 2014.
2. Alur, Rajeev. Principles of cyber-physical systems. MIT Press, 2015.
3. Colombo, Armando W., Thomas Bangemann, Statmatis Karnouskos, Jerker Delsing, Petr Stluka, Robert Harrison, Francois Jammes, and Jose L. Lastra. "Industrial cloud-based cyber-physical systems."
4. Andrew M Sloss, Dominic Symes, Chris Wright, "ARM System Developers Guide: Designing optimizing System Software" (Online resource).

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 -AIML

Bachelor of Technology (B.Tech.)

Semester VII

PEC-CL04(D)	Semantic Web & Ontologies	3L: 0T:0P (3hrs.)	Credits:03

Prerequisite: NA

Course Objective:

The objective of this course is to familiarize the students with Semantic Web Vision and able to understandXML, RDF, and Querying Ontology.

Course Contents: (40 Hours)

Module 1: **(06 hrs)**

Semantic Web: Building Models, calculating with knowledge, Exchanging Information, Semantic Web Technologies, Types of Web: Smart Web & Dumb Web, Applications, Semantic Data, Search Engine for Semantic Web.

Module 2: **(06 hrs)**

Semantic Modeling: Modeling for human communication, Explanation and prediction, Mediating Variability: Variation & Classes, Variation & Layers, and Expressivity in Modeling.

Module 3: **(08 hrs)**

Resource Description Language RDF: Introduction, Advanced features, simple Ontologies in RDF Schema, encoding of special data structures, RDF formal semantics, syntactic reasoning with deduction rules, Distributing data across web, Managing data from multiple sources.

Module 4: **(10 hrs)**

Web Ontology Language OWL: OWL syntax and Intuitive semantics, OWL species, Owl formal semantics: Description Logics, Model-Theoretic Semantics of OWL, Automated reasoning with OWL, Ontology Matching and Distributed Information.

Module 5: **(10 hrs)**

Semantic Web Application Architecture: RDF Parser/Serializer, RDF store: RDF data standards and Interoperability of RDF stores, RDF query engines, SPARQL: Query language for RDF, conjunctive Queries for OWL DL, RDF backed web portals, Data federation. Ontology Engineering: Constructing Ontologies manually, Reusing Existing Ontologies, Semiautomatic Ontology Acquisition, Ontology Mapping.

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 -AIML

Bachelor of Technology (B.Tech.)

Semester VII

Course Outcomes:

1. Describe Semantic Web technologies, models, and their applications.
2. Construct semantic models to handle variability and expressivity in knowledge representation.
3. Implement RDF and RDFS to model, encode, and reason over semantic data across the web.
4. Analyze OWL syntax and semantics to perform ontology modeling and reasoning.
5. Develop Semantic Web applications using RDF tools, SPARQL, and ontology engineering techniques.

List of Text/ Reference Books:

1. Hitzler, Markus, Rudolph, "Foundations of Semantic Web Technologies", Chapman & Hall/CRC
2. Allemang, Hendler, "Semantic Web for the working Ontologist" 2nd ed. Elsevier Pub.
3. Liang Yu, "Introduction to the Semantic Web and Semantic Web Services", Chapman & Hall/CRC
4. Antoniou, Harmelen, "A semantic Web Primer", PHI Pub.
5. Rajendra Akerkar, "Foundations of Semantic Web", Narosa Publishing, New Delhi.

List of Practical's

1. Create simple semantic models using tools like Protégé or online RDF editors.
2. Implement a basic search engine prototype that utilizes semantic technologies for indexing and querying semantic data.
3. Design semantic models that aim to improve communication between humans and machines.
4. Create RDF documents, defining resources, properties, and relationships.
5. Implementing and experimenting with techniques to distribute RDF data across the web and manage it from multiple sources.
6. Implementing parsers and serializers for RDF data in different formats.
7. Setting up and working with RDF stores and querying RDF data using SPARQL.

IPS Academy, Institute of Engineering & Science

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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

LC-CL16 (P)	Advanced Machine Learning Lab	0L: 0T:2P	Credits:01

Course Objective: Gain hands-on experience in implementing neural networks, decision trees, ensemble methods, boosting algorithms, reinforcement learning, and deep reinforcement learning using popular frameworks like TensorFlow and PyTorch.

Module 1:

Foundations of Neural Networks Perceptron implementation with NumPy, Multi-layer perceptron (MLP) for classification using TensorFlow or PyTorch.

Module 2:

Decision Trees and Ensemble Methods ID3 algorithm implementation, Decision tree libraries (scikit-learn) for classification and regression, Bagging with decision trees.

Module 3:

Boosting and Markov Decision Processes: Boosting algorithm (AdaBoost, Gradient Boosting) from scratch, Value Iteration for solving Markov Decision Processes (MDPs).

Module 4:

Reinforcement Learning Fundamentals: Q-learning for grid world problems Policy iteration and value iteration for solving MDPs.

Module 5:

Deep Reinforcement Learning Deep, Q-Learning (DQN) for Atari games using TensorFlow or PyTorch.

Course Outcomes:

After completion of the course, the student will be able to

1. Implement basic neural network models and understand the fundamentals of deep Learning libraries.
2. Construct decision trees, apply them to various problems.
3. Implement advanced ensemble techniques.
4. Apply fundamental reinforcement learning algorithms.
5. Design and implement deep reinforcement learning solutions.

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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

List of Text Books / Reference Books:

1. Raj Kamal, "Internet of Things", Tata McGraw Hill publication, 1st Edition, 2017.
2. Vijay Madisetti and Arshdeep Bahga, "Internet of things (A-Hand-on-Approach)" 1st Edition Universal Press, 2014.
3. Hakima Chaouchi "The Internet of Things: Connecting Objects", Wiley publication, 1 edition, 2013.
4. Charless Bell "My SQL for the Internet of things", A press publications, 1st edition, 2016.
5. Francis dacosta "Rethinking the Internet of things: A scalable Approach to connecting everything" 1st edition, A press publications 2013.

List of Experiment

1. Implement a perceptron in Python using NumPy.
2. Build a multi-layer perceptron (MLP) for a classification problem using a library like TensorFlow or PyTorch.
3. Implement the ID3 algorithm for building decision trees from scratch.
4. Use a decision tree library (e.g., scikit-learn) to build decision trees for classification and regression problems.
5. Implement bagging using decision trees as base learners.
6. Implement boosting algorithms like AdaBoost or Gradient Boosting from scratch.
7. Implement the Value Iteration algorithm to solve Markov Decision Processes (MDPs).
8. Implement Q-learning algorithm for solving a simple grid world problem.
9. Implement Deep Q-Learning (DQN) algorithm for solving Atari games using libraries like TensorFlow or PyTorch.
10. Implement policy iteration and value iteration algorithms for solving MDPs.

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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

LC-PEC-CL03 A (P)	Cloud Computing Lab	0L: 0T:2P	Credits:01

Prerequisite: Computer Networking.

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.

Course Contents:

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 Directory: Concepts and Basic Administration, Fundamentals of OLAP (Online Analytical Processing) Databases, Introduction to Platforms for Hybrid Cloud (OpenStack, Kubernetes).

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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

Course Outcomes:

1. Demonstrate a foundational understanding of 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 Books/ 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. To study cloud architecture and cloud computing model.
2. Setting up a basic virtualization environment using VirtualBox or VMware.
3. Study and Implementation of Storage as a Service Using AWS S3 Storage.
4. Study of AWS Identity and Access Management.
5. Create VPC with Amazon Web Services.
6. Launch Web Server in Virtual Private Cloud.
7. Create EC2 instance with Amazon Web Services.
8. Installation and configure Google App Engine

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 -AIML

Bachelor of Technology (B.Tech.)

Semester VII

LC-PEC-CL03 B (P)	Internet of Things Lab	0L: 0T:2P	Credits:01

Prerequisite: Fundamental electronics concepts such as voltage, current, resistance, and basic circuit design, Familiarity with common electronic components like resistors, capacitors, LEDs, and transistors, Basic proficiency in programming, preferably in C or C++.

Course Objective:
The course aims to provide students with comprehensive knowledge and practical skills in the field of embedded systems and Internet of Things (IoT) using the Arduino platform.

Course Contents:

Module 1:

Overview of Arduino Platform, Study of Arduino Uno Board, Understanding the components and functionalities of the board, Power supply and pin configurations, Getting Started with Arduino IDE: Installation and setup of Arduino IDE, Writing and uploading the first program ("Blink" example), Basic Programming and Digital I/O: Structure of an Arduino program (setup and loop functions), Basics of digital input and output, Interfacing LED with Arduino (Turn ON and OFF LED).

Module 2:

Interfacing Buzzers and LEDs: Working with buzzers: generating sound, Controlling multi-color LEDs (RGB LED Color Mixing), Push Buttons and Digital Input: Interfacing push buttons with Arduino Reading digital inputs and controlling outputs.

Module 3:

Advanced Sensor Interfacing Ultrasonic Sensors: Principles of ultrasonic distance measurement, Interfacing and programming an ultrasonic sensor with Arduino, Temperature and Humidity Sensing, Understanding temperature sensors (e.g., LM35, DHT11), Reading sensor data and displaying it.

Module 4:

Serial Communication and Data Handling Serial Communication Basics: Understanding Arduino serial communication, Sending and receiving data through the serial port, Controlling Devices via Serial Port: Writing programs to control LEDs using serial commands, Reading sensor data and sending it to a computer.

Module 5:

Analog Input and Motion Detection Analog Output and PWM: Understanding Pulse Width Modulation (PWM), Fading an LED using analog output, Motion Detection with PIR Sensors: Principles of motion detection using PIR sensors, Interfacing and programming a PIR sensor.

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

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

Course Outcomes:

After completion of the course the student will be able to

1. Understand and use the Arduino development environment effectively.
2. Interface various sensors and actuators with Arduino and write programs to control them.
3. Implement serial communication between Arduino and other devices.
4. Develop practical skills in reading and processing data from sensors.
5. Apply PWM techniques for analog control applications.

List of Text Books/ Reference Books:

1. Raj Kamal, “Internet of Things”, Tata McGraw Hill publication, 1st Edition, 2017.
2. Vijay Madisetti and Arshdeep Bahga, “Internet of things (A-Hand-on-Approach)” 1st Edition, Universal Press, 2014.
3. Hakima Chaouchi “The Internet of Things: Connecting Objects”, Wiley publication, 1 edition, 2013.
4. Charless Bell “My SQL for the Internet of things”, A press publications, 1st edition, 2016.
5. Francis dacosta “Rethinking the Internet of things: A scalable Approach to connecting everything”, 1st edition, A press publications 2013.

List of Experiment

1. Study of Arduino Uno Board, and Installation of Arduino IDE
2. To interface LED with Arduino and write a program to turn ON and OFF LED
3. To interface Buzzer with Arduino and write a program to turn ON and OFF Buzzer.
4. To interface Multi Color LED with Arduino and write a program for RGB LED Color Mixing.
5. To interface Push button with Arduino and write a program to turn ON LED when push button is pressed (Digital Input with a Push button).
6. To measure distance using ultrasonic sensor with the help of Arduino
7. To interface Temperature sensor with Arduino and write a program to print temperature readings on LCD
8. To interface LED with Arduino and write a program to control it using Arduino Serial Port.
9. Write a program to read temperature and humidity
10. Write a program of Fading LED with Arduino Analog Output.
11. To interface PIR (Passive InfraRed) Motion Sensor with Arduino and write a program to check motion.

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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

LC-PEC-CL03 C (P)	Android Development Lab	0L: 0T:2P	Credits:01

Prerequisite: Java Programming.

Course Objective:
The course aims to provide a practical approach to learning Android development, covering the key concepts from your modules.

Course Contents:

Module 1:

Introduction to Android Development: Setting up Android Development Environment, Building Your First Android Application, Exploring Android Project Structure and Manifest File, Working with Activities and Intents.

Module 2:

User Interface and Data Handling, Working with Basic UI Elements, How to setup Android Development Environment, Android development Framework - Android-SDK, Eclipse, Emulators – What is an Emulator / Android AVD, Creating & setting up custom Android emulator, Android Project Framework, My First Android Application.

Module 3:

Android Activities and UI Design Understanding Intent, Activity, Activity Lifecycle and Manifest, Creating Application and new Activities, Expressions and Flow control, Android Manifest, Simple UI - Layouts and Layout properties, Fundamental Android UI Design, Introducing Layouts Creating new Layouts, Drawable Resources, Resolution and density independence (px,dip,dp,sip,sp), XML Introduction to GUI objects viz., Push Button Text / Labels, EditText, ToggleButton, WeightSum, Padding, Layout Weight.

Module 4:

Networking, Telephony, and Location Services, Implementing Basic Networking, Working with Telephony API (Basic Information) Implementing Location Services.

Module 5:

Sensors and Publishing, Working with Device Sensors: Implement listeners for common sensor like accelerometer, gyroscope, and light sensor. Basic Hardware Interaction, Preparing for Publishing: Generate a signed APK (Android Package Kit) for the application.

IPS Academy, Institute of Engineering & Science

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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

Course Outcomes:

After completion of the course the student will be able to

1. Experiment on Integrated Development Environment for Android Application Development.
2. Design and Implement User Interfaces and Layouts of Android App.
3. Use Intents for activity and broadcasting data in Android App.
4. Design and Implement Database Application and Content Providers.
5. Experiment with Camera and Location Based service and develop Android App with Security features.

List of Text Books/ Reference Books:

1. Headfirst Android Development by Dawn Griffiths.
2. Android App Development for Dummies by Michael Burton.
3. Android App Development for Beginners by David H. Rogers.
4. Android 9 for Developers: The Complete Guide by Charles-William Ebersole.

List of Experiment

1. Setting Up Android Studio Environment.
2. Creating a Sample Android Application and Handling Permissions.
3. Create layouts, strings, and drawables in the resource directory and use them in the application.
4. Implement data persistence using Shared Preferences, SQLite database, or Room Persistence Library.
5. HTTP requests to a JSON web service and parsing the response data.
6. Create a gallery application that displays images from the device's storage.
7. Implement network operations using HTTP URL Connection, Volley, or Retrofit to fetch data from a remote server.
8. Explore telephony features like making phone calls, sending SMS messages programmatically.
9. Integrate Google Maps SDK to display maps, mark locations, and obtain user's current location.
10. Generating a signed APK and publishing the application on any App Store.

IPS Academy, Institute of Engineering & Science

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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

LC-PEC-CL03 D (P)	AI In Health Care Lab	0L: 0T:2P	Credits:01

Prerequisite: Python with libraries.

Course Objective: Students will gain hands-on experience with data manipulation, model building, evaluation, and interpretation in the context of medical diagnosis, prognosis, and treatment effect estimation.

Module 1:

Disease Detection with Computer Vision: Medical Image Data Exploration and Preprocessing, Building and Training a Binary Image Classifier, Addressing Class Imbalance, Model Evaluation and Testing.

Module 2:

Evaluating Models and Medical Image Segmentation, Evaluating Classification Models, Medical Image Segmentation - MRI Data Exploration, Implementing a 2D U-Net for Segmentation, Evaluating Segmentation Performance.

Module 3:

Linear Prognostic Models: Building and Evaluating a Linear Prognostic Model, Understanding Concordance and Discordance, Prognosis with Tree-based Models, Handling Missing Data in Prognostic Models.

Module 4:

Estimating the Survival Function, Building a Linear Risk Model (Cox Proportional Hazards), Building a Survival Tree, Non-parametric Hazard Estimation.

Module 5:

Medical Treatment Effect Estimation: Analyzing Data from a Randomized Control Trial (RCT), Estimating Conditional Average Treatment Effect (CATE), Implementing T-Learner and S-Learner, Exploring C-for-benefit.

Course Outcomes:

After completion of the course the student will be able to

1. Preprocess and analyze medical image data.
2. Build, train, and evaluate deep learning models for medical image classification tasks.
3. Apply appropriate evaluation metrics and understand the significance.
4. Implement and evaluate deep learning models for medical image segmentation.
5. Develop and evaluate linear and tree-based prognostic models.

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Based on AICTE Flexible Curriculum

Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

List of Text Books/ Reference Books:

1. Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow" by Aurélien Géron (3rd Edition Recommended).
2. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.
3. Pattern Recognition and Machine Learning" by Christopher Bishop.
4. Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy.
5. The Elements of Statistical Learning: Data Mining, Inference, and Prediction" by Hastie, Tibshirani, and Friedman.

List of Experiments

1. Load and visualize a sample medical image dataset (e.g., chest X-rays, retinal images)
2. Implement basic image preprocessing techniques: resizing, normalization, and data augmentation (rotation, flipping)
3. Build a simple Convolutional Neural Network (CNN) model using Keras for binary classification (e.g., disease vs. no disease).
4. Implement techniques to handle class imbalance: oversampling (e.g., SMOTE) and under sampling.
5. Calculate key evaluation metrics: accuracy, precision, recall, F1-score.
6. Calculate sensitivity, specificity, and plot the Receiver Operating Characteristic (ROC) curve for the models trained in Module 1.
7. Build a basic 2D U-Net architecture using Keras for segmenting a specific anatomical structure in MRI images.
8. Perform data preprocessing, including handling missing values and feature scaling.
9. Implement the Kaplan-Meier estimator to estimate the survival function.
10. Calculate the Average Treatment Effect (ATE) using simple difference in means.
11. Implement the T-Learner and S-Learner approaches using machine learning models (e.g., regression, classification) to estimate treatment effects.

IPS Academy, Institute of Engineering & Science

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Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

PROJ CL05	Project-III	0L: 0T:8P	Credits:04

Course Objective:

1. To enable students to formulate a relevant research or practical problem in the domain of Computer Science and AI/ML.
2. To apply computational thinking and AI/ML methodologies in developing effective and innovative solutions.
3. To foster critical thinking through model analysis, validation, and benchmarking of results.
4. To enhance professional communication through report writing, technical documentation, and oral presentations.

Module 1:

This module focuses on identifying a research gap or application domain problem in computer science or AI/ML. Students will conduct a systematic literature survey using reputed digital libraries (IEEE, ACM, etc.) and formalize a research question with clear objectives, scope, and constraints. Emphasis is placed on ethical AI considerations and feasibility assessment.

Module 2:

Students will explore AI/ML algorithms or general computational methods relevant to their chosen problem. This phase includes choosing appropriate models, tools, datasets, and defining the experimental setup. Design decisions must align with ethical and efficiency standards.

Module 3:

This module involves the actual coding, model training, system building, or simulation, depending on the nature of the project. Students will apply frameworks such as Python, TensorFlow, PyTorch, Scikit-learn, or other tools based on project needs.

Module 4:

Students will evaluate the performance of the solution using metrics like accuracy, precision, recall, F1-score, or computational efficiency. This module includes comparison with baseline or existing methods and identifying areas for improvement.

Module 5:

The final module covers structured technical report writing and the preparation of effective oral and visual presentations. Students will document their work in formats such as IEEE paper or project report templates and present their findings to faculty panels.

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 -AIML

Bachelor of Technology (B.Tech.)

Semester VII

Course Outcomes:

After completion of the course the student will be able to

1. Students will be able to identify, review, and formulate a meaningful problem statement backed by existing literature.
2. Students will be able to design an appropriate solution architecture and select suitable algorithms, tools, and datasets for implementation.
3. Students will be able to develop, implement, and test the proposed solution or model using real or synthetic data.
4. Students will be able to analyze, validate, and compare their results with established benchmarks or models.
5. Students will be able to compose a technical report and present their work clearly and effectively to both technical and non-technical audiences.

IPS Academy, Institute of Engineering & Science

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Department of Computer Science & Engineering -AIML

Bachelor of Technology (B.Tech.)

Semester VII

PROJ CL06	Evaluation of Internship-II	0L: 0T:4P	Credits:02

Course Objective:

To provide students with industry exposure and evaluate their ability to apply academic knowledge in real-world professional environments.

The Evaluation of Internship course begins with students selecting and joining an approved organization for internship placement in the domain of Computer Science, Artificial Intelligence, Data Science, Software Development, or a related field. During the internship period, students are expected to engage in meaningful technical work under the guidance of industry mentors, applying their academic knowledge to real-world scenarios. Students must maintain a weekly work log detailing tasks, tools used, and learning reflections. Midway through the internship, students submit a progress report to faculty coordinators for feedback. Upon completion, a comprehensive internship report is submitted, including project details, outcomes, tools/technologies used, and reflections on professional growth. The course concludes with a formal presentation and viva-voce, during which students demonstrate what they learned and how it aligns with academic and industry expectations. Evaluation is based on employer feedback, report quality, presentation clarity, and the depth of learning.

Course Outcomes:

After completion of the course the student will be able to:

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.