INDIRA GANDHI DELHI TECHNICAL UNIVERSITY FOR WOMEN
(Established by Govt. of Delhi vide Act 9 of 2012)
Department of Information Technology

Syllabus for B.Tech (Artificial Intelligence and Machine Learning)
(From Academic Session August 2024 (Odd semester) onwards)

SEMESTER V

Code	Subject	L-T-P	Credits	Category
BAM-301	Optimization Techniques and Decision Making	3-0-2	4	DCC
BAM-303	Cryptography and Network Security	3-0-2	4	DCC
BAM-305	Social Networking and Mining	3-0-2	4	DCC
BCS-303	Theory of Computation	3-1-0	4	DCC
HMC-301	Professional Ethics and Human Values	3-0-0	3	HMC
BAM-353	Industrial Training/Internship	-	1	DCC
GEC-301	Generic Open Elective	0-2-0 0-0-4 2-0-0	2	GEC
		Total	**22**	

SEMESTER VI

Code	Subject	L-T-P	Credits	Category
BAM-302	Reinforcement Learning	3-0-2	4	DCC
BAM-304	Neural Networks and Deep Learning	3-0-2	4	DCC
BAM-306	Computer Vision	3-0-2	4	DCC
BAM/BAI-3xx	Departmental Elective - I	-	4	DEC
BAM/BAI/BIT-3xx	Departmental Elective – II	-	4	DEC
HMC-30x	Management Elective	-	2	HMC
		Total	**22**	

List of Departmental Elective Courses

Category	Course Code	Subject	L-T-P	Credits
Departmental Elective-I	BAM-308	Cloud computing & IoT	3-0-2	4
	BAI-310	Blockchain Technologies	3-0-2	4
	BAI-312	Quantum Computing	3-0-2	4
	BAM-310	Cyber Security and Forensics	3-0-2	4
	BAM-312	Advanced Java Programming	3-0-2	4
Departmental Elective-II	BIT-308	Advanced Data Structures and Algorithms	3-0-2	4
	BAI-314	Information Retrieval	3-0-2	4
	BAI-316	Recommender Systems	3-0-2	4
	BAI-318	Semantic Web	3-0-2	4
	BAM-314	Natural Language Processing	3-0-2	4
	BEC-318	Digital Image Processing	3-0-2	4

List of Management Elective Courses

Course Code	Subject	L-T-P	Credits
HMC-302	Principles of Management	2-0-0	2
HMC-304	Marketing Management	2-0-0	2
HMC-306	Financial Management	2-0-0	2
HMC-308	Human Resource Management…	2-0-0	2

OPTIMIZATION TECHNIQUES AND DECISION MAKING	
Course Code: BAM-301 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 5

Introduction: Optimization Techniques are specific method to achieve the minima and maxima or the optimizing problems. Decisions making in businesses, research and scientific domains often strive to solve the optimizing problems for achieving the underlying objectives of the businesses, research and scientific domains. This course introduces several optimization techniques and their applications in computer science domain.

Course Objectives:

- To study Linear Programming and Integer Programming Problems
- To learn constraints satisfaction and its application aspects in engineering problems
- To apply data analysis and harness in decision makings
- To be able to apply optimal solutions in variety of engineering domains

Pre-requisite: Basic Mathematics

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

CO1: To be able to understand LP paradigm and pure & mixed Integer Problems
CO2: Understand the basic concepts of the Constraint Satisfaction and Applications
CO3: Understand Classification, Clustering and Regression Queuing Theory
CO4: To be able to understand Analysis and Decision making aspects

Pedagogy: Classroom teaching which focuses on developing understanding of students to digest the concepts of subject with large number of examples. The teaching-learning of the course would be organized through lectures, tutorials, assignments, and quizzes.

Contents

UNIT-I	10 Hours
Fundamental theorem of linear programming, Degenerate solutions, Simplex based methods, Cycling, Duality, Complementary slackness conditions. Non-linear programming: First and second order conditions. Iterative methods and associated issues, Line search methods: Stationarity of limit points of steepest decent, successive step-size reduction algorithms, etc.	
UNIT-II	**10 Hours**
Hessian based algorithms: Newton, Conjugate directions and Quasi-Newton methods. Constrained optimization problems: Lagrange variables, Karush-Kuhn-Tucker conditions, Regular points, Sensitivity analysis. Quadratic programming, Convex problem	
UNIT-III	**12 Hours**
Prescriptive Analytics**,** decision support systems, Statistical learning techniques, including regression, Logistic Regression, Ridge Regression, Lasso Regression, K Nearest Neighbors Regression & Classification Methods, Bias-Variance Dichotomy Model Validation Approaches	
UNIT-IV	**10 Hours**
Linear Discriminant Analysis, Quadratic Discriminant Analysis, Regression and Classification Trees, Support Vector Machines, Clustering, Analytic Hierarchy Process (AHP), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Reinforcement learning: Introduction, Applications, Markov decision process, Q-learning, SARSA, DQN. Optional Topics: Mixed integer models; Interior point methods; Iterative schemes for constrained problems; Sequential quadratic programming methods; Barrier methods; Trust-region methods	

Text Books	
1	Jiawei Han, Micheline Kamber, Jian Pei. Data Mining: Concepts and Techniques, 3rd Edition, MK publisher, 2011.
2	Taha, H.A. Operations Research, 5th ed., Macmillan Publishing Company, 1992.
3	Mustafi, C. K. Operations Research, 4th ed., New Age International, 2009
Reference Books	
1	Smith, David K. Network Optimization in Practice. Ellis Harwood Publications, 1982.
2	Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar. Introduction to Data Mining, 2nd ed., Pearson Education, 2021.

CRYPTOGRAPHY AND NETWORK SECURITY	
Course Code: BAM-303 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 5

Introduction:
Cryptography and Network Security are integral facets of modern computing, working in tandem to fortify the confidentiality, integrity, and availability of information within computer networks. Cryptography employs mathematical algorithms to encode data, ensuring secure communication, while Network Security encompasses measures safeguarding networks from unauthorized access and cyber threats.

Course Objectives:

- To provide students with a practical and theoretical knowledge of cryptography and network security.
- To develop an understanding of different cryptographic protocols and techniques
- To understand methods for authentication, access control, intrusion detection and prevention.

Pre-requisite: Computer Networks

Course Outcomes: After completion of the course, students will be able to:
CO1: Students will demonstrate a comprehensive understanding of foundational concepts in cryptography, security threats, and vulnerability, including active and passive attacks, applying the CIA model to assess security needs. Utilizing principles of integer and modular arithmetic, matrices, linear congruence, and algebraic structures, students will proficiently analyze and implement traditional symmetric key ciphers, as well as modern block and stream ciphers, such as DES and AES.
CO2: Exhibit proficiency in the mathematics of asymmetric cryptography. They will apply this knowledge to implement asymmetric-key cryptography algorithms like RSA, Rabin, ElGamal, and Elliptic Curve Cryptosystems.
CO3: Demonstrate proficiency in Cryptographic concepts, apply key exchange mechanisms and implement advanced encryption techniques.
CO4: By studying cryptographic hash functions, digital signature standards, key management, and entity authentication, students will gain expertise in ensuring message integrity and authenticity. Additionally, they will explore advanced topics such as side-channel attacks, SSL, IPSec, Quantum Cryptography, Blockchain, and system security measures like IDS, Firewall, and IPS.

Pedagogy: Classroom teaching which focuses on developing understanding of students to digest the concepts of subject with large number of examples. The teaching-learning of the course would be organized through lectures, tutorials, assignments, and quizzes.

Contents

UNIT-I	12 Hours
Introduction: Introduction to Cryptography, Security Threats, Vulnerability, Active and Passive Attacks, Security Services and Mechanisms, CIA Model, **Mathematics of Cryptography**: Integer and Modular Arithmetic, Matrices, Linear Congruence; **Traditional Symmetric Key Ciphers**: Substitution, Transposition, Block and Stream; **Mathematics of Symmetric Key Cryptography:** Algebraic Structures, GF(2^n) Fields; Modern Block and Stream Ciphers; Data Encryption Standard (DES), Advanced Encryption Standard (AES).	
UNIT-II	**10 Hours**
Mathematics of Asymmetric Cryptography: Primes, Primality Testing, Factorization, Chinese Remainder Theorem, Quadratic Congruence, Exponentiation and Logarithm; **Asymmetric-Key Cryptography:** RSA, Rabin Cryptosystem, ElGamal Cryptosystem, Elliptic Curve Cryptosystem; Message Integrity, Message Authentication	
UNIT-III	**10 Hours**
Cryptographic Hash Functions, Secure Hash Algorithm (SHA), Digital Signature Standard (DSS), Entity Authentication, Key Management, Key Exchange, Cryptanalysis, Time-Memory Trade-off Attack, Differential and Linear Cryptanalysis, Cryptanalysis on Stream Cipher, Modern Stream Ciphers, Shamir's secret sharing and BE, Identity-based Encryption (IBE), Attribute-based Encryption (ABE)	
UNIT-IV	**10 Hours**
Side-channel attack, The Secure Sockets Layer (SSL), IPSec, Pretty Good Privacy (PGP), Introduction to Quantum Cryptography, Blockchain, Bitcoin and Cryptocurrency, System Security: Buffer Overflow, Malicious Software, IDS, Firewall, IPS.	

Text Books	
1	Forouzen and Mukhopadyay, “Cryptography and Network Security”, TMH, Second, 2012/Latest Edition
2	William Stallings, “Cryptography and Network Security- Principles and Practice”, Pearson Education India, Seventh, 2017/Latest Edition
Reference Books	
1	William Stallings, “Network Security Essentials: Applications and Standards”, Pearson, Sixth, 2018/Latest Edition
2	Stinson and Paterson, “Cryptography: Theory and Practice”, CRC Press, Fourth, 2018/Latest Edition

SOCIAL NETWORKING AND MINING	
Course Code: BAM-305 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 5

Introduction:
Social media expansion has completely changed how people connect and how businesses operate. The main reasons people sign up for social network platforms are to interact with friends, connect with them, and share information. Users are generating data through social media. This course provides the understanding and processing of this new kind of data to extract useful patterns.

Course Objectives:

- To study and analyze social network data.
- Learn different algorithms at play in the operation of social networks.

Pre-requisite: Basic understanding of machine learning.

Course Outcomes: After completion of the course, students will be able to:
CO1: Understand and perform network analysis and modeling on different social media platforms
CO2: Learn and apply algorithms for link analysis, and community detection.
CO3: Understand concepts and methods in link prediction and graph representation learning.
CO4: Learn information cascades and anomaly detection.

Pedagogy: Classroom teaching which focuses on developing understanding of students to digest the concepts of subject with large number of examples. The teaching-learning of the course would be organized through lectures, tutorials, assignments, and quizzes.

Contents

UNIT-I	10 Hours
Introduction to Social Network Analysis and applications. Data Collection Methods - APIs, Web Scraping, Selenium. Network basics, Node Centrality Measures, Power Law. Properties of real world networks - Small world, Scale free. Random network models, Preferential attachment models.	
UNIT-II	**10 Hours**
Link Analysis - Applications, Signed Networks, Strong & Weak Ties, Algorithms - Page Rank vs Personalized Page Rank. Community Detection - Applications, Types of Communities. Methods for Community Detection. Disjoint vs Overlapping Communities. Evaluation of Community Detection.	
UNIT-III	**12 Hours**
Link Prediction - Applications, Problem Definitions, Methods. Evaluation of link prediction models. Heuristic vs Probabilistic models. Machine Learning Review. Representation Learning - Intuition & Benefits. Graph Representation Learning pipeline and methods.	
UNIT-IV	**10 Hours**
Cascade Behaviors - Preliminaries, Cascade model, Probabilistic cascades, Epidemic models, independent cascade model, cascade prediction. Anomaly detection - Outliers vs network based anomalies, detection in static & dynamic networks. Case Studies of Social Network Platforms.	

Text Books	
1	Tanmoy Chakraborty. “Social Network Analysis”. Wiley, 2021/ Latest Edition.
2	Zafarani, Reza, Mohammad Ali Abbasi, and Huan Liu. Social media mining: an introduction. Cambridge University Press, 2014 / Latest Edition.
Reference Books	
1	Bonzanini Marco. Mastering Social Media Mining. Packt Publishing, 2016/ Latest Edition.
2	Mikhail Klassen, Matthew A. Russell. Mining the Social Web. 3rd Edition. O’Reilly Media, Inc, 2019/ Latest Edition.

THEORY OF COMPUTATION	
Course Code: BCS-303 Contact Hours: L-3 T-1 P-0 Course Category: DCC	Credits: 4 Semester: 5

Introduction:

The study of automata and the theory of computation deal with the concepts of working of automatic machine and processing of input formal language data. This subject provides an important background material to students involved in understanding the basic functionalities of automata theory.

Course Objectives:

- Introduce concepts in Automata theory and theory of computation
- Identify different formal language classes and their relationships
- Design grammars and recognizers for different formal languages

Pre-requisite: Basic concepts of mathematics

Course Outcome: Upon successful completion of this course, students will be able to:

CO1: Understand the basics of automata and its fundamentals.
CO2: Understand theory of computation and concepts of formal languages
CO3: Design grammars and recognizers for different formal languages
CO4: Analyze the finite automata and regular expressions for accepting the language.

Pedagogy:

The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Students would be encouraged to develop an understanding of the existing real life cyber security issues and how they are solved. Emphasis would be given on assignments where students will be given numerical/ programming assignments based on topics studied in previous lectures. Course will have a blend of theory and practice for the benefit of students. Use of ICT, web-based sources as well as blackboard teaching will be adopted.

Contents

UNIT I	11 hours
Introduction to Theory of Computation: Definitions: Languages, Grammar, Automata, Applications of Theory of Computation, Finite Automata: DFA, NDFA, Equivalence of DFA and NDFA, DFA Minimization Regular Languages, Regular Grammars, Properties of Regular Languages, Pumping Lemma	
UNIT II	**10 hours**
Context Free Language: Introduction, Parsing and Ambiguity, Pushdown Automata (PDA), Non-Deterministic PDA, Context Free Grammar, Chomsky Normal Form, Greibach Normal Form, Parse Tree representation of Derivation Tree, Equivalence of PDA and CFGs, Properties of Context Free Grammars	
UNIT III	**11 hours**
Pumping Lemmas: Pumping Lemma for context free languages, Pumping lemma for linear languages. Turing Machine: Definition, TM as language acceptors, TM as transducers, Hierarchy of Formal Languages and Automata, Chomsky Hierarchy, Context Sensitive Languages and LBA, Unrestricted Grammars	
UNIT IV	**10 hours**
Turing machine Models and complexity: Some NP Problems, Complexity classes P and NP, Unsolvable Problem, Halting problem, Finite State Transducers: Introduction, Mealy Machines**,** Moore Machines, Mealy and Moore Equivalence, Limitations of Finite State transducer	

Text Books	
1	P. Linz, "An Introduction to Formal Languages and Automata", Narosa Publishers, 2010/ Latest Edition.
2	J. Ullman, J. Hopcroft, "Introduction to Automata Theory, Languages and Computation", Pearson Education India, 3rd Edition, 2008/ Latest Edition.

Reference Books	
1	M. Sipser, "Introduction to the Theory of Computation", Cengage, 3rd Edition, 2014/Latest Edition.
2	C.K. Nagpal, "Formal Languages and Automata Theory", Oxford University Press, 2015/Latest Edition.

REINFORCEMENT LEARNING	
Course Code: BAM-302 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 6

Introduction: Reinforcement learning (RL) is a paradigm of learning via interactions with the environment. RL algorithms are at the frontier of current success of AI. RL refers to a collection of machine learning techniques which solve sequential decision making problems using a process of trial-and-error. It is a core area of research in artificial intelligence and machine learning, and today provides one of the most powerful approaches to solving decision problems.

Course Objectives:

- To gain knowledge of basic and advanced reinforcement learning techniques.
- To understand RL Framework and Markov Decision Process.
- To gain an ability to formulate decision problems, set up and run computational experiments, evaluation of results from experiments.
- To implement reinforcement learning techniques.
- Acquire knowledge in reinforcement learning techniques to solve real-world problems.

Pre-requisite: Probability, Linear Algebra, Data Structures and Algorithms

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

CO1: Formalize problems as Markov Decision Processes.
CO2: Understand TD(0) algorithm, TD(λ) algorithm.
CO3: Understand function approximations.
CO4: Understand basic exploration methods and the exploration/exploitation tradeoff.

Pedagogy: Classroom teaching which focuses on developing understanding of students to digest the concepts of subject with large number of examples. The teaching-learning of the course would be organized through lectures, tutorials, assignments, and quizzes.

Contents

UNIT-I	11 Hours
Markov Decision Processes (MDP): Origin and history of Reinforcement Learning, Introduction to RL terminology, The K-Armed Bandit Problem, Markov property, Markov chains, Markov reward process (MRP), Bellman equations, Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations. **Planning by Dynamic Programming (DP):** Overview of dynamic programming for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, DP extensions and Convergence using Contraction Mapping.	
UNIT-II	**11 Hours**
Model-free Prediction and Model-free Control: Overview of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling. Incremental Monte Carlo Methods for Model Free Prediction, Overview TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.	
UNIT-III	**10 Hours**
Approximation: Approximation methods, Revisiting risk minimization, gradient descent from Machine Learning, Gradient MC and Semi-gradient TD(0) algorithms, Eligibility trace for function approximation, After states, Control with function approximation, Least squares, Experience replay in deep Q-Networks.	
UNIT-IV	**10 Hours**
Actor-Critic: Policy gradient, naïve REINFORCE algorithm, Natural actor-critic. **Exploration and Exploitation:** k-armed Bandit problem, Multi-arm Bandits, Goals and Rewards, Returns and Episodes, MDP extensions, Upper Confidence Bound (UCB), Upper Confidence Reinforcement Learning (UCRL), Deep RL.	

Text Books	
1	Richard S. Sutton and Andrew G. Barto, "Introduction to Reinforcement Learning", 2nd Edition MIT Press, 2017/ Latest Edition.
2	Sugiyama, Masashi, "Statistical reinforcement learning: modern machine learning approaches," First EditionCRC Press 2015/ Latest Edition.
Reference Books	
1	Lattimore, T. and C. Szepesvári, "Bandit algorithms," First Edition/ Latest Edition., Cambridge University Press. 2020/ Latest Edition.
2	Boris Belousov, Hany Abdulsamad, Pascal Klink, Simone Parisi, and Jan Peters, "Reinforcement Learning Algorithms: Analysis and Applications," First EditionSpringer 2021/ Latest Edition..
3	Alexander Zai and Brandon Brown "Deep Reinforcement Learning in Action," First Edition, Manning Publications 2020. / Latest Edition.

NEURAL NETWORKS AND DEEP LEARNING	
Course Code: BAM-304 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 6

Introduction: Neural networks and deep learning are fundamental constituents of artificial intelligence (AI), catalyzing significant advancements across various domains such as computer vision, natural language processing, and reinforcement learning. Understanding the underlying principles of neural networks and deep learning is paramount due to their pervasive impact on modern technologies. Proficiency in these concepts enables individuals to effectively address challenges and leverage opportunities within fields like computer vision and natural language processing. By mastering the intricacies of neural networks and deep learning, practitioners gain the capacity to develop innovative solutions and drive progress in AI applications, shaping the future of technology and society.

Course Objectives:

- To learn basic computational units inspired from biological systems (brain).
- To study various algorithms in deep learning for various domains.
- To understand fundamental machine learning concepts with respect to neural networks.
- To apply deep learning models to solve sequence and vision problems.

Pre-requisite: Fundamentals of Python Programming, Machine Learning.

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

CO1: Interpret the basic computational units inspired from biological systems (brain).
CO2: Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.
CO3: Define the fundamental machine learning concepts with respect to neural networks.
CO4: Apply basic deep learning models to solve sequence-based problems and vision problems.

Pedagogy: Classroom teaching cover theoretical concepts and math foundations, paired with hands-on programming in TensorFlow or PyTorch. Project-based learning applies these to real-world issues in vision, language processing, or robotics. Case studies and guest talks offer industry insights. Interactive discussions encourage collaboration. Assessments, including quizzes and presentations, gauge understanding. This approach aims to thoroughly prepare students in neural networks and deep learning for varied applications.

Contents

UNIT-I	10 Hours
Artificial Neural Networks: Human Brain, Model of an artificial Neuron, Basic concepts of Neural Networks, Fundamentals of Biological Neural Network and Artificial Neural Network, Evolution of Neural Networks, Characteristics of Neural Networks, Learning Methods – supervised, unsupervised and reinforcement, Taxonomy of Neural Network Architectures, Terminologies – weights, bias, threshold, learning rate, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm. Applications of Neural Networks.	
UNIT-II	**10 Hours**
Supervised and Unsupervised Neural Networks: Hebb Network theory and training algorithm, Perceptron Networks architecture and training algorithm, Backpropagation Network architecture and training algorithm, Associative Memory Network architecture and training algorithm, Hopfield Networks architecture and training algorithm, Counter propagation Networks architecture and training algorithm, adaptive Resonance Theory Network architecture and training algorithm.	
UNIT-III	**12 Hours**
Foundations of Deep Learning: Artificial Neural Networks: Single Layer Neural Network, Multilayer Perceptron, Gradient Descent, Back Propagation Learning, Architectural Design Issues. Learning Curves. Overfitting vs Under fitting, Regularization: L1, L2, Dropout, Data Augmentation. **Deep Neural Network:** Deep Learning, Deep Neural Networks: Difficulty of training deep neural networks, Activation Function, Hyper parameters vs Parameters, Greedy layer wise training, Recurrent Neural Networks: Backpropagation through time, Long Short Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs.	
UNIT-IV	**10 Hours**
Applications: Convolutional Neural Networks. Filters, Pooling. Image Classification. Well known case studies: LeNet, AlexNet, VGG-16, ResNet, InceptionNet. Transfer Learning. Weight Initialization, Batch Normalization, Regularization. Applications in Vision, Speech, and Audio-Video, Natural Language Processing.	

Text Books	
1	Duda, Richard O., Peter E. Hart, and David G. Stork. Pattern Classification. 2nd ed., John Wiley & Sons, 2000/ Latest Edition.
2	Gibson, Adam, and Josh Patterson. Deep Learning: A Practical Approach. 1st ed., O'Reilly Media, 2017/ Latest Edition.
3	Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. Deep Learning. MIT Press, 2016/ Latest Edition.
Reference Books	
1	Aggarwal, Charu C. Neural Networks and Deep Learning. 1st ed., Springer, 2018/ Latest Edition.
2	Duda, Richard O., and Peter E. Hart. Pattern Classification. 2nd ed., John Wiley & Sons, 2006/ Latest Edition.

COMPUTER VISION	
Course Code: BAM-306 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 6

Introduction: Computer vision is an important applied research area encompassing aspects from geometry, machine learning, probabilistic models, optimization etc. The course consists of various important aspects of computer vision namely geometry, motion, image features, and low-level and high level image labeling.

Course Objectives:

- To understand basic concepts of data driven approach of image processing.
- To appreciate the well-known computer vision computation pipelines.
- To understand techniques for processing text inside images.
- To develop an understanding of advanced computer vision problems and their solutions.

Pre-requisite: Introduction to Python.

Course Outcomes: After completion of the course, students will be able to:
CO1: Understand basic concepts of data driven based image processings.
CO2: Analyze well known computer vision processing architectures.
CO3: Understand the working of image captioning systems.
CO4: Apply advanced concepts in computer vision to solve problems.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	11 Hours
Computer Vision: Overview, History, Key Problems, Challenges. Data Driven Approach: KNN. Linear Classification. Loss Function and Optimization, Stochastic Gradient Descent, Numerical Computations. Neural Networks and Back propagation.	
UNIT-II	**11 Hours**
Convolutional Neural Networks: Architecture Overview. Types of Layers - Convolution, Pooling, Fully Connected. Parameter Sharing. Well known case studies: LeNet, AlexNet, VGG-16, ResNet, InceptionNet. Transfer Learning. Weight Initialization, Batch Normalization, Regularization.	
UNIT-III	**10 Hours**
Text in Image: Language Model, RNNs, Image Captioning, Vision & Language. Attention Models: Self Attention, Soft vs Hard Attention. Transformer: Key, Value, Query, Encoder-Decoder. Transformers for Image Recognition.	
UNIT-IV	**10 Hours**
Advanced Vision: Data Augmentation, Semantic Segmentation, Object Detection, Face Recognition using Siamese Networks, Generative Models, Adversarial Networks, Biases in Image Datasets.	

Text Books	
1	S. Khan, H. Rahmani, "A Guide to Convolutional Neural Networks for Computer Vision", Morgan & Claypool Publishers, 201 / Latest Edition.
2	Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press, 2016 / Latest Edition.
Reference Books	
1	S. J. D. Prince, "Computer vision: Models, Learning and Inference", 1st Edition, Cambridge University Press, 2012 / Latest Edition.
2	L. G. Shapiro, and G.C. Stockman, "Computer Vision", 1st Edition/ Latest Edition, Pearson Prentice Hall, 2001 / Latest Edition.
3	R. Klette, "Concise Computer Vision: An Introduction into Theory and Algorithms", 1st Edition/ Latest Edition, Springer Nature, 2014 / Latest Edition.
4	R. Szeliski, "Computer Vision: Algorithms and Applications", 1st Edition/ Latest Edition, Springer, 2011/ Latest Edition.

CLOUD COMPUTING & IOT	
Course Code: BAM-308 Contact Hours: L-3 T-0 P-2 Course Category: DEC-I	Credits: 4 Semester: 6

Introduction: This course offers a comprehensive exploration of two transformative technologies that are shaping the future of computing and connectivity**.** In today's rapidly evolving digital landscape, Cloud Computing has emerged as a cornerstone technology, offering organizations scalable and on-demand access to computing resources over the internet. Concurrently, The Internet of Things (IoT) represents the next revolution in computing, with billions of interconnected devices fundamentally changing the way we interact with the world around us. This course provides a deep dive into Cloud Computing and IoT technologies, starting from the basics and building up to advanced concepts.

Course Objective: To familiarize with Internet of Things (IoT) and Cloud Computing concepts, infrastructures, and capabilities, aiding students in constructing IoT systems and utilizing cloud services for data processing and storage.

Pre-requisite: Basics of Computer Science and Engineering.

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Learn the fundamentals of cloud computing, the concept of virtualization and its need in cloud computing.
CO2: Demonstrate the use cases of cloud computing and Implement security features to protect data stored in the cloud.
CO3: Learn the fundamentals of IoT and determine the right sensors and communication protocols to use in a IoT system.
CO4: Apply the Cloud Services in different aspects of IoT project.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations, and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT -I	10 Hours
Cloud Computing Fundamentals: Concept and evolution of cloud computing paradigm, Trends in computing, NIST definition and characteristics of cloud computing, Cloud architecture, Deployment models, Service models. Virtualization: Virtualization concept, Need of virtualization, Benefits & drawbacks of virtualization, Server virtualization, Resource Virtualization, Storage Virtualization, and Network virtualization.	
UNIT- II	**11 Hours**
Cloud Security: Web services, Web 2.0 v/s Web 3.0, Web OS, Security challenges and preventive measures: Infrastructure layer, Network layer, and Application layer of cloud computing architecture, Security models in cloud, Resource management in cloud computing, Static and dynamic load balancing in cloud computing, Identity & access management, and Trust in cloud computing. Case studies on cloud service providers – Amazon EC2, Google App Engine, and Microsoft Azure.	
UNIT-III	**11 Hours**
Internet of Thing (IoT): Overview, Conceptual framework, Architecture, Major components, Common applications, Design principles for connected devices: Modified OSI Model for IoT/M2M systems, ETSI, M2M Domains and High-level capabilities, Wireless communication technologies - NFC, RFID, Bluetooth BR/EDR and Bluetooth low energy, ZigBee, WiFi, RF transceiver and RF modules. Data enrichment, Data consolidation & device management at gateway.	
UNIT- IV	**10 Hours**
Design principles for web connectivity: Web communication protocols for connected devices: constrained application protocol, CoAP Client web connectivity, client authentication, lightweight M2M communication protocol. Message communication protocols for connected devices: CoAP-SMS, CoAP-MQ, MQTT, XMPP. IoT privacy, Security and vulnerabilities and their solutions.	

Text Books

1. Barrie Sosinsky, "Cloud Computing Bible" Wiley Publishing House, 2011, 1st Edition/Latest Edition.
2. M. J. Kavis, "Architecting the Cloud: Design Decision for Cloud Computing" John Wiley & Sons, 2014, 1st Edition/Latest Edition.
3. D. Hanes, G. Salgueiro, P. Grossetete, R. Barton, and J. Henry; IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Pearson India Pvt. Ltd., 2018/1st Edition.

Reference Books

1. T.Velte, A. Velte, and R. C. Elsenpeter, "Cloud computing a practical approach", McGraw-Hill Osborne, 2009, 1st Edition/Latest Edition.
2. Z. Mahmood, R. Puttini, and T. Erl, "Cloud Computing: Concepts, Technology & Architecture," Prentice Hall, Pearson Publications, 2013, Latest Edition
3. YY. Kanetkar and S. Korde, "21 Internet of Things (IOT) Experiments: Learn IoT, the programmer's way", BPB Publications, 2018, 1st Edition/Latest Edition.

BLOCKCHAIN TECHNOLOGIES	
Course Code: BAI-310 Contact Hours: L-3 T-0 P-2 Course Category: DEC-I	Credits: 4 Semester: 6

Introduction: Blockchain technology is a structure that stores transactional records, also known as the block, of the public in several databases, known as the "chain," in a network connected through peer-to-peer nodes.

Course Objectives:

- To understand the history, types, and applications of Blockchain.
- To acquire knowledge about cryptography and consensus algorithms.
- To deploy projects using blockchain technology.

Pre-requisite: Distributed systems.

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Discuss the overview of Blockchain and its different categories.
CO2: Analyze the need of Blockchain in various domains.
CO3: Define cryptography and Consensus algorithms.
CO4: Design and build an Initial Coin Offerings (ICO) on Ethereum

Pedagogy:
The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations, and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	10 Hours
Introduction to Blockchain: Distributed DBMS – Limitations of Distributed DBMS, Introduction to Block chain – History, Definition, Distributed Ledger, Blockchain Categories – Public, Private, Consortium, Blockchain Network and Nodes, Peer-to-Peer Network, Mining Mechanism, Generic elements of Blockchain, Features of Blockchain, and Types of Blockchain.	
UNIT-II	**11 Hours**
Blockchain Architecture: Operation of Bitcoin Blockchain, Blockchain Architecture – Block, Hash, Distributer P2P, Structure of Blockchain- Consensus mechanism: Proof of Work (PoW), Proof of Stake (PoS), Byzantine Fault Tolerance (BFT), Proof of Authority (PoA) and Proof of Elapsed Time (PoET)	
UNIT-III	**11 Hours**
Blockchains in Business and creating ICO: Public versus private and permissioned versus permission less blockchains- Privacy and anonymity in Ethereum- Why are privacy and anonymity important? - The Ethereum Enterprise Alliance- Blockchain-as-a-Service- Initial Coin Offering (ICO): Project setup for ICO implementation- Token contracts- Token sale contracts-Contract security and testing the code.	
UNIT-IV	**10 Hours**
Distributed Storage IPFS and Swarm: Ethereum Virtual Machine- Swarm and IPFS: Installing IPFS, hosting our frontend: Serving your frontend using IFPS, serving your frontend using Swarm, IPFS file uploader project: Project setup the web page	

Text Books	
1	Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, decentralization, and smart contracts explained”, 2nd Edition, Packt Publishing Ltd, March 2018.
2	Bellaj Badr, Richard Horrocks, Xun (Brian) Wu, “Blockchain By Example: A developer's guide to creating decentralized applications using Bitcoin, Ethereum, and Hyperledger”, Packt Publishing Limited, 2018.
Reference Books	
1	Antonopoulos, Andreas M., and David A. Harding. Mastering bitcoin. " O'Reilly Media, Inc.", 2023.
2	Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction”, Princeton University Press, 2016.

QUANTUM COMPUTING	
Course Code: BAI-312 Contact Hours: L-3 T-0 P-2 Course Category: DEC-I	Credits: 4 Semester: 6

Introduction: Quantum computation captured the imagination of computer scientists with the discovery of efficient quantum algorithms for factoring and fast algorithms for search. Quantum computing exploits the quantum mechanical nature of matter to simultaneously exist in multiple possible states. Building up on the digital binary logic of bits, quantum computing is built based on interacting two-level quantum systems or 'qubits' that follow the laws of quantum mechanics. Addressability of the quantum system and its fragility to fidelity are the major issues of concern, which if addressed appropriately, will enable this new approach to revolutionize the present form of computing. The aim of quantum computing is to do computation using quantum mechanical effects.

Course Objectives:

- To impart the basic understanding of quantum mechanics and its usage in quantum computing.
- To provide a general introduction to the algebra of complex vector spaces.
- To simulate quantum computing algorithms using IBM Qiskit Technology.
- To give insights to conceive and model quantum systems on their own for societal applications.

Pre-requisite: Binary Digital Logic, Linear Algebra, Algorithms Design, Probability and Statistics.

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Describe the fundamentals of quantum mechanics in quantum computing.
CO2: Analyze the behavior of basic quantum algorithms.
CO3: Implement simple quantum algorithms and information channels in the quantum circuit model
CO4: Describe the standard quantum algorithms in IBM Qiskit and state the benefits along with constraints of quantum computational models.

Pedagogy: Course teaching and learning through lectures, tutorials, assignments, projects, and quizzes. Encouragement to the students for developing an understanding and simulations of the existing quantum computational models. Emphasis on mathematical and programming assignments based on topics from previous lectures. The course will have a blend of theory and lab practice for the benefit of students. Use of ICT, web-based sources as well as blackboard teaching will be adopted.

Contents

UNIT-I	10 Hours
Introduction to Quantum Computing, Postulates of Quantum Mechanics, Qubit-The smallest unit, Qubit- Bloch sphere representation, Multiple Qubit States and Quantum Gates, Quantum Gates, Quantum Circuits, No-Cloning Theorem and Quantum Teleportation, Bell's Inequality and its Implications, Super Dense Coding.	
UNIT-II	**11 Hours**
Density Matrix, Bloch Sphere and Density Matrix, Measurement Postulates, Simple Algorithms, Deutsch Algorithm, Deutsch-Josza Algorithm, Bernstein-Vazirani Algorithm, Simon Problem, Grover's Search Algorithm, Shore's Factorization Algorithm	
UNIT-III	**11 Hours**
Quantum Fourier Transform, Period Finding and QFT, Implementing QFT, Implementing QFT-3 qubits, Shor's Factorization Algorithm, Shor's Factorization Algorithm- Implementation, Quantum Error Correction, Quantum Error Correction Three Qubit Code. Fault Tolerance	
UNIT-IV	**10 Hours**
Classical Information Theory, Shannon Entropy, Shannon's Noiseless Coding Theorem, Ven Neumann Entropy, EPR and Bell's Inequalities, Cryptography-RSA Algorithm, Quantum Cryptography, Experimental Aspects of Quantum Computing. Issues of Fidelity, Security and Scalability in Quantum Computing	

Text Books	
1	Vishal Sahni, "Quantum Computing ", McGrawHill, 2007
2	Eleanor Rieffel and Wolfgang," Quantum Computing: A Gentle Introduction", MIT press, 2011
3	Michael Nielsen and Isaac Chuang and, "Quantum Computation and Quantum Information", Cambridge University Press, 2013
Reference Books	
1	Michael A. Nielsen and Issac L. Chuang, "Quantum Computation and Information", Cambridge University Press, 2002.
2	P. Kaye, R. Laflamme, and M. Mosca. An Introduction to Quantum Computing. Oxford University Press, 2007.
3	Benenti G., Casati G. and Strini G., Principles of Quantum Computation, and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific, 2004

CYBER SECURITY AND FORENSICS	
Course Code: BAM-310 Contact Hours: L-3 T-0 P-2 Course Category: DEC-I	Credits: 4 Semester: 6

Introduction: Cyber Security and Forensics is the application of investigation and analysis techniques to gather and preserve evidence from a particular computing device in a way that is suitable for presentation in a court of law. This course provides for a broad introduction of cyber security and forensics concepts, industry best practices for information security and key security concepts that will protect an organization against fraud, data breaches and other vulnerabilities. It enables the students to gain in-depth knowledge in the field of Computer forensics & Cyber Crime.

Course Objectives:

- To maintain an appropriate level of awareness, knowledge and skill to allow students to minimize the occurrence and severity of information security incidents.
- To learn techniques used to detect, respond and prevent network intrusions.
- To identify and apply appropriate forensics tools to acquire, preserve and analyze system image.
- To protect information and information systems from unauthorized access, use, disclosure, disruption, modification or destruction in order to provide confidentiality, integrity and availability.
- Identify sources of evidentiary value in various evidence sources including network logs, network traffic, volatile data.

Prerequisite: Knowledge of Computer Networking, Linux, UNIX, Understanding of Web Application Architecture and HTTP/HTTPS communication.

Course Outcomes: After completion of the course the students will be able to:

CO1: Understand the fundamentals of Cyber Security and comprehend the incident response process

CO2: Demonstrate the difference between data acquisition techniques

CO3: Apply forensic analysis tools to recover important evidence for identifying cyber-crime.

CO4: Apply investigation tools and techniques for analysis of data to identify evidence related to cyber-crime and use available digital forensics tools.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Students would be encouraged to develop an understanding of the existing real life cyber security issues and how they are solved. Course will have a blend of theory and practice for the benefit of students. Use of ICT, web based sources as well as blackboard teaching will be adopted.

Contents

UNIT-I	12 Hours
Cyber Security Concepts, Security Goals, Security Services, Types of Cybercrime, Cyber Attacl Process, Introduction to Incident Response Process, Computer Security Incident, Goals of Inciden response, Who is involved in Incident response, Incidence Response Methodology, Pre Inciden preparation, Detection of Incidents, Initial response, Formulate a response strategy, Investigate th incident, Reporting and Resolution.	
UNIT-II	**10 Hours**
Computer Forensics Fundamentals, Data Acquisition of digital evidence from electronic media Acquisition tools, Evidence collection and preservation, Windows Forensics, Live data collectio from Windows systems, Live data Collection from Unix systems	
UNIT-III	**10 Hours**
Sources of Digital/Electronic Evidence, Computer Forensic Analysis and Validating Forensic Data, System Forensics, Network Forensics, Database Forensics, Fighting against Macro Threats Information Warfare Arsenal, Tactics of the Military	
UNIT-IV	**10 Hours**
Malware forensics, Mobile Device Forensics, Google Forensics, Internet Forensics, Emai Forensics, Messenger Analysis, Web Forensics, Current Computer Forensics Tools Software/Hardware Tools. An Indian perspective on digital forensics: Indian IT act, Cyber laws.	
Text Books	
1. K Mandla, C. Prosise , Matt Pepe, " Incident Response and Computer Forensics", McGrav Hill, 3rd Edition, 2014/Latest Edition	
2. Nelson, B, Phillips, A, Enfinger, F, Stuart, C., "Guide to Computer Forensics an Investigations, Cengage, 6th Edition, 2020/Latest Edition	
Reference Books	
1. Computer Forensics, Computer Crime Investigation by John R. Vacca, Firewall Media, Nev Delhi, 1st Edition, 2015 /Latest Edition	

ADVANCED JAVA PROGRAMMING	
Course Code: BAM-312 Contact Hours: L-3 T-0 P-2 Course Category: DEC-I	Credits: 4 Semester: 6

Introduction:
This course is designed to enable students to recognize the need for distributed, transactional and portable applications that leverage speed, security and reliability of server side technologies. This course shall inculcate programming capability to handle business logic and develop and deploy applications using Java Platform, Enterprise Edition.

Course Objectives:
- To explore advanced topic of Java programming
- Enhance knowledge to manipulate and store data
- Learn about dynamic application developed in varied platform

Prerequisite:
Basic Knowledge of Object Oriented Programming , Java Programming and DBMS

Course Outcome:
CO1: Understand the basic concepts related to Java Technology and demonstrate use of network based application
CO2: Understanding web application framework ,Servlet and learning access to databases through JDBC.
CO3: Creating dynamic web pages using JSP and implement electronic messages through java email
CO4: Developed advanced skills using JSF and Hibernate Framework to apply in real world applications.

Pedagogy: Lectures will be imparted along with hands on lab sessions and development of a Web Application for case study

UNIT-I	10 Hours
Overview of Java: Classes, objects and methods,Inheritance in java,Packages and interfaces, Wrapper classes in java , Collection framework in java, Overview of Multithreaded Programming in java: Creating and running thread, Multiple thread synchronization, Thread synchronization; **Networking in java :** Network Basics and Socket overview,Socket programming, TCP/IP client, InetAddress, URL, URLConnection and RMI (Remote Method Invocation): Introduction, Steps in creating a Remote Object, Generating Stub & Skeleton, RMI Architecture, RMI packages	
UNIT-II	11 Hours
JDBC packages: Introduction to JDBC, Types of JDBC drivers, Obtaining a Connection, Creating a SQL Query statement,Executing SQL Queries, ResultSet,ResultSetMetaData, Updating Database Data, Error Checking, Prepared Statement, Callable Statement, Program example using JDBC.**Servlets: Overview of Servlet, HTTP Methods Structure and Deployment descriptor,** Using Servlets - Servlet Package - Servlet lifecycle - init() , method - service() method , doGet() method, doPost() method ,use of cookies, Session management,Session Tracking, URL Rewriting	
UNIT-III	10 Hours
JSP(Java Server Pages): Introduction to JSP, Advantages of JSP over Servlet,JSP Life Cycle,Creating a simple JSP Page,JSP scriptlet tag, JSP expression tag, JSP declaration tag, implicit object in JSP, **Java Email**-understanding Java Email, Java email API, Java email architecture,•Sending and receiving email in java, compose the message	
UNIT IV	11 Hours
Working with JSF- Java Server faces, JSF-MVC, JSF Benefits, Component of JSF, Benefits of JSF, JSF UI components, Implement Simple JSF Application; **Introduction to Hibernate-** Why Object Relational Mapping (ORM),What is ORM,Working with Hibernates, Hibernates Advantages,Hibernate architecture, Case Study-University Management system,Simple ecommerce application,Book Store system	

Text Books	
1	Jim Koegh, “Java EE Complete Reference”, Mc Graw Hill , First Edition, 2017
2	Core and Advanced Java, Black Book, DreamTech Publications, First Edition, 2018
3	Java Platform, Enterprise Edition: The Java EE Tutorial Oracle , java Documentation, 2018
Reference Books	
.1	David R. Heffelfinger, “Java EE 8 Application Development”, Packt Publishing, First Edition December 2017
2	Black Book “ Java server programming” J2EE, 1st ed., Dream Tech Publishers, 2008. 3. Kathy walrath

INFORMATION RETRIEVAL	
Course Code: BAI-314 Contact Hours: L-3 T-0 P-2 Course Category: DEC-II	Credits: 4 Semester: 6

Introduction: Information retrieval is precursor of Data Mining and Data analytics in the decision based industry and research. This course introduces about various IR techniques and their applications in computer science domain.

Course Objectives:

- To study different kinds scoring and probabilistic aspects for Information retrieval
- To study linear algebra and data manipulations for analysis and mining
- To study indexing, statistics and Bayes Theorem's applications
- To explore the applications of IR in fields like Health care, CRM and BI

Pre-requisite: Mathematics-I

Course Outcomes: After completion of the course, students will be able to:
CO1. Students will know the fundamentals of Information Retrieval.
CO2. Understand and be able to use the data structures, such as inverted indices, used in information retrieval systems.
CO3. Understand the various methods for compressing an index, dictionary and its posting lists.
CO4. Learn how to compute scores in a complete search system and measure the effectiveness of the IR systems.
CO5. Learn the probabilistic model, language model and various machine learning approaches in Information retrieval systems.
Pedagogy: Classroom teaching which focuses on developing understanding of students to digest the concepts of subject with large number of examples. The teaching-learning of the course would be organized through lectures, tutorials, assignments, and quizzes.

Contents

UNIT-I	10 Hours
Introduction: Introduction to Information Retrieval, Boolean retrieval, the term vocabulary and postings lists, Dictionaries and tolerant retrieval, Introduction to index-construction and index-compression	
UNIT-II	**10 Hours**
. Scoring, term weighting and the vector space model, Computing scores in a complete search system, Evaluation in information retrieval, Introduction to Relevance feedback and query expansion. Probabilistic information retrieval, review of basic probability theory, the probability ranking principle	
UNIT-III	**12 Hours**
the binary independence model, Language models for information retrieval, Language modeling versus other approaches to IR, Text classification and Naive Bayes, Bayesian Network approaches to IR.	
UNIT-IV	**10 Hours**
Vector space classification, Support vector machines and machine learning on documents, Flat clustering, Hierarchical clustering, Matrix decomposition and latent semantic indexing. Introduction to Web search basics, Web crawling and indexes, Link analysis.	

Text Books	
1	Manning, C.D., Raghavan, P. and Schutze, H.,Introduction to Information Retrieval, Cambridge University Press, England, 2012/ Latest Edition.
2	Buttcher, S., Clarke, C.L.A. and Gordon V Cormack, Information Retrieval: Implementing and Evaluating Search Engines, MIT Press, 2010/ Latest Edition.
Reference Books	
1	Grossman, D.A. and Ophir, F.,Information Retrieval: Algorithms and Heuristics, Springer, 2013/ Latest Edition.
2	Frakes, W.B., Pearson, Information Retrieval: Data Structures and Algorithms, Prentice Hall, 2002/ Latest Edition.

RECOMMENDER SYSTEMS	
Course Code: BAI-316 Contact Hours: L-3 T-0 P-2 Course Category: DEC-II	Credits: 4 Semester: 6

Introduction: In an age characterized by an abundance of information, the role of recommender systems is paramount in facilitating personalized access for users, thereby streamlining the process of navigating and making informed choices online. This course serves as an introduction to the essential concepts, methodologies, evaluation design, and user experiences pertaining to recommender systems. Through a comprehensive exploration, students will gain insights into the practical applications of recommender systems across various domains, including e-commerce platforms and social networks. By examining real-world scenarios, this course aims to provide a holistic understanding of the deployment and impact of recommender systems on enhancing user experiences in the digital landscape.

Course Objectives:

- To understand the basic concepts such as user preference and prediction.
- To learn variety of typical recommendation approaches.
- To understand system evaluation design and metrics
- To get the knowledge of human roles in system implementation and user-centered evaluation.

Pre-requisite: Data structures and basic knowledge of programming languages like C, C++.

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

CO1: Describe basic concepts and framework of recommender systems
CO2: Explain a variety of approaches for building recommender systems
CO3: Define system evaluation methods from both algorithmic and users' perspectives
CO4: Discuss the applications of recommender systems and apply in various domains.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	10 Hours
Introduction: Recommender system functions, Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses; covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system. Collaborative Filtering: User-based nearest neighbor recommendation, Item-based nearest neighbor recommendation, Model based and pre-processing based approaches, Attacks on collaborative recommender systems.	
UNIT-II	**10 Hours**
Content-based recommendation: High level architecture of content-based systems, Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents, Obtaining item features from tags, Representing item profiles, Methods for learning user profiles, Similarity based retrieval, Classification algorithms. Knowledge based recommendation: Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders	
UNIT-III	**12 Hours**
Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies. Evaluating Recommender System: Introduction, General properties of evaluation research, Evaluation designs, Evaluation on historical datasets, Error metrics, Decision-Support metrics, User-Centred metrics.	
UNIT-IV	**10 Hours**
Recommender Systems and communities: Communities, collaboration and recommender systems in personalized web search, social tagging recommender systems, Trust and recommendations, Group recommender systems.	

Text Books	
1	Jannach, Dietmar, Markus Zanker, and Alexander Felfernig. Recommender Systems: An Introduction. 1st ed., Cambridge University Press, 2011/ Latest Edition.
2	Ricci, Francesco, Lior Rokach, Bracha Shapira, and Paul B. Kantor. Recommender Systems Handbook. 1st ed., Springer, 2011/ Latest Edition.
3	Manouselis, Nikos, Hendrik Drachsler, Katrien Verbert, and Erik Duval. Recommender Systems for Learning. 1st ed., Springer, 2013/ Latest Edition.
Reference Books	
1	Ekstrand, Michael D., John T. Riedl, and Joseph A. Konstan. Collaborative Filtering Recommender Systems. 1st ed., Now Publishers Inc, 2011 / Latest Edition.
2	Aggarwal, Charu C. Recommender Systems: The Textbook. 1st ed., Springer, 2016/ Latest Edition.

SEMANTIC WEB	
Course Code: BAI-318 Contact Hours: L-3 T-0 P-2 Course Category: DEC-II	Credits: 4 Semester: 6

Introduction: The Semantic Web is a vision about an extension of the existing World Wide Web, which provides software programs with machine-interpretable metadata of the published information and data. It aims to enrich the Web with a layer of machine-interpretable metadata so that computer programs can predictably derive new information.

Course Objectives:

- To introduce the basic concept of the web and its terminologies.
- Understanding RDF, RDFS, OWL, SPARQL.
- Familiar with current trends and applications of Semantic Web.

Pre-requisite: Computer Networks and basic programming knowledge.

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Comprehend the basic concepts of the semantic web along with its technologies and development.
CO2: Explain the Semantic Web's fundamental concepts, issues, architecture and technologies.
CO3: Describe the various technologies of the Semantic Web focusing on RDF, Ontology and Sparql.
CO4: State the latest trends and applications of Semantic Web in real-world applications.

Pedagogy:
The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. The use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	10 Hours
Introduction: Review of Internet and Web: History, Internet protocols and services, OSI Seven layer model, terms and terminologies, concepts like WWW, W3C, ISP, DNS, Search Engines etc. HTML and it'stags, various web development issues and technologies.Web 1.0 and Web 2.0.	
UNIT-II	**10 Hours**
Semantic Web: Limitations of Web 2.0, Need of Web 3.0, Sir Tim Berners LEE vision and contributions, Semantic Web vision and roadmap, Semantic web fundamental concepts and issues, Semantic Web architecture layered cake and technologies, XML basics and metadata, Jorge Cardoso Survey, scientific American article 2001.	
UNIT-III	**12 Hours**
RDF, Ontology and SPARQL: Overview of various technologies of Semantic Web with focus on pillar technologies. Semantic Web standards, RDF basics and examples, RDFS, Ontology and its issues, OWL, Ontology design and development, using Ontology editor Protégé, benefits and challenges of Ontologies, SPARQL and its concerns, Exporting SPARQL query using tools like Protégé, Twinkle etc	
UNIT-IV	**10 Hours**
Applications and upcoming trends: An overview of various Semantic Web Services and applications, Semantic Annotation, Information Extraction and Retrieval, Semantic Search, Semantic Agents and Search Engines, Semantic Social Networks, Web Intelligence, SWoT, Chatbots, Web Data Analytics.	

Text Books	
1	RajendraAkerkar, "Foundations of the Semantic Web:XML,RDF and Ontology",Oxford, 2009 / Latest Edition.
2	Karin Breitman and Marco, "Semantic Web: Concepts, Technologies and Applications", Springer. 2009 / Latest Edition.
3	Berners-LEE, Godel and Turing, "Thinking on the Web", Wiley, 2006/ Latest Edition.
Reference Books	
1	John Hebeler, Mathew Fisher and Ryan Blace, "Semantic Web Programming", Wiley, 2011/ Latest Edition.
2	Krotzsch and Rudolph, "Foundations of Semantic Web Technologies", SRC Press, 2009/ Latest Edition.
3	Grigoris Antoniou and Paul Groth, "A Semantic Web Primer", MIT Press, 2012/ Latest Edition.

NATURAL LANGUAGE PROCESSING	
Course Code: BAM-314 Contact Hours: L-3 T-0 P-2 Course Category: DEC-II	Credits: 4 Semester: 6

Introduction: Natural language processing (NLP) refers to the branch of computer science and more specifically, the branch of artificial intelligence or AI—concerned with giving computers the ability to understand text and spoken words in much the same way human being scan. NLP combines computational linguistics—rule-based modelling of human language with statistical, machine learning, and deep learning models. Together, these technologies enable computers to process human language in the form of text or voice data and to 'understand' its full meaning, complete with the speaker or writer's intent and sentiment.

Course Objectives:

- To learn the fundamentals of Natural language Processing and its algorithm.
- To understand machine translation and applications of NLP.
- Basic understanding of deep learning models for NLP.

Pre-requisite: Artificial Intelligence, Data structures and algorithms, programming languages.

Course Outcomes: After completion of the course, students will be able to:
CO1: Learn the fundamentals of Natural language Processing and its algorithm.
CO2: Understand machine translation and applications of NLP.
CO3: Provide basic understanding of deep learning models for NLP.
CO4: Apply the concept of NLP in the real domain.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	10 Hours
Introduction to NLP: Characteristics of Natural Language, Language structure, Sentence Structure, Language analyzer, Lexicon, word formation, Morphology, syntax analysis (parsing), semantics, ambiguity, pragmatics and discourse.	
UNIT-II	**11 Hours**
NLP Algorithms: Understanding Corpus and data attributes, Corpus Formats CSV, JSON, XML, LibSVM, Operations on Text Corpus, Tokenisation, stop words, Term Frequency Inverse Document Frequency (TF-IDF), Text Analysis and word embedding using word2vec, doc2vec, GLoVe, Bag-of-words (BoW).	
UNIT-III	**11 Hours**
Machine Translation and Applications of NLP: Introduction to Machine Translation (MT), Approaches, Structure of Anusaraka: an Interlingua based MT system, Example/Analogy based MT, Word/phrase based MT, Neural MT. Applications of NLP: Sentiment analysis, chatbots, conversational models (Question Answering system) for Digital Assistants.	
UNIT-IV	**10 Hours**
Deep learning models for NLP: Neural Net based NLP models: Study of Convolutional Neural Network(CNN), Recurrent Neural Network(RNN), Long Short-Term Memory (LSTM) and Gated Recurrent Unit(GRU) using Natural Language Toolkit (NLTK).	

Text Books	
1	Daniel Jurafsky, James H. Martin,"Speech and Language Processing: An Introduction to Natural Language Processing", Computational Linguistics and Speech, Pearson Publication, 2014/ Latest Edition.
2	Thanaki, Jalaj, "Python natural language processing". Packet Publishing Ltd, 2017/ Latest Edition.
Reference Books	
1	Lawrence Rabiner And Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2003/ Latest Edition.
2	Samuel Burns, "Natural Language Processing: A Quick Introduction to NLP with Python and NLTK" Independently Published, 2019/ Latest Edition.
3	Bird, Steven, Ewan Klein, and Edward Loper. "Natural language processing with Python: analyzing text with the natural language toolkit." O'Reilly Media, Inc.", 2009/ Latest Edition.