Master of Engineering in Information Technology
Program code: FET/IT/ME
Department of Information Technology
Jadavpur University

Vision and Mission of the Department

Vision: To provide young undergraduate and postgraduate students a responsive research environment and quality education in Information Technology to contribute in education, industry and society at large.

Mission:
M1: To nurture and strengthen professional potential of undergraduate and postgraduate students to the highest level.

M2: To provide international standard infrastructure for quality teaching, research and development in Information Technology.

M3: To undertake research challenges to explore new vistas of Information and Communication Technology for sustainable development in a value-based society.

M4: To encourage teamwork for undertaking real life and global challenges.

Program Outcomes (POs)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Program Specific Outcomes (PSOs)

At the end of the program a student will be able to

PSO1: Design and develop secure systems that prevent threats, leveraging the understanding of next-generation networks.

PSO2: Apply statistical processes to analyze complex data and extract insights that can support data-driven decision making.

PSO3: Integrate knowledge and research skills from various domains of cutting edge technologies to handle real world problems.

1st Semester

Course code	PG/ITE/PC/T/111
Category	Program Core
Course title	**Data Structures and Algorithms**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	

Syllabus:

Fundamentals: Elementary Data Structures such as lists, stacks, queues, binary search trees, Growth of functions, Recurrence relation, Master's Theorem, Basic Concept of algorithms, Analysis of Algorithm, Amortized Analysis [6 hours]

Advanced Data Structures: Hash Table, Disjoint sets, Skip Lists, AVL tree, Red-Black Tree, B-tree, B+-tree, Augmenting data structures (e.g., Interval Trees, dynamic ranking of elements) and their applications [10 hours]

Algorithmic paradigms: Divide and Conquer, Dynamic Programming, Greedy Algorithm, Back tracking, Branch and Bound: illustrate with graph and geometric algorithms [14 hours]

Randomized Algorithms: Basic concepts and design techniques, Quick sort, binary search, Election of leader [2 hours]

NP-completeness: Informal concepts of deterministic and nondeterministic algorithms, P and NP, NP-completeness, statement of Cook's theorem, some standard NP-complete problems, approximation algorithms. [10 hours]

Reference Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein , Introduction to Algorithms is a book on computer programming, MIT press.
2. Mark Allen Weiss , Data Structures and Algorithm Analysis.
3. Robert Sedgewick and Kevin Wayne , Algorithms.
4. UdiManber, Introduction to Algorithms: A Creative Approach.
5. Donald E. Knuth, The Art of Computer Programming.
6. Jeff Erickson, Algorithms.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Explain** and **discuss** the concepts of data structures, algorithms and analysis of the algorithms.
CO2	**Understand** and **illustrate** the use of advanced and augmented data structures.
CO3	**Apply** different algorithm techniques to **solve** problems.
CO4	**Describe** and **express** the concept of NP-completeness and Approximation algorithms.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	**1**	**1**	**3**			**2**
CO2	**2**	**2**	**3**			**2**
CO3	**3**	**1**	**3**			**3**
CO4	**2**		**3**	**2**		**3**

Course code	PG/ITE/PC/T/112
Category	Program Core
Course title	**Networking and Internet Technologies**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	

Syllabus:

Introduction: Recap on packet switching, OSI and TCP/IP reference model, different network parameters, PAN. [2 hours]

Data Link Layer: Efficiency of CRC and Hamming code, performance analysis

of ARQ protocols, and performance analysis of sliding window protocol. Example protocols: HARQ, Packet over SONET. [3 hours]

Medium Access Control: Performance measurements of MAC protocols. IEEE Standards 802.3, 802.4, 802.5, High Speed LANs, Fast and Gigabit Ethernet, FDDI; Bridges: IEEE 802.x to IEEE 802.y Bridges, Transparent Bridge, Source Routing Bridge, Wireless systems: Wireless LANS (i.e., 802.11 standards MAC management, Framing, Architecture and services), WMAN, WPAN, IrDA technologies, Wireless Broadband-802.16 [8 hours]

Network Layer: Routing Algorithms: Recap on Unicast routing, Hierarchical Routing, Broadcast and Multicast Routing: Anycast routing, Congestion control: Congestion Prevention Policies, Admission control, Effect of routing on congestion. Cross layer approaches- ECN, RED, Quality of Service: Traffic Shaping, Leaky-Bucket Algorithm, Token Bucket Algorithm, Weighted Fair Queuing, integrated services, differentiated services, Network Protocols: IPv4: class full and classless addressing, sub-netting, super-netting, address aggregation, IPv6, ICMPv6, Internet control protocols: MPLS, multicasting: IGMP, Routing Protocols: RIP, OSPF, BGP, Mobility management protocols: MIPv4, MIPv6, HMIPv6, FMIPv6 and PMIPv6. [20 hours]

Transport Layer: TCP, Max-min fairness, AIMD, TCP Tahoe, TCP Reno, BIC TCP, TCP Cubic, RTP, RTCP and SCTP. [6 hours]

Application Layer: Secure Shell, SNMP, VoIP, streaming media, SIP, Peer-to-peer systems. [3 hours]

Reference Books:

1. Andrew S. Tanenbaum, “Computer Networks”, PHI.
2. W. Stallings, “Data and Computer Communications”, 8th Edition, PHI.
3. D. E. Comer, “Internetworking with TCP/IP Vol. 1: Principles, Protocols, and Architecture”, 5th Edition, PHI.
4. B. A. Forouzan, “Data Communications and Networking”, 4th Edition, Tata McGraw-Hill.
5. James F. Kurose, W. Ross, “Computer Networking: A top-down approach

featuring the Internet", 3rd Edition, Pearson.

6. M. Hassan, R. Jain, "High Performance TCP/IP Networking", PHI.
7. L. Garcia, I. Widjaja, "Communication Networks", 2nd Edition, TMH.
8. Jochen Schiller, "Mobile Communications" Pearson publication.
9. Theodore (Ted) S. Rappaport, "Wireless Communications", Pearson publication.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Distinguish** and **demonstrate** different reference models, networks, data link layer mechanisms and protocols and **solve** related problems.
CO2	**Illustrate** various medium access protocols, local area networks and wireless systems' standards and **apply** them to solve problems.
CO3	**Analyze** and **illustrate** different routing algorithms, congestion control algorithms, and **apply** different network protocols in the Internet
CO4	**Explain** application and transport layer services and protocols and **solve** problems using them.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	**2**		**3**	**1**		
CO2	**2**		**3**	**1**		
CO3	**1**		**3**			**3**
CO4	**2**		**3**			**3**

Course code	PG/ITE/PE/T/113/A
Category	Program Elective
Course title	**Mathematics for Cryptography**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	
Syllabus:	

Group Theory: Elementary properties, subgroups, cosets, Lagrange's theorem, Different types of groups, cyclic groups, homomorphism and isomorphism, Group of Units modulo n (Z_n^*,.) [8 hours]

Algebra of matrices: rank and inverse, normal Forms, Determinants and their elementary properties, System of linear equations, algorithms for solving linear equations. [5 hours]

Vector spaces: subspaces, linear independence, basis, dimension, linear transformation. [3 hours]

Rings and fields: Rings, ring of integers, Ideals, Integral domains, fields, polynomials in commutative ring R[x], irreducible polynomial, primitive polynomial. [7 hours]

Finite Fields: elementary properties, construction, congruence classes of modulo polynomial, polynomial arithmetic, algorithms for finite field [3 hours]

Division: Divisibility, Division algorithm, primality, GCD, factorization, Euclidean algorithm. [2 hours]

Modular arithmetic: Basic properties; Computing modular inverses, extended Euclidean Algorithm, solving linear congruences, Chinese remainder theorem. Eulers φ function, Fermat's theorem,Euler's Theorem,quadratic residues, Finding generators and discrete log in (Z_n^*, $*$), square and multiply algorithm, Pseudo random number. [8 hours]

Prime numbers: Distribution of primes, prime number Theorem, Probabilistic

Algorithms: Basic definitions, generating a prime number, Primality testing: Miller Rabin, Solovay–Strassen, Integer factorization algorithm: Pollard Rho method. Complexity of these algorithms. [6 hours]

Reference Books:

1. Victor Shoup: A Computational Introduction to Number Theory and Algebra, Cambridge University Press.
2. Abhijit Das: Computational Number Theory, CRC Press.
3. I. N. Herstein: Topics in Algebra, Vikas Pub., New Delhi 1987.
4. R. Lidl and H. Niederreiter: Introduction to Finite Fields and their Applications, Cambridge University Press, London, 1994.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Understand** and **illustrate** the concept of group theory.
CO2	**Summarize** and **apply** the properties of matrices in algebraic transformation.
CO3	**Explain** the structures like ring, field and finite field and **illustrate** the polynomial arithmetic in finite field.
CO4	**Apply** the knowledge in modulo arithmetic for cryptographic computation.
CO5	**Apply** and **describe** the concept of primality and its testing.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	**1**	**2**	**3**	**3**		**1**
CO2	**1**	**2**	**3**	**3**		**1**
CO3	**1**	**2**	**3**	**3**		**1**
CO4	**1**	**1**	**3**	**3**		**1**
CO5	**1**	**1**	**3**	**3**	**2**	**1**

Course code	PG/ITE/PE/T/113/B
Category	Program Elective
Course title	**Probability, Statistics and Stochastic process**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	
Syllabus:	

Probability

Introduction to probability: Sample space, Classical, and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, problems. [3 hours]

Random Variables: Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, expectation, variance & Standard Deviation, Markov's, Chebyshev's, , Jensen's, and Holder's inequality. [5 hours]

Special Distributions: Discrete Distribution: Binomial, Poisson Distribution related problems; continuous Distribution: uniform, exponential,normal Distribution & related problem, Determine of mean & variance for Binomial, Poisson, uniform & normal Distribution. [6 hours]

Statistics

Measures of Central Tendency: Introduction, Mean, Median & Mode, relation between Mean, Median & Mode; moments, skewness& kurtosis. Correlation & regression. [2 hours]

Random sampling: Parameter, Statistic and its Sampling distribution, Standard error of statistic. Sampling distribution of sample mean and variance, random sampling from a normal distribution (statement only) and related problems [3 hours]

Estimation of Parameters: Unbiased and consistent estimators, Point estimation, Interval estimation, Maximum likelihood estimation of parameters of Binomial, Poisson and Normal distribution, Confidence intervals and related problems. [5 hours]

Applied Statistics: Curve fitting of straight lines, second degree parabola. [2 hours]

Stochastic process

Random/Stochastic processes: Examples, Notions of convergence, Definition of a stochastic process, Independence, Zero-one laws, Laws of large numbers, Central limit theorems, Markov chains, Markov processes as generalizations of IID variables, Markov property [4 hours]

Discrete and Continuous time Markov chains: Motivation and construction, First step analysis and Chapman-Kolmogorov equations, Long-range behavior and invariant probability, Classification of states, Return times (first return times, mean return times), Hidden Markov Chains; Poisson process (construction from Exponential Distribution), Birth and Death process, Semi Markov Chains. [7 hours]

Elements of stochastic analysis: Stochastic integration, Ito formula and (Stochastic) Integration by parts formula, Stochastic differential equations, Diffusion processes, Ito processes, Girsanov transformation. [5 hours]

Reference Books:

1. N. G. Das, Statistical Methods (Combined edition volume 1 & 2), McGraw Hill Education (India).
2. K. S. Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Applications, Wiley Publication.
3. Peter Watts Jones and Peter Smith, Stochastic Processes: An Introduction, Taylor and Francis.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Define** and **illustrate** the concept of probability and random variables.
CO2	**Discuss** the concept of the continuous and discrete distribution along with its mean and variance and **illustrate** with different distributions.
CO3	**Explain** the concept of random sampling and measure central tendency, correlation, and regression.

CO4	**Explain** and **illustrate** Estimation of Parameters and curve fitting.
CO5	**Identify** the random processes, **compute** their averages and **solve** various problems using them.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	**1**		**3**		**3**	**1**
CO2	**1**		**3**		**3**	**1**
CO3	**2**		**3**		**3**	**1**
CO4	**2**		**3**		**3**	**1**
CO5	**2**		**3**		**3**	**1**

Course code	PG/ITE/PE/T/113/C
Category	Program Elective
Course title	**Next Generation Networks**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	

Syllabus:

Introduction: Applications, network generations (with the range frequency bands), recap on wireless transmissions and media access control, Multiplexing (w.r.t., time, frequency and power level), Fading (types and different models used in LoS and non-LoS propagation), recap on MAC protocols (i.e., CSMA/CA, FDMA (e.g., Orthogonal, Single-carrier, General etc.), TDMA, RSMA), non-orthogonal MA (i.e., NOMA: code and power domain), simplified reference model. [5 hours]

Mobility management: Recap of conventional mobility management protocols(i.e.,MIP and its variants), NEMO, Distributed Mobility Management (DMM). Application of DMM in LTE and its beyond. [3 hours]

Routing Algorithms (adhoc and others): AODV, DSDV, DSR, LEACH, Cluster based routing, Energy efficient routing, routing in delay tolerant networks (DTN). [5 hours]

Wireless Transport protocols and dependents: Problems of TCP,TCP SACK,I-TCP, TCP SNOOP, DDA, TCP Veno, TCP-Freeze, ATCP, Multipath TCP, TCP configuration parameters, overview of QUIC, AMQP and MQTT. [8 hours]

Wireless systems: Recap of conventional Wireless Systems (e.g., 802.11 standards, WMAN, WPAN, IrDA technologies, 802.16 standards etc.), MIMO (including massive-MIMO and MU-MIMO), Beam-forming and its management, Vehicular Networks. [3 hours]

Legacy and Next generation networks (RAN, TN and CN): Recap on cellular concept, GSM, UMTS, LTE, LTE-Advanced (e.g., CA, ICIC, Relaying etc.), 5G Networks and its beyond (B5G), Integrated Access and Backhaul (IAB)-networks, Software Define Networks (SDN), Network Virtualization and Slicing (NS), D2D communications, Ubiquitous connectivity (i.e., integration of UAV and Satellite Networks), Cognitive Radio Networks (CRN), Multi Radio Access Technologies, Overview of 6G networks. [18 hours]

Reference Books:

1. Jochen Schiller, Mobile Communications, Pearson publication.
2. Theodore (Ted) S. Rappaport, Wireless Communications, Pearson publication.
3. Christopher Cox, An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications, Willey publication.
4. HarriHolma, AnttiToskala, LTE FOR UMTS : EVOLUTION TO LTE-ADVANCED, Willey publication.
5. André Perez, LTE and LTE Advanced: 4G Network Radio Interface, Willey publication.
6. Erik Dahlman, Stefan Parkvall, Johan Skold, 5G NR : THE NEXT GENERATION WIRELESS ACCESS TECHNOLOGY, Academic Press.
7. William Stallings, 5G Wireless: A Comprehensive Introduction, Addison-Wesley Professional.

8. Erik Dahlman, Stefan Parkvall, Johan Skold, 5G NR- The Next Generation Wireless Access Technology, Academic Press.
9. AfifOsseiran, Jose F. Monserrat, Patrick Marsch, 5G Mobile and Wireless Communications Technology, Cambridge University Press.
10. Mangesh M. Ghonge, RamchandraSharadMangrulkar, Pradip M. Jawandhiya, NitinGoje, Future Trends in 5G and 6G: Challenges, Architecture, and Applications, CRC Press.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Explain** and **illustrate** the basics of wireless transmission and medium access control issues.
CO2	**Apply** the distributed features of various mobility management protocols, and **illustrate** various algorithms of adhoc and delay tolerant networks.
CO3	**Demonstrate** various mobile transport layer and dependent protocols and **solve** problems using them.
CO4	**Explain** various wireless technology and LAN standards in view of physical and MAC management.
CO5	**Discuss** and **familiarize** with the basics of legacy and next generation networks and **apply** different metrics to measure the performance in different scenarios.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1			**3**	**3**		**1**
CO2	**2**	**1**	**3**	**3**		**1**
CO3	**3**		**3**	**3**		**2**
CO4	**1**		**3**	**3**		**2**
CO5	**1**	**1**	**3**	**3**		**2**

Course code	PG/ITE/PE/T/114/A
Category	Program Elective
Course title	**Information Security**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	PG/ITE/PE/T/113/A (Mathematics for Cryptography)

Syllabus:

Introduction to Information Security: Security Approaches, Principles of security; Types of attacks: Active attack - interruption, modification, fabrication; Passive attack – release of message contents, traffic analysis; Cryptography Terminologies; Similarities and Differences between Information Security and Cryptography. [2 hours]

Classical Cryptography: Shift Ciphers, Substitution Ciphers, Hill Ciphers, Transposition Ciphers, Playfair Ciphers, Affine Ciphers, Vignette Ciphers. [3 hours]

Modern Symmetric Ciphers: Stream Ciphers, Block Ciphers, Data Encryption Standard (DES), Advanced Encryption Standard (AES), Different Encipherment Modes. [6 hours]

Public-Key Cryptography: Characteristics of Public Key Cryptosystem, Diffie-Hellman, RSA, ElGamal, Rabin, Elliptic-curve cryptography (ECC). [6 hours]

Authentication: Message Integrity and Message Authentication; Hash Algorithms - MD4, MD5, Secure Hash algorithm; Digital Signatures - RSA scheme, Elgamal scheme; watermarking [6 hours]

Entity Authentication Protocols: Passwords, Challenge response, Zero Knowledge, Biometric [3 hours]

Key Management: Symmetric Key Distribution and Key Distribution center, Public Key Distribution [4 hours]

Steganography: History of Steganography, History of Digital Steganography; Image Steganography, Audio Steganography, Video Steganography, Text Steganography, Network Steganography; Steganalysis. [4 hours]

Image Encryption: Overview of image encryption, Confusion and diffusion, Chaotic and Non-Chaotic Image encryption, Performance Measure. [4 hours]

Secret Sharing Scheme: Overview, Need for Secret Sharing; Shamir's Scheme, Blakley's Scheme, Asmuth Bloom's Scheme; Modern Trends. [4 hours]

Reference Books:

1. Stallings, William, Cryptography and Network Security Principles and Practices, Pearson Edu.
2. Forouzan, Behrouz A., Cryptography and Network Security, TMH.
3. Kahate, Atul, Cryptography and Network Security, TMH.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Explain** and **illustrate** different types of security attacks and Classical Ciphers.
CO2	**Illustrate** Symmetric Key and asymmetric Key Cryptosystems.
CO3	**Demonstrate** different authentication and key management schemes.
CO4	**Understand** and **Apply** different modern techniques of image encryption, stegnography, and secret sharing scheme.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1			**2**	**3**	**1**	**1**
CO2	**2**		**2**	**3**		**1**
CO3	**1**		**2**	**3**		**1**
CO4	**2**	**2**	**3**	**3**	**2**	**2**

Course code	PG/ITE/PE/T/114/B
Category	Program Elective
Course title	**Machine Learning**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	

Syllabus:

Introduction: Components of Learning, Learning Models, Geometric Models, Probabilistic Models, Logic Models, Grouping and Grading, Designing a Learning System, Types of Learning, Supervised, Unsupervised, Reinforcement, Perspectives and Issues, Version Spaces, PAC Learning, VC Dimension; datasets, Dataset division: test, train and validation sets, cross validation, Real life examples of Machine Learning. [4 hours]

Basics of Feature engineering: Data visualization, Data cleaning and preprocessing techniques, Feature selection and Feature extraction and reduction [2 hours]

Supervised learning: Classification and Regression: K-Nearest Neighbor, Linear Regression, Logistic Regression, Random Forest, Decision tree, Multilayer Perceptron, Support Vector Machine (SVM), Evaluation Measures: SSE, MME, R2, confusion matrix and evaluation metrics, ROC-Curve, AUC curve. [8 hours]

Unsupervised learning: Introduction to clustering, Types of Clustering: Hierarchical, Agglomerative Clustering and Divisive clustering; PartitionalClustering - K-means clustering, Naïve Bayes classifier [4 hours]

Reinforcement Learning and Evaluating Hypotheses: Learning Task, Q Learning, Non deterministic Rewards and actions, temporal-difference learning, Relationship to Dynamic Programming, Active reinforcement learning, Generalization in reinforcement learning. Motivation, Basics of Sampling Theory: Error Estimation and Estimating Binomial Proportions, the Binomial Distribution, Estimators, Bias, and Variance [8 hours]

Ensemble and Probabilistic Learning: Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, Boosting: Adaboost, Stacking. Gaussian mixture models - The Expectation-Maximization

(EM) Algorithm, Information Criteria, Nearest neighbour methods - Nearest Neighbour Smoothing, Efficient Distance Computations: the KD-Tree, Distance Measures. [10 hours]

MLtools: Weka,TensorFlow, PyTorch, Keras [6 hours]

Reference Books:

1. Ethem Alpaydin, Introduction to Machine Learning.
2. Tom Mitchell., Machine Learning. McGraw- Hill, 1997.
3. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, Foundations of Machine Learning, MIT Press, 2012.
4. Stephen Marsland, Machine Learning - An Algorithmic Perspective, 2015.
5. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective. The MIT Press, 2012.
6. C. M. Bishop, Pattern Recognition and Machine Learning (Information Science and Statistics). Springer, 2006.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Explain** and **illustrate** basic application and characteristics of Machine Learning techniques.
CO2	**Apply** various supervised learning methods to **evaluate** an appropriate ML model.
CO3	**Create** probabilistic and unsupervised learning models for **handling** unknown pattern
CO4	**Interpret** and **Analyze** results with reasoning on different datasets using various ML techniques.
CO5	**Demonstrate** ensemble techniques to combine predictions from different models.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1			**3**		**3**	

CO2	**2**	**2**	**3**		**3**	**2**
CO3	**2**	**2**	**3**		**3**	**2**
CO4	**2**	**2**	**3**		**3**	**2**
CO5	**2**	**2**	**3**		**3**	**2**

Course code	PG/ITE/PE/T/114/C
Category	Program Elective
Course title	**IoT and Cloud Computing**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	
Syllabus:	

Introduction to 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. [10 hours]

Introduction to Cloud Computing

Cloud Computing: Definition, roots of cloud computing, characteristics, cloud architecture, deployment models, service models.

Virtualization: Benefits & drawbacks of virtualization, server virtualization, virtualization of - operating system, platform, CPU, network, application, memory and I/O devices etc. [10 hours]

Cloud Service and Security

Cloud Computing Service Platforms – Compute services, storage services, database services, application services, queuing services, e-mail services, notification services, media services, content delivery services, analytics services, deployment & management services, identity & access management services and

their case studies. Security in cloud computing: issues, threats, data security and information security. [9 hours]

IoT Protocols

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. [9 hours]

Application and Use cases of IoT& Cloud [4 hours]

Reference Books:

1. Chellammal Surianarayanan and Pethuru Raj Chelliah, (2019). Essentials of Cloud Computing, A Holistic Perspective, Springer Nature Switzerland AG, Switzerland.
2. Dimitrios Serpanos and Marilyn Wolf, 2018, Internet-of-Things (IoT) Systems Architecture s, Algorithms, Methodologies, Switzerl and Springer, Switzerland.
3. Andrew Minteer, 2017, Analytics for the Internet of Things (IoT): Intelligent analytics for your intelligent devices, Packt Publishing.
4. Geoffrey C. Fox, Jack Dongarra, Kai Hwang, (2013), Distributed and Cloud Computing From Parallel Processing to the Internet of Things.
5. Pradeeka Seneviratne, 2015, Internet of Things with Arduino Blueprints, Packt Publishing.
6. G. Coulouris, J. Dollimore, T. Kindberg, and G. Blair, (2012), Distributed Systems: Concepts and Design, 5th Edition, Addison Wesley, USA.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Describe** the IoT and Cloud architectures and **determine** the right sensors and communication protocols to use in a particular IoT system.

CO2	**Deploy** Cloud Services using different cloud technologies and **implement** cloud computing elements such virtual machines, web apps, mobile services, etc.
CO3	**Establish** data migration techniques from IoT devices to the cloud and **implement** security features to protect data stored in the cloud.
CO4	**Use** visualization techniques to show data generated from the IoT device.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1			**3**	**3**		**1**
CO2	**2**		**3**	**3**		**1**
CO3	**2**	**2**	**3**	**3**		**2**
CO4	**1**	**1**	**3**	**3**		**2**

Course code	PG/ITE/PE/T/115/A
Category	Program Elective
Course title	**Linux and Kernel Programming**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	

Syllabus:

Introduction: Review of Operating System; Unix/Linux design principle; Linux File system structure, inode, soft and hard links; implementation of multi-user system; protecting files; file permission and implementation; umask; special permissions; [8 hours]

System calls: File related system calls: read(), write(), open(); Kernel Modules: compiling, installing and removing modules, Device drivers; [8 hours]

Linux processes and threads: Process states; Process descriptors and implementation; Process scheduling; Linux process scheduling algorithms;

choosing scheduling algorithm and parameters and their effect; System calls related to processes; creating new processes: system(), exec() family of system calls, fork(); zombie and orphan processes; waiting for a process; Signals; [12 hours]

Inter-process communication: IPC using signals; Threads; thread synchronization using mutex and semaphore; solution to classical problems; Inter-Process-Communication (IPC): pipes, FIFOs, shared memory; Message queue; sockets [14 hours]

Reference Books:

1. Richard Stones & Neil Matthew, Beginning Linux Programming, A Wrox publication.
2. Daniel P. Bovet, Marco Cesati, Understanding the Linux Kernel, O'Reilly publication.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Memorize** the fundamental concepts of Operating Systems.
CO2	**Explain** Linux File system related concepts including kernel modules and device drivers and **solve** problems on File Systems.
CO3	**Explain** Process Management related concepts and **solve** problems of Process Management.
CO4	**Illustrate** various inter-process communication techniques and **solve** basic problems using them.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1			**2**			**1**
CO2	**2**		**3**			**1**
CO3	**2**		**2**			**1**
CO4	**2**		**2**			**3**

Course code	PG/ITE/PE/T/115/B
Category	Program Elective
Course title	**Agile Model Engineering and DevOps**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	
Syllabus:	

Introduction: Need of Agile software development, agile context– Manifesto, Principles, Methods, Values, Roles, Artifacts, Stakeholders, and challenges. Business benefits of software agility, overview of Scrum framework and its origins. Benefits, drawbacks and comparison of Agile and Scrum to traditional project management methodologies. [3 hours]

Agile Principles: Structure of an agile team– Programmers, Managers, and Customers. User stories– Definition, Characteristics and content. Estimation– Planning poker, Prioritizing, and selecting user stories with the customer, projecting team velocity for releases and iterations. Design principles–Single responsibility, Open-closed, Liskov substitution, Dependency-inversion, Interface-segregation. Agile lifecycle and its impact on testing- Continuous integration, Code refactoring, Risk based testing, Regression tests, Test automation. [8 hours]

Scrum Framework: Need of scrum, Scrum practices –Working of scrum, Project velocity, Burn down chart, Sprint backlog, Sprint planning and retrospective, Daily scrum, Scrum roles– Product Owner, Scrum Master, Scrum Team. Extreme Programming- Core principles, values and practices. Kanban, Feature-driven development, Lean software development. [4 hours]

Devops: Emergence, Principles, culture, and History of DevOps, Benefits, DevOps Lifecycle, DevOps with agile using Scrum. [4 hours]

Version Control: Git Fundamentals, version control, and repositories; Workflow-Mastering common Git workflows and branching strategies; Collaboration-Understanding how to work collaboratively on code using Git. [3 hours]

Continuous Integration and Continuous Deployment (CI/CD): An in-depth look at CI/CD principles and their importance, Jenkins- Setting up and

configuring Jenkins for automated builds and deployments, Pipeline as Code- Creating and managing CI/CD pipelines with code. [3 hours]

Infrastructure as Code (IaC): IaC Concepts: Understanding the concept of treating infrastructure as code; managing infrastructure with Terraform and creating reusable modules, Automating Deployments- Integrating IaC into the CI/CD pipeline. [3 hours]

DevOps Tools: Monitoring Tools, Logging Strategies, Alerting and Notifications, Configuration Management, Container Orchestration- Kubernetes, Security in DevOps. [4 hours]

Case Studies: Applying Agile and Scrum to various industries and projects, relationship between Agile & DevOps. [10 hours]

Reference Books:

1. Ken Schwaber, Agile Project Management with Scrum (Developer Best Practices), Microsoft Press US, 2004.
2. Mike Cohn, Agile Estimating and Planning, Pearson Education India, 2006.
3. Jim Highsmith, Agile Project Management: Creating Innovative Products, Addison-Wesley, 2009.
4. Gene Kim, Patrick Debois, Professor John Willis, Jez Humble, John Allspaw, TheDevOPS Handbook: How to Create World, IT Revolution Press, 2016.
5. Gene Kim, The Phoenix Project: A Novel about It, Devops, and Helping Your Business Win, IT Revolution Press, 2018.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Explain** fundamentals of Agile methodology and interpret their difference from traditional methodologies.
CO2	**Apply** and **analyze** the core practices and various tools available to agile

	teams to facilitate the project.
CO3	**Identify** the Scrum principles and apply the concept of Team organization and user stories.
CO4	**Define** and **discuss** the key principles of DevOps and explain how to work collaboratively on code.
CO5	**Explain** the concepts of build and deployment automation and assess the implications of continuous delivery using various tools available in DevOps.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1			**3**	**3**		**1**
CO2	**3**			**3**		**1**
CO3	**3**			**3**		**1**
CO4		**3**		**3**		**2**
CO5	**3**			**3**		**2**

Course code	PG/ITE/PE/T/115/C
Category	Program Elective
Course title	**Computational Biodiversity**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	

Syllabus:

Introduction: Basic concepts of biodiversity and conservation: definitions and terms, causes, values and threats related to biodiversity, biodiversity conservation and climate change, global biodiversity, getting to know biodiversity areas in the world, biodiversity hot spots and issues related to global biodiversity [6 hours]

Taxonomy and Classification: Taxonomy and systematics of animals, plants and microbes: principles of taxonomy, the role of taxonomy, taxonomy and the

future of diversity science, plant documentation, introduction to animal taxonomy and systematics methodology used in taxonomy, introduction to the classification of bacteria, algae, fungi and plants, classification of protozoa, non-chordates and chordates.

Methods for species identification & classification- Information needs in biodiversity assessments and inventorying programs- Role of information technology in distributing biodiversity information. [6 hours]

Species, Genetic, and Ecosystem Biodiversity: Species diversity and conservation, genetics and ecosystems diversity: independent and density-dependent growth, metapopulation ecology, genetic variation, population genetics, ecosystem concepts, protected areas, water ecosystems and wetlands (Freshwater, Lake, River, Marine, Estuarine) [10 hours]

Computational biodiversity conservation: Non-parametric tests for one sample, two samples and more than two samples, Feature selection, dimensionality reduction, feature generation for biodiversity data preparation, Application of different machine learning techniques (e.g., clustering classification, rule mining, pattern mining algorithms for Biodiversity data analysis) [12 hours]

Biodiversity Document, Database and Software: Assessing, analyzing, and documenting biodiversity- Morphological and molecular characterization of biodiversity- Introduction to biodiversity database: endangered animals, endemism and Red data books- Biodiversity registers.

Designing information systems to support biodiversity conservation- Networks for distributing information- Distributed Databases and Web-Accessible Resources.

Software for identification of Assessing existing biodiversity databases on the world-wide-web - Probabilistic and deterministic identification, Delta, MicroIS, AVIS, ICTV.

Overview of the UNEP/GEF biodiversity data management project (BDM) – CBD and bioethics– General agreement on trade and traffic. [8 hours]

Reference Books:

1. Biodiversity: Measurement & Estimation Hawkswoth, D.I. (Ed.) (1995),

Chapman & Hall, London.
2. Alice, 1990. A Biodiversity database system. Alice software partnership. Cnhos, D.A.L. Canhos, V.P and Kirsop, B.E (eds) 1994. Linking Mechanisms for Biodiversity Information, Tropical foundation, Tropical Foundation, Campinas, Brazil.
3. Global Biodiversity: Status of the Earth's Living Resources. Water Conservation Monitoring Centre (1992), Chapman & Hall, London.
4. Systematics and Conservation Evaluation- Forey, P.L., C.J. Humphries and R.I Vane-Wright (eds) (1994), Clarendon press, Oxford.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Understand** and **know** the basic Biological diversity of life and the distributed databases and web-accessible resources
CO2	**Analyze** the software for identification of Assessing existing biodiversity databases
CO3	**Understand** the statistical and deterministic methods for analyzing biodiversity data
CO4	**Understand** the computational methods for analyzing biodiversity data

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1			**3**		**3**	**2**
CO2	**1**		**3**		**3**	**2**
CO3	**2**	**2**	**3**		**3**	**2**
CO4	**2**	**2**	**3**		**3**	**2**

Course code	PG/FET/RM/T/116
Category	Theoretical
Course title	**Research Methodology, Ethics & IPR**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	PG/FET/RM/T/116

Course code	PG/ITE/AC/T/117/A
Category	Audit Course
Course title	**Latex for Report Writing**
Scheme and Credits	L-T-P: 0-0-2; Credits: 0;
Pre-requisites (if any)	
Syllabus:	

Introduction: overview, latex Installation, class of the documents, packages, writing the first document [2 hours]

Latex Document: [10 hours]

Basic document: prepare basic document, create a title, chapters and sections and their labels, create a pdf file

Text formatting: Listing includes verbatim, enumerate, itemize, description, special characters, headers and footers, page style, fonts, font sizes, font style

Spaces: horizontal space, vertical space, tabbing, line break, paragraphs, page break, page numbering, minipage

Changing margins: left margin, top margin, text height and width, line spacing

Tables: caption and label, multi-columns, multi-rows

Additional features: Table of content, list of figures, list of tables, appendix, input tex file

Maths mode: symbols, formulas, superscript and subscript, overline, underline, overbrace, underbrace, fractions, functions, Text in Math Displays, Operators &Relations, cases, More Symbols, Greek letters, Matrix, determinant and other similar structure. Equations and Arrays, Equation numbering. [6 hours]

Theorems: basic theorems and proofs, theorem styles, lemma, corollary [2 hours]

Working with Image: incorporating figure/image, caption and label, create eps file, figures with in tabular environment [2 hours]

Referencing: bibliography, bibliography style, and citation [1 hour]

Document class: Thesis, report, article and customized document styles [2 hours]

Presentations: beamer class, themes of beamer presentations [3 hours]

Reference Books:

1. LaTeX: A Document Preparation System, Leslie Lamport
2. LaTeX Beginner's Guide, Stefan Kottwitz
3. The Latex Companion, Frank Mittelbach and Michel Goossens
4. Guide to LATEX, Helmut Kopka and Patrick W.Daly
5. https://www.latex-project.org/

Content Delivery Method

- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Create** a basic report and article using Latex
CO2	**Insert** figures, tables and equations and cross reference them.
CO3	**Add** bibliography and use citations in the document
CO4	**Create** beamer presentations

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	**1**	**3**	**2**			**3**
CO2	**1**	**3**	**2**			**3**
CO3	**1**	**3**	**2**			**3**
CO4	**1**	**3**	**2**			**3**

Course code	PG/ITE/AC/T/117/B
Category	Audit Course
Course title	**R Programming**
Scheme and Credits	L-T-P: 0-0-2; Credits: 0;
Pre-requisites (if any)	

Syllabus:

Introduction to R and RStudio: R interpreter, list and data frames, Control Structures, vectorized if and multiple selection, functions. [4 hours]

Basic Object Types and Operations in R: Understanding R data structure Variables in R Scalars Vectors Matrices List Data frames Using c, Cbind, Rbind, attach and detach functions in R Factors [6 hours]

Data Import and Export: Reading and Importing Tabular Data files, Accessing database, Loading R data objects, Writing to files, Merging data, Relabelling the column names, Converting variable types, Data sorting, Data aggregation [4 hours]

Function and Packages: Common Statistical Functions, Building Packages, Commonly used Mathematical Functions, Commonly used Summary Functions, Commonly used String Functions User-defined functions, local and global variable [5 hours]

Data Visualization: Building Box plot, Histogram, Pareto charts, Pie graph, Line chart, Scatterplot, Developing graphs [3 hours]

R GUI: Designing GUI using R Shiny, Building interactive application and connecting it with database. [6 hours]

Reference Books:

1. The R Book by Michael J Crawley
2. 2. Advanced R. by Hadley Wickham
3. 3. R Graphics Cookbook: Practical Recipes for Visualizing Data by Hadley Wickhamand Garrett Grolemund.
4. 4. R Packages: Organize, Test, Document, and Share Your Code
5. R Markdown: The Definitive Guide. by Yihui Xie, JJ Allaire, and Garrett Grolemund.

Content Delivery Method

- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

After completing the course, the students will be able to	
CO1	**Understand** and **illustrate** the use of R Studio, R Object and Data Structure
CO2	**Create** and **use** different packages to solve problems using data
CO3	**Illustrate** the use of data visualization and R shiny

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	**3**		**2**		**2**	**1**
CO2	**3**		**2**		**2**	**1**
CO3	**3**		**2**		**2**	**1**

Course code	PG/ITE/S/111
Category	Sessional
Course title	**Software Lab - I**
Scheme and Credits	L-T-P: 0-0-4; Credits: 2;
Pre-requisites (if any)	

Syllabus:

Part-A (50 marks)

1. Develop and demonstrate programs on

- Advance data structures like AVL tree, hash function, B-tree etc.
- Algorithm paradigm like greedy approach, dynamic programming, divide-and-conquer, etc.
- Randomize algorithms like quick sort, election of leader, etc.

Part B (50 marks)

2. Network programming and Simulators

- Learning some Network tools (commands), Shell programming, Socket programming: TCP socket, UDP socket, raw socket and developing their applications.

- Implementation: Various ARQ protocols, window protocols etc. Network packet analysis: wireshark, pcap etc.
- Overview of standards network simulators and case studies on routing algorithms and other algorithms using the simulators

Reference Books:

1. Part A as mentioned in PG/ITE/PC/T/111
2. Part B as mentioned in PG/ITE/PC/T/112

Content Delivery Method

- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Implement** programs on advanced data structures
CO2	**Apply** different algorithmic techniques to **solve** optimization problems.
CO3	**Use** various networking tools/commands and **apply** various shell and socket programming.
CO4	**Implement** various network models and protocols and **use** different software packet analyzer and standard simulators.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1			**3**		**3**	**1**
CO2	**1**		**3**		**3**	**1**
CO3	**2**	**2**	**3**	**3**	**1**	**1**
CO4	**2**	**2**	**3**	**3**	**1**	**1**

Course code	PG/ITE/S/112
Category	Sessional
Course title	**Seminar**
Scheme and Credits	L-T-P: 0-0-4; Credits: 2;
Pre-requisites (if any)	

Syllabus:

Seminar (on any topic related to the course) with a brief report.

Content Delivery Method

- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Identify** relevant information on a selected topic
CO2	**Understand** and **recognize** different tools and methods related to the topic
CO3	**Compare** related methods, techniques, architectures and protocols
CO4	**Write** a report to present the state-of-the-art on the selected topic
CO5	**Plan** and **prepare** slides and **present** the topic during presentation

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1		**3**	**1**			**3**
CO2		**3**	**1**			**3**
CO3		**3**	**1**		**2**	**3**
CO4		**3**	**1**			**3**
CO5		**3**	**1**			**3**

2nd Semester

Course code	PG/ITE/PC/T/121
Category	Program Core
Course title	**Object Oriented Systems**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	

Syllabus:

Introduction: Recapitulation of programming paradigm; From Procedural to OOP, Review of Object oriented concepts; [6 hours]

UML: Importance of and Principles of modeling, Object oriented modeling, Introduction to UML, structural modeling: classes, objects, interfaces etc.; Behavioral modeling: dependency, association, generalization, realization; architectural modeling: class diagram, sequence diagram, use case diagram etc. Object-oriented design and analysis using UML things, relationships and diagrams; Unified development process; Use cases [15 hours]

Design patterns: Code reuse and concept of Design patterns and its importance; GoF design patterns, Creational design patterns: Singleton, Factory Method, Abstract Factory, Builder, Prototype, Object Pool, structural design pattern: Adapter, Bridge, Composite, Decorator, Façade, Flyweight, Proxy; behavioral design patterns: Chain of Responsibility, Command, Interpreter, Iterator, Mediator, Memento, Observer, State, Strategy, Template Method, Visitor; use cases. [15 hours]

Frameworks: Distributed objects, components and framework; Interoperability and middleware; Object-oriented storage systems; Object-relational system [6 hours]

Reference Books:

1. Grady Booch, James Rumbaugh, Ivar Jacobson, The Unified Modeling Language User Guide, An Addison-Wesley publication
2. Craig Larman, Using UML and Patterns, An Addison-Wesley publication

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Describe** the basics of Object Oriented concepts and modeling.
CO2	**Learn** various UML notations and **design** Object-oriented software using them.
CO3	**Identify** and **explain** various Design Patterns and **use** them during software design.
CO4	**Explain** various distributed object systems and **use** them to solve problems.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1			**3**	**1**	**1**	**2**
CO2	**1**		**3**	**1**	**1**	**2**
CO3	**2**	**1**	**3**	**2**		**3**
CO4	**3**	**2**	**3**	**2**		**3**

Course code	PG/ITE/PC/T/122
Category	Program Core
Course title	**Advanced Databases**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	

Syllabus:

Advanced Database Concepts: Database Storage Models and Data Layout, Design of Database Kernels, Data Partitioning, Database Indexes, Data Access Methods, Decorrelation techniques, Query Processing, Advanced Query Optimization Techniques and holistic optimization of database applications.

[13 hours]

Large Scale databases : Parallel and distributed Database systems, Streaming Databases, Spatial Databases, Temporal Databases, Main-Memory Databases: Couchbase , Columnar Databases: HBase, NoSQL Database: MongoDB/ Cassandra , Case studies on large-scale data management and computing [15 hours]

Introduction to Data Mining: Data Preprocessing, Rule Mining, Classification, Decision Tree, Clustering, Outlier detection [8 hours]

Data Warehouse: Data Warehouse Architecture, Modern Analytical Database Systems, OLAP Tools, OLAP COMMODITIZATION: System Catalogs, File Formats/Libraries and Execution Engines, Case study [4 hours]

Database Security and Integrity: Discretionary access control, Mandatory access control and multi-level security, Statistical database security, Data masking, Security best practices in database design [2 hours]

Reference Books:

1. R. Elmasri and S. B. Navathe, Fundamentals of Database Systems, Addison-Wesley
2. R. Ramakrishnan and J. Gehrke, Database Management Systems, McGraw-Hill
3. J. Ullman and J. Widom , H. Garcia-Molina, Database Systems - The Complete Book, Prentice Hall
4. J. Ullman, Principles of Database and Knowledge-Base System, Computer Science Press
5. M. Stonebraker and J. Hellerstein Morgan Kaufmann, Readings in Database Systems
6. JW Foreman, Data Smart - Using Data Science to Transform Information into Insight, Wiley

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Analyze** and **evaluate** different data storage models and **apply** advanced query processing and optimization techniques to enhance database performance
CO2	**Design** and **implement** large scale databases and analyze case studies on large scale data management and computing to understand real-world challenges and solutions
CO3	**Apply** data mining algorithms to discover patterns and associations in data and **implement** classification and decision tree algorithms for predictive analytics
CO4	**Assess** the features of Data Warehouse Architecture and Analytical Database Systems and **utilize** OLAP tools for multidimensional data **analysis** and reporting
CO5	**Evaluate** different data access control techniques and **implement** security best practices in database design to ensure data integrity and mitigate potential threats

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1			**3**		**3**	
CO2	**2**		**3**		**3**	
CO3	**3**		**3**		**2**	
CO4		**1**	**3**		**3**	**2**
CO5	**1**	**2**	**3**		**2**	**3**

Course code	PG/ITE/PE/T/123/A
Category	Program Elective
Course title	**Computer Vision**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	
Syllabus:	
Introduction: Basic concepts of Computer Vision - Low-level, Mid-level, High-	

level. Image sampling, interpolation, transformations, Image filtering techniques, Linear filters and edges, Feature extraction, Optical flow and feature tracking, Object recognition. [5 hours]

Feature Extraction and Pattern Analysis: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT. Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods. [12 hours]

Segmentation and Shape Representation: Contour based representation, Region based representation, Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Medial representations, Multi resolution analysis. Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation, Object detection. [15 hours]

Applications of Computer Vision: Content-Based Image Retrieval, Video Data Processing, Medical image analysis, Image stitching, 3D reconstruction, Image-based rendering [10 hours]

Reference Books:

1. Reinhard Klette , Concise computer vision: an introduction into theory and algorithms.
2. E.R. Davies, Computer vision: principles, algorithms, applications, learning.
3. Simon J.D. Prince, Computer vision: models, learning and inference.
4. Yeshwanth Reddy and Kishore Ayyaderava , Modern computer vision with Pytorch.
5. David A. Forsyth , Computer vision: a modern approach.
6. Scott Krig , Computer vision metrics: survey, taxonomy, and analysis.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Discuss** the basic concepts, terminology, and various methods of computer vision.
CO2	**Illustrate** the methods of feature extraction and **analyze** the pattern.
CO3	**Describe** the different segmentation approaches and shape representations.
CO4	**Discuss** the various applications of computer vision.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1			**3**			**3**
CO2	**1**		**3**		**2**	**3**
CO3	**1**		**3**			**3**
CO4	**3**	**3**	**2**			**3**

Course code	PG/ITE/PE/T/123/B
Category	Program Elective
Course title	**Data Science**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	PG/ITE/PE/T/123/B

Syllabus:

Introduction

Data Science: Benefits and uses – facets of data – Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation – Exploratory Data

analysis – build the model– presenting findings and building applications – Data Mining – Data Warehousing – Basic Statistical descriptions of Data [3 hours]

Describing Data and their Relationships

Types of Data – Types of Variables -Describing Data with Tables and Graphs – Describing Data with Averages – Describing Variability – Normal Distributions and Standard (z) Scores - Correlation –Scatter plots –correlation coefficient for quantitative data –computational formula for correlation coefficient – Regression –regression line –least squares regression line – Standard error of estimate – interpretation of r2 –multiple regression equations –regression towards the mean - Outlier Analysis - Extreme Value Analysis Using Univariate Methods - Multivariate Analysis for Outlier Detection - DBSCAN Clustering to Identify Outliers - Implementing rule-based anomaly detection - Percent Difference - Tukey fence - Z-score [5 hours]

Python Libraries for Data Wrangling

Basics of Numpy arrays –aggregations –computations on arrays –comparisons, masks, Boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – type conversion - missing/duplicate data – Hierarchical indexing – combining datasets – aggregation and grouping – pivot tables - Understanding data wrangling - Data cleaning - Data transformation - Data enrichment - Aggregating data - Summarizing DataFrames - Aggregating by group - Pivot tables and crosstabs Reshaping data - Transposing DataFrames - Pivoting DataFrames -Melting DataFrames - Handling duplicate, missing, or invalid data - Finding the problematic data - Mitigating the issues [7 hours]

Data Visualization

Foundation for a Science of Data Visualization – Environment- Optics –Optimal Display – Overview about Lightness, Brightness, Contrast, Constancy, Color – Visual attention that Pops Out - Importing Matplotlib – Line plots – Scatter plots - Heatmap - Boxplots - Scatter Matrices – three-dimensional plotting – Geographic Data with Basemap – Visualization with Seaborn - Categorical data - Correlations and heatmaps - Regression plots - Faceting - Customizing visualizations - Adding reference lines - Shading regions - Annotations - Colors - Textures - Web-Based Data Visualizations with Plotly - Collaborative Analytics - Basic Charts -

Statistical Charts - Plotly Maps - Web Scraping with Beautiful Soup - The BeautifulSoup Object - Exploring NavigableString Objects - Data Parsing - Web Scraping [7 hours]

Time series Data

Introduction of Time Series data – Time Series variables – Different components of Time Series data – Visualize the data to identify Time Series Components – Implement ARIMA model for forecasting – Exponential smoothing models – Identifying different time series scenario based on which different Exponential Smoothing model can be applied – Implement respective ETS model for forecasting [5 hours]

Data Ethics and Privacy

Data access and analysis – Risk mitigation – Risks, Harms and Benefit assessment – Sensitive data – Data Retention – Data Minimization – Data Quality – Open data transparency – Introduction to Data privacy – Modern privacy risks – Anonymity – Data validity – Errors in Data Processing – Errors in Model Design – Data Ethics – Importance of Data Ethics – Data ownership – Data Integrity – Data anonymization – Key issues in Data Ethics [3 hours]

Hands-on topics:

1. Download, install and explore the features of NumPy, SciPy, Jupyter, Stats models and Pandas packages.
2. Working with Numpy arrays, Pandas data frames
3. Reading data from CSV, JSON, HTML, XML, TAR, GZip, Zip files and web
4. Use dataset for performing: Univariate analysis, Bivariate analysis, Multiple Regression analysis
5. Apply and explore various plotting functions like Normal curves, Density and contour plots, Correlation and scatter plots, Histograms, Three dimensional plotting
6. Visualizing Geographic Data with Basemap, Cylindrical projections , Pseudo-cylindrical projections, Perspective projections, Conic projections

Mini Project: Students may do it in groups. In teams, students may carry out the projects such as Leaf Disease Detection, Brain Tumor Detection, Sentiment Analysis, Fake News Detection, Gender and Age Detection, Credit Card Fraud Detection, Movie Recommendation System, Driver Drowsiness Detection, Traffic Signs Recognition, Breast Cancer Classification, etc. using datasets from UCI repository [12 hours]

Reference Books:

1. David Cielen, Arno D. B, Meysman and Mohamed Ali, Introducing Data Science, Manning Publications, 2016.
2. Robert S. Witte and John S. Witte, Statistics, Eleventh Edition, Wiley Publications, 2017.
3. Jake Vander Plas, Python Data Science Handbook, O'Reilly, 2016.
4. Matthew O. Ward, George Grinstein, Daniel Keim, Interactive Data Visualization: Foundation, Techniques and Applications, Second Edition, A. K. Peters/CRC Press, 2015.
5. Robert Johansson, Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib, Apress, 2019.
6. Mike Loukides, Hilary Mason, DJ Patil, Ethics and Data Science, O'REILLY Media, Inc., 2018.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Define** and **illustrate** the data science process
CO2	**Illustrate** and **analyze** different types of data description techniques.
CO3	**Use** the Python libraries for data wrangling.
CO4	**Apply** visualization libraries in Python to interpret and explore data.
CO5	**Understand** data privacy, ethics, importance of data ethics, Data security

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1			**2**	**1**	**3**	**1**

CO2			**3**	**1**	**3**	**2**
CO3			**3**	**1**	**3**	**2**
CO4		**2**	**3**	**1**	**3**	**2**
CO5		**2**	**3**	**2**	**3**	**1**

Course code	PG/ITE/PE/T/123/C
Category	Program Elective
Course title	**Management and Business Systems**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	PG/ITE/PE/T/123/C
Syllabus:	

Business Fundamentals for IT Professionals: [8 hours]

Understanding core business functions through the concept of ERP: Marketing, finance, operations, human resources, and their connection to IT.
Financial literacy for IT: Key financial statements, budgeting, cost analysis, and return on investment (ROI).
Strategic business planning: Analyzing the business environment, developing strategic goals, and aligning IT initiatives with business strategy.
Organizational structures and culture: Understanding different organizational structures, their impact on decision-making and communication, and navigating internal politics.

Management Principles for IT: [10 hours]
Leadership and team management: Different leadership styles, effective communication, motivating and developing IT teams, managing conflict, and fostering collaboration.
Project management for IT: Agile methodologies, project planning, resource allocation, risk management, and performance tracking.
Human resource management in IT: Talent acquisition, performance management, building high-performing teams, and addressing ethical

considerations in IT workplaces.

Change management: Strategies for managing technological and organizational change within IT teams and the wider organization.

Business Systems and Technology: [8 hours]

Business Intelligence (BI) and data analytics: Leveraging data to inform decision-making, identify trends, and measure IT performance.

Cyber security and risk management: Understanding cyber threats, implementing security measures, and managing risks associated with IT systems.

Emerging technologies and their impact on business: Blockchain, artificial intelligence, cloud computing, and their potential impact on organizations and IT infrastructure.

Management Tools and Techniques: [10 hours]

Negotiation and influencing: Negotiating effectively with stakeholders, advocating for IT initiatives, and managing challenging conversations.

Presentation and communication skills: Tailoring communication to different audiences, presenting technical information effectively, and actively listening.

Time management and delegation: Prioritization techniques, delegating tasks effectively, and managing a demanding workload.

Problem-solving and decision-making: Applying frameworks for creative problem-solving and making data-driven decisions.

Developing Your Management Skills: [6 hours]

Personal development for leaders: Self-awareness, emotional intelligence, building trust, ethical leadership, and fostering a positive team environment.

Building your professional network: Strategies for networking within and outside the organization, developing mentors, and building professional relationships.

Career development in IT management: Identifying career paths, preparing for promotions, and navigating internal leadership transitions.

Reference Books:

1. ALEXIS LEON, Enterprise Resource Planning, , McGraw Hill, 2017.
2. Michael A. Cusumano, The Business of Software, Free Press (March 15,

2004).
3. Erik W. Larson, Clifford F. Gray, et al., Project Management: The Managerial Process, 8th Edition , 29 October 2021.
4. K Aswathappa and Sadhna Dash, Human Resource Management: Text and Cases, 10th Edition, 29 May 2023
5. SumitBelapure and Nina Godbole, Cyber Security, Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley India Pvt. Ltd. (First Edition, 2011).
6. Cameron and Whetten, Developing Management Skills, 7/E, January 2009, PHI Learning.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Understand** the Business Fundamentals as relevant for IT Professionals
CO2	**Understand** the basic Management Principles as relevant in the IT Industry
CO3	**Illustrate** various Business Systems and relevant Technologies
CO4	**Explain** various Management Tools and Techniques relevant for IT Professionals
CO5	**Understand** how to develop your own Personal Management Skill

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1			**3**		**1**	
CO2			**3**		**1**	**3**
CO3			**3**		**1**	**3**
CO4			**3**		**1**	**3**
CO5			**3**		**1**	**3**

Course code	PG/ITE/PE/T/124/A
Category	Program Elective
Course title	**Cyber Security**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	PG/ITE/PE/T/114/A (Information Security)

Syllabus:

Overview of Cyber security: Principles of security, Security Approaches, Various Types of Security Attacks; Similarities and Differences among Cryptography, Information Security, Network Security and Cyber Security; Related Cyber security terminologies. [6 hours]

Network Security: IP Security (Transport & Tunnel Mode, Security Association & Security Policy, IKE Phases & Modes), SSL/TLS (Secured Socket Layer Protocol Stack, Session State Parameters, SSL Record & Handshake Protocol, Transport Layer Security), Email Security (Pretty Good Privacy, PGP Operational Modes, PGP Key Management), Web Security, Firewalls, Intrusion Detection, VPN. [8 hours]

Cyber Security Fundamentals: Defining CyberSpace, Architecture of CyberSpace; Regulation of CyberSpace, Concept of Cyber Security, Issues and challenges of cyber security. [5 hours]

Cyber Crimes: Cyber crimes targeting Computer systems and Mobiles (spyware, logic bombs, DoS, APTs, viruses, Trojans, ransomware); Online scams and frauds (Phishing, Vishing, Smishing, Online job fraud, Online sextortion, Online payment fraud, Social Media Scams & Frauds); Cyberbullying, website defacement, Cyber espionage, Cryptojacking, Darknet; Cyber Crime against persons; Cyber Police stations, Crime reporting procedure, Case studies.[10 hours]

Cyber Law: Cybercrime and legal landscape around the world, IT Act 2000 and its amendments, Limitations of IT Act 2000, 2016 Personal Information Protection and Electronic Documents Act (PIPEDA); Cybercrime and punishments, Cyber Laws and Legal and ethical aspects related to new technologies; Case Studies. [6 hours]

Cyber security Management, Compliance and Governance: Cyber security Plan- cyber security policy, cyber crisis management plan; Business continuity, Risk assessment, Types of security controls and their goals, Cyber security audit and compliance, National cyber security policy and strategy. [7 hours]

Reference Books:

1. Stallings, William, Cryptography and Network Security Principles and Practices, Pearson Edu.
2. Forouzan, Behrouz A., Cryptography and Network Security, TMH.
3. SumitBelapure and Nina Godbole, Cyber Security, Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley India Pvt. Ltd. (First Edition, 2011).
4. Henry A. Oliver, Security in the Digital Age: Social Media Security Threats and Vulnerabilities, Create Space Independent Publishing Platform. (Pearson, 13th November, 2001).
5. Kumar K, Cyber Laws: Intellectual Property & E-Commerce Security, Dominant Publishers.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Identify** and **illustrate** different types of cyber-attacks and network security.
CO2	**Develop** knowledge about Network Security.
CO3	**Understand** the basics of Cyber Security
CO4	**Develop** knowledge about Cyber Crime, and Cyber Law.
CO5	**Understand** and **describe** various situations related to Management, Compliance and Governance of Cybercrime

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1			**3**	**3**	**1**	**1**
CO2			**3**	**3**	**1**	**1**
CO3			**3**	**3**	**1**	**2**

CO4		**2**	**3**	**3**	**1**	**2**
CO5	**2**	**2**	**3**	**3**	**1**	**2**

Course code	PG/ITE/PE/T/124/B
Category	Program Elective
Course title	**Deep Learning**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	PG/ITE/PE/T/114/B (Machine Learning)
Syllabus:	

Introduction to Deep Learning: Overview of machine learning and deep learning, basics of artificial neural networks, single layer and multilayer perceptron, activation functions, and feedforward networks, backpropagation algorithm for training neural networks, Gradient descent and its variants: SGD, Mini-batch GD. [4 hours]

Deep Learning Fundamentals: Convolutional Neural Networks (CNNs), architectures and building blocks of CNNs, popular CNN architectures: LeNet, AlexNet, VGG, ResNet, Transfer learning and pre-trained models, application on computer vision, speech recognition using CNNs. [9 hours]

Recurrent Neural Networks (RNNs): Introduction to RNNs and their applications, Long Short-Term Memory (LSTM) networks and Gated Recurrent Units (GRUs), Training and optimizing RNNs, application on text generation, sentiment analysis, and others NLP task. [8 hours]

Optimization and Regularization Techniques: Regularization methods: L1/L2 regularization, dropout, batch normalization, Optimization algorithms: Momentum, RMSProp, Adam, Learning rate scheduling and adaptive methods, addressing overfitting and underfitting in deep learning models, case study of regularization and optimization techniques. [9 hours]

Advanced Topics in Deep Learning: Generative Adversarial Networks (GANs) and VariationalAutoencoders (VAEs), Reinforcement learning basics and applications in deep learning, attention mechanisms and Transformer architectures, Recent advancements in deep learning research, case studies and applications across various domains. [12 hours]

Reference Books:

1. Simon J.D. Prince. Understanding Deep Learning. MIT Press. (2023).
2. Ian J. Goodfellow, YoshuaBengio, and Aaron Courville. Deep learning. MIT Press. (2016).
3. Charu C. Aggarwal, Neural Networks and Deep Learning: A Textbook.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Explain** the deep learning fundamentals, including neural network architectures and activation functions.
CO2	**Apply** optimization algorithms and regularization techniques effectively in training deep learning models.
CO3	**Demonstrate** CNN architectures, utilize pre-trained models for computer vision and speech recognition tasks.
CO4	**Apply** RNNs, including LSTM and GRUs, for sequential data processing tasks like text generation and sentiment analysis, others NLP task.
CO5	**Explore** advanced topics in deep learning, including GANs, VAEs, reinforcement learning, attention mechanisms, and Transformer architectures, across various domains.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1			**3**		**3**	**2**
CO2	**1**	**1**	**3**		**3**	**2**
CO3	**2**		**3**		**3**	**2**
CO4	**2**		**3**		**3**	**2**

CO5	**2**		**3**		**3**	**2**

Course code	PG/ITE/PE/T/124/C
Category	Program Elective
Course title	**Big Data Storage and Computing**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	PG/ITE/PE/T/114/C (IoT and Cloud Computing)
Syllabus:	

Introduction To Big Data : Introduction to Big Data, Apache Hadoop, Analyzing Data with Hadoop, Big Data Enabling Technologies, Hadoop Stack for Big Data [4 hours]

Big Data Storage Platforms: Introduction to Big Data Storage Platforms for Large Scale Data Storage, HDFS (Hadoop Distributed File System), Hadoop Architecture**,** Hadoop file system interfaces, Data flow, Serialization, Data Placement Strategies, CAP Theorem [6 hours]

Map Reduce and related paradigms : Anatomy of a Map Reduce Job Run, Driver, Mapper and Reducer classes, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map reduce Programming (Page rank, k-means, matrix multiplication) [8 hours]

Enabling Technologies for Big Data: Introduction to Pig, Execution Modes of Pig, Hive : Hive Shell, Hive Services, Hive Metastore, HiveQL, Hbase :HBasics, Concepts, Clients, Example, Hbase Versus RDBMS. [10 hours]

Big Data Streaming Platforms: Parallel Programming with Spark, Design of Key-Value Stores, Spark Streaming, Introduction to Kafka [4 hours]

Machine Learning Algorithms for Big Data Analytics: K–means using Map

Reduce, Big data Cluster Analysis, Decision Trees [6 hours]

NoSQL distributed databases: NoSQL Storage Architecture, CRUD operations with MongoDB, Querying, Modifying and Managing NoSQL Data stores, Indexing and ordering datasets (MongoDB/Apache Cassandra) [4 hours]

Reference Books:

1. Anand Rajaraman, Jeffrey David Ullman , Mining of Massive Datasets, Cambridge University Press.
2. Tom White, Hadoop: The Definitive Guide: Storage and Analysis at Internet Scale, 4th Edition, Shroff/O'Reilly.
3. Nathan Marz, James Warren, Big Data: Principles and best practices of scalable realtime data systems, Manning Publications Co.
4. Bart Baesens, Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Wiley.
5. JW Foreman, Data Smart - Using Data Science to Transform Information into Insight, Wiley.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Understanding** of Big Data Storage platforms and explain Apache Hadoop ecosystem and its role in handling large-scale data processing.
CO2	**Evaluate** different types of MapReduce jobs and **Apply** Map-reduce paradigm to solve different problems by **developing** mapper, reducer and other functions
CO3	**Differentiate** among Hadoop enabling technologies and perform data querying and manipulation using Pig scripts and Hive QL
CO4	**Implement** parallel programming with Spark for real-time data processing and **develop** applications using Machine Learning Algorithms for Big Data Analytics
CO5	**Assess** the features and detailed architectures of different types of No-SQL databases, and **manipulate** them through CRUD operations in an optimized way

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)						
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1			**3**		**3**	**2**
CO2	**3**	**1**	**2**		**3**	**2**
CO3	**3**	**1**	**2**		**3**	**2**
CO4	**3**		**2**		**3**	**2**
CO5	**1**		**3**		**3**	**2**

Course code	PG/ITE/OE/T/125/A
Category	Open elective
Course title	**Software Engineering**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	
Syllabus:	

Introduction: Changing Nature of Software, Importance of Software Engineering Paradigms, Software Development Myths, Boehm's Top Ten Industrial Software Metrics, Professional and Ethical Responsibilities of a Software Engineer.

[2 hours]

Software Process Models: Various Software Development Life Cycle Models; Waterfall Model, Evolutionary Development Model, Prototyping Model, RAD, Reuse Oriented Development Model, V Model, Agile Development Process Models. [4 hours]

Requirement Engineering Process: Requirement Engineering Process, Various types of Requirements (Functional, Users etc.), Mechanism of Analysis Model (ERD, DFD, STD), Object Oriented Approach, Detailed Modeling Activities.

[6 hours]

Design Process: Transition from Analysis to Design, Design Principles, Design Goals, Technical Criteria for Good Design, Various Design Concepts

(Abstraction, Refinement, Modularity,etc).Various Architectural Styles (Data Flow Architecture, Call & Return Architecture, Client Server Architecture etc.), Transform and Transaction Analysis & Mapping, User Interface Design, Component Level Design [6 hours]

Coding: Ideal Coding Attitude, Styles, Practices & Guidelines, Organizational Specific Coding Guidelines, Platform Specific Coding Guidelines. [2 hours]

Testing: Testing Objectives-Principles-Goals-Priorities, Test Case Design, Testability, White Box and Black Box Testing, Loop Testing. Software Testing Strategy (Strategy, Technique, Target, Focus), Unit Testing, Integration Testing, Validation Testing, System Testing, Verification & Validation of Software, Entry & Exit Criteria for Testing, Typical Test Plan Template, Modern Testing Trends. [6 hours]

Maintenance Process: Software Maintenance Process & Characteristics, Factors Affecting Maintenance Cost, Maintenance Categorization (Corrective, Adaptive, Perfective, Preventive), Lehman's Law of Software Change. [3 hours]

Metrics & Measurements: Software Measures, Measurements, Metrics & Indicators; Process, Project & Product Metrics; Private & Public Metrics; Size & Function Oriented Metrics; McCall's Quality Factors, Architectural Design Metrics, Component Level Design Metrics, Test & Maintenance Metrics. [4 hours]

Software Cost Estimation: Factors Influencing Software Cost; Different Techniques for Software Cost Estimation; Estimation using Decomposition Technique (LOC, FP, Process Based); Empirical Estimation Model (COCOMO – I and II); [4 hours]

Software Quality Management: What is Quality; Various Interpretation of Quality; Quality Timeline, Software Quality Assurance (SQA), SQA Benefits, Responsibilities and reporting, SQA activities as per different phases of SDLC, Risk analysis and management. [5 hours]

Reference Books:

1. R. S. Pressman, Software Engineering – A practitioner's Approach,

McGrawHill.

2. Ian Sommerville, Software Engineering, Pearson Education.
3. Rajib Mall, Fundamentals of Software Engineering, PHI.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Memorize** the Importance of Software Engineering Paradigms and **recall** various Life Cycle Models.
CO2	**Describe** various requirements and structured analysis techniques.
CO3	**Explain and describe the** issues and methods of the software planning, design, and process.
CO4	**Illustrate** different software testing methods and apply them in real life examples.
CO5	**Discuss** the various methods of software quality management and risk management.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO2			**3**			**3**
CO3			**3**			**3**
CO4			**3**			**3**
CO5			**3**			**3**

Course code	PG/ITE/OE/T/125/B
Category	Open elective
Course title	**Natural Language Processing**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	

Syllabus:

Introduction: Natural Language Processing Basics – Human Languages model, ambiguity, Stages of NLP, Morphology and Finite State Transducer, Recall to probability calculus - N-grams and Language Models Markov Models, Introduction to Machine Learning and Deep Learning, Recurrent Neural Network Language Models, The evaluation of NLP applications. [6 hours]

Text classification: Language models as probability distributions over strings, Information theory and the Shannon game, Naive Bayes classification as language modelling, Classification as function learning, From generative to discriminative linear classifiers with the perceptron, Conditional likelihood and logistic regression Non-linear classification with multi-layer perceptron. [6 hours]

Language modelling: Markov (n-gram) models and the bias-variance trade off, Recurrent neural network LMs: Elman and LSTM architectures, Attention, alignment, and Transformers, Evaluation, prediction, and perplexity. [6 hours]

Sequence labelling: Regular languages, finite-state machines and transducers, Hidden Markov models as noisy-channel models, Deduction and backpropagation, Recurrent models for sequence labelling, Applications of sequence labelling. [6 hours]

Syntactic parsing: Grammar formalisms and treebanks. Efficient parsing for context-free grammars (CFGs). Statistical parsing and probabilistic CFGs (PCFGs). Lexicalized PCFGs. Neural shift-reduce dependency parsing. [6 hours]

Semantic Analysis: Lexical semantics and word-sense disambiguation. Compositional semantics. Semantic Role Labelling and Semantic Parsing [3 hours]

Information Extraction: Named entity recognition and relation extraction. IE using sequence labelling. [3 hours]

Applications: Machine Translation, Opinion mining and Sentiment Analysis, Question answering, Dialog systems, Conversational Agents etc. [6 hours]

Reference Books:

1. Daniel Jurafsky and James H. Martin, Speech and Language Processing, 2020. 3rd Edition.
2. Christopher D. Manning and HinrichSchütze, Foundations of Statistical Natural Language Processing 1999. MIT Press.
3. SowmyaVajjala, BodhisattwaMajumder, Anuj Gupta, HarshitSurana, Practical Natural Language Processing, 2020. O'Reilly.
4. Hobson Lane, Cole Howard, HannesHapke, Natural Language Processing in Action. 2019.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)

Course Outcomes:

After completing the course, the students will be able to

CO1	Discuss and Recognize Basics of NLP.
CO2	Explain and Illustrate Text Classification and Language Modelling.
CO3	Analyze and Demonstrate syntactic parsing and different semantic representation of text.
CO4	Illustrate information retrieval and extraction, question answering and textual entailment, text summarization.
CO5	Demonstrate a few applications of NLP.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1			**2**		**1**	**1**
CO2	**1**	**2**	**2**		**1**	**3**
CO3	**2**	**2**	**2**		**1**	**3**
CO4	**2**	**2**	**2**		**1**	**3**
CO5	**3**	**2**			**1**	**3**

Course code	PG/ITE/OE/T/125/C
Category	Open elective
Course title	**Management of Information System**
Scheme and Credits	L-T-P: 3-0-0; Credits: 3;
Pre-requisites (if any)	PG/ITE/OE/T/125/C

Syllabus:

Introduction: Information Systems, IT Architecture, Data Governance, and Cloud Computing, Hardware, software and networks related to MIS. [3 hours]

Digital Technology Trends - Business in Data Management, Data Analytics, and Business Intelligence, Networks, Collaborative Technology, and the Internet of Things (IoT), Cyber-Security and Risk Management. [6 hours]

Winning, Engaging, and Retaining Consumers with Technology: Search, Semantic, and Recommendation Technology, Social Networking, Engagement and Social Metrics, Retail, E-commerce, and Mobile Commerce Technology. [8 hours]

Optimizing Performance with Enterprise Systems: Processes, and Productivity, Functional Business Systems, Enterprise Systems, Data Visualization and Geographic Info Systems, Total Quality Management and Enterprise Management System viz. ERP, SCM, CRM and Ecommerce. [8 hours]

Knowledge Management: Programmed and Non- Programmed decisions, Decision Support Systems, Models and approaches to DSS, Expert Systems, Learning Management Systems, Executive Information Systems [8 hours]

Managing Business Relationships, Projects, and Ethical Responsibilities: IT Strategy, Sourcing, and Strategic Tech Trends SDLC and Project Management, IT Ethics, Privacy, and Sustainability [7 hours]

Reference Books:

1. C. Laudon Kenneth, P. Laudon Jane, Management Information System: Managing the digital firm.

2. Patricia Wallace, Introduction to Information Systems: People, Technology and Processes.
3. Ramesh Sharda , Business Intelligence and Analytics: Systems for Decision Support.

Content Delivery Method

- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Improve** efficiency and efficacy of business models.
CO2	**Understanding** of role, advantages and components of an Information System.
CO3	**Applying** the knowledge from functional areas, decision making process in an organization
CO4	**Realizing** the role of Information Systems to have a vintage point in this competitive world

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1			**3**		**1**	**2**
CO2			**3**		**1**	**2**
CO3			**3**		**3**	**2**
CO4			**3**		**1**	**3**

Course code	PG/ITE/S/121
Category	Sessional
Course title	**Software Lab - II**
Scheme and Credits	L-T-P: 0-0-4; Credits: 2;
Pre-requisites (if any)	PG/ITE/S/121
Syllabus:	

Part-A (50 marks)

1. UML and design diagrams: Create class and object diagrams, Develop interaction, use case, activity diagrams. Design component and deployment diagrams. Draw UML diagrams for various design patterns.
2. Write suitable programs to demonstrate various design patterns.
3. Write suitable programs to deal with distributed objects using various frameworks such RMI, XML-RPC, SOAP, middleware(CORBA),Message queue etc

Part B (50 marks)

This laboratory syllabus is designed to provide students with practical skills and experience in advanced database topics and data mining. Assignments may be given from any three of the subsequent topics.

A. Columnar Databases

a) Setting up a columnar database environment (e.g., using HBase)
b) Implementing columnar storage and retrieval operations
c) Case study: Analyzing large-scale log data using HBase

B. NoSQL Databases

a) Setting up a NoSQL database environment (e.g., using MongoDB or Cassandra)
b) Implementing data modeling and CRUD operations in a NoSQL database
c) Case study: Building a scalable e-commerce platform using MongoDB or Cassandra

C. Parallel and distributed database systems

a) Setting up a distributed database environment using frameworks like Apache Hadoop or Apache Spark.
b) Implementing parallel query processing and performing data analytic tasks on large scale datasets
c) Case study: Analysis of Social media data /Customer Behavioir data on E-Commerce Platform

D. Spatial databases

a) Setting up a spatial database environment (e.g., using PostGIS)
b) Implementing spatial queries and spatial indexing techniques, Experimenting with spatial data visualization and analysis
c) Case study: Building a location-based service application using spatial databases

E. Temporal Databases

a) Setting up a temporal database environment (e.g., using SQL Server Temporal Tables)
b) Implementing temporal queries and temporal joins, Experimenting with versioning and snapshot isolation in temporal databases
c) Case study: Tracking changes in a dataset over time using temporal databases

F. Main-Memory Databases

a) Setting up a main-memory database environment (e.g., using Couchbase)
b) Implementing data modeling and querying in a main-memory database, Experimenting with caching and indexing strategies for performance optimization
c) Case study: Building a high-performance web application using Couchbase

Reference Books:

1. Part A as mentioned in PG/ITE/PC/T/121
2. Part B as mentioned in PG/ITE/PC/T/122

Content Delivery Method

- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Design** and **illustrate** various design patterns using UML
CO2	**Write** and **demonstrate** distributed object based programs using various frameworks.

CO3	**Implement** distributed database environments using Apache Hadoop frameworks, and perform parallel query processing and demonstrate data analytics on large-scale datasets
CO4	**Assess and implement** advanced database functionalities and solve problems utilizing various specialized database systems such as spatial, temporal, main-memory, columnar, and NoSQL databases.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	**2**	**1**	**3**		**1**	**3**
CO2	**3**		**2**		**1**	**3**
CO3	**3**	**1**	**2**		**3**	**2**
CO4	**3**	**1**	**2**		**1**	**3**

Course code	PG/ITE/S/122
Category	Sessional
Course title	**Term Paper**
Scheme and Credits	L-T-P: 0-0-4; Credits: 4;
Pre-requisites (if any)	

Syllabus:

Mini project with report and seminar and /or research paper survey with report and seminar

Content Delivery Method

- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Identify** relevant information on a selected topic
CO2	**Understand** and **recognize** different tools and methods related to the topic

CO3	**Compare** related methods, techniques and protocols.
CO4	**Write** a report to present the state-of-the-art on the selected topic
CO5	**Plan** and **prepare** slides and **present** the topic during presentation

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO2		**3**	**1**		**1**	**3**
CO3		**3**	**1**		**1**	**3**
CO4		**3**	**1**		**2**	**3**
CO5		**3**	**1**		**1**	**3**

3rd Semester

Course code	PG/ITE/S/211
Category	Sessional
Course title	**Dissertation with evaluation OR Industrial or Research Internship with evaluation**
Scheme and Credits	L-T-P: X-X-X; Credits: 16;
Pre-requisites (if any)	

Syllabus:

The evaluation will be based on the progress during the one semester period internally without any external examiner

Content Delivery Method

- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

After completing the course, the students will be able to

CO1	**Formulate** a research question and make it suitable to work in a collaborative environment.
CO2	**Apply** fundamentals of ICT concepts and/or theories to **analyze** the

	research question; develop a research framework/model and/or design a solution
CO3	**Use** appropriate data and techniques for the validation of the empirical findings
CO4	**Demonstrate** autonomy to write documents and present them on a public platform.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	**3**			**1**	**1**	**3**
CO2	**3**			**1**	**1**	**3**
CO3	**3**			**1**	**2**	**3**
CO4		**3**		**1**	**1**	**3**

4th Semester

Course code	PG/ITE/S/221
Category	Sessional
Course title	**Dissertation with evaluation OR Industrial or Research Internship with evaluation**
Scheme and Credits	L-T-P: X-X-X; Credits: 18;
Pre-requisites (if any)	

Syllabus:

The evaluation to be carried out by an external examiner along with supervisor(s).

Content Delivery Method

- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

As mentioned in PG/ITE/S/211

CO-PO Mapping: as mentioned in PG/ITE/S/211