Central University of Haryana

('A' Grade, NAAC Accredited)

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

NEP 2020/LOCF/OBE/NBA CURRICULUM (2021 -2022)
Program Name: M. Tech. - Computer Science and Engineering

Background

Considering the curricular reforms as instrumental for desired learning outcomes, all the academic departments of Central University of Haryana made a rigorous attempt to revise the curriculum of undergraduate and postgraduate programmes in alignment with National Education Policy-2020 and UGC Quality Mandate for Higher Education Institutions-2021. The process of revising the curriculum could be prompted with the adoption of "Comprehensive Roadmap for Implementation of NEP-2020" in the 32nd meeting of the Academic Council of the University held on April 23, 2021. The Roadmap identified the key features of the Policy and elucidated the Action Plan with well-defined responsibilities and indicative timeline for major academic reforms.

The process of revamping the curriculum started with the series of webinars and discussions conducted by the University to orient the teachers about the key features of the Policy, enabling them to revise the curriculum in sync with the Policy. Proper orientation of the faculty about the vision and provisions of NEP-2020 made it easier for them to appreciate and incorporate the vital aspects of the Policy in the revised curriculum focused on 'creating holistic, thoughtful, creative and well-rounded individuals equipped with the key 21st century skills' for the 'development of an enlightened, socially conscious, knowledgeable, and skilled nation'.

With NEP-2020 in background, the revised curricula articulate the spirit of the policy by emphasizing upon— integrated approach to learning; innovative pedagogies and assessment strategies; multidisciplinary and cross-disciplinary education; creative and critical thinking; ethical and Constitutional values through value-based courses; 21st century capabilities across the range of disciplines through life skills, entrepreneurial and professional skills; community and constructive public engagement; social, moral and environmental awareness; Organic Living and Global Citizenship Education (GCED); holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning; exposure to Indian knowledge system, cultural traditions and classical literature through relevant courses offering 'Knowledge of India'; fine blend of modern pedagogies with indigenous and traditional ways of learning; flexibility in course choices; student-centric participatory learning; imaginative and flexible curricular structures to enable creative combination of disciplines for study; offering multiple entry and exit points initially in undergraduate programmes; alignment of Vocational courses with the International Standard Classification of Occupations maintained by the International Labour Organization; breaking the silos of disciplines; integration of extra-curricular and curricular aspects; exploring internships with local industry, businesses, artists and crafts persons; closer collaborations between industry and higher education institutions for technical , vocational and science programmes; and formative assessment tools to be aligned with the learning outcomes, capabilities, and dispositions as specified for each course. In case of UG programmes in Engineering and Vocational Studies, it was decided that the departments shall incorporate pertinent NEP recommendations while complying with AICTE, NBA, NSQF, International Standard Classification of Occupations, Sector Skill Council and other relevant agencies/sources. The University has also developed consensus on adoption of Blended Learning with 40% component of online teaching and 60% face to face classes for each programme.

The revised curricula of various programmes could be devised with concerted efforts of the faculty, Heads of the Departments and Deans of Schools of Study. The draft prepared by each department

was discussed in a series of discussion sessions conducted at Department, School and the University level. The leadership of the University has been a driving force behind the entire exercise of developing the uniform template and structure for the revised curriculum. The Vice Chancellor of the University conducted series of meetings with Heads and Deans to deliberate upon the vital parameters of the revised curriculum to formulate a uniform template featuring Background, Programme Outcomes, Programme Specific Outcomes, Postgraduate Attributes, Structure of Masters Course, Learning Outcome Index, Semester-wise Courses and Credit Distribution, Course-level Learning Outcomes, Teaching-Learning Process, Blended Learning, Assessment and Evaluation, Keywords, References and Appendices. The experts of various Boards of Studies and School Boards contributed to a large extent in giving the final shape to the revised curriculum of each programme.

To ensure the implementation of curricular reforms envisioned in NEP-2020, the University has decided to implement various provisions in a phased manner. Accordingly, the curriculum may be reviewed annually.

Vision and Mission

UNIVERSITY VISION

To develop enlightened citizenship of a knowledge society for peace and prosperity of individuals, nation and the world, through promotion of innovation, creative endeavours, and scholarly inquiry.

UNIVERSITY MISSION

To serve as a beacon of change, through multi-disciplinary learning, for creation of knowledge community, by building a strong character and nurturing a value-based transparent work ethics, promoting creative and critical thinking for holistic development and self-sustenance for the people of India. The University seeks to achieve this objective by cultivating an environment of excellence in teaching, research and innovation in pure and applied areas of learning.

DEPARTMENT VISION AND MISSION

VISION

- To provide a sound technical foundation combined with intelligence, critical thinking and experiential learning while encouraging entrepreneurship through open innovation.

MISSION

- **M1:** To provide students with excellent engineering education by endowing students with the knowledge and technical skills.
- **M2:** To prepare the foundation for undertaking the research for systems involving emerging field of Computer Science & Engineering.
- **M3:** To produce motivated professional technocrat capable of generating solutions for industrial and other real-life problems.

- **M4:** To prepare dynamic entrepreneurs with ethical values that will be useful for the society.

Mapping of University Vision and Mission to Department Vision and Mission

Acclaimed as modal Centre of Learning and Research by

University Vision and Mission	Department Vision and Mission
High quality knowledge society creation for peace and prosperity of individuals, nation and the world, through and scholarly inquiry	**M1**
Promotion of innovation, creative endeavours, research and development	**M2,M3**
Students excellence through multi-disciplinary learning, value-based transparent work ethics, creative and critical thinking	**M3,M4**
Environment of excellence in teaching, research and innovation in pure and applied areas of learning	**M1, M2**

Programme Educational Objectives (PEOs):

The Department of Computer Science & Engineering in consultation with various stakeholders have formulated the Programme Educational Objectives (PEO's) that are broad statements that describe the career and professional accomplishments that the program is preparing its graduates to achieve in a few years, subsequent to receiving the degree. The PEO's of the M. Tech. programme in Computer Science and Engineering are as follows:

- **PEO1:** To impart knowledge and skills to analyze, design, test and implement a diverse range of software.
- **PEO2:** To develop teamwork capability so that they can work on multidisciplinary and innovative projects and exhibit a high level of professional and ethical values.
- **PEO3:** To employ their skills with a strong base to prepare them for higher learning and research activities.
- **PEO4:** To interact with their peers in industry and society as engineering professionals and leaders to set up technical ambience in the society.

Program Specific Outcomes (PSO's):

- **PSO-1:** Augmented knowledge of Computer Science and technologies
- **PSO-2:** Enhanced capability to develop computational tools and applications and improved skills to solve contemporary challenges
- **PSO-3:** Exhibit attitude for continuous learning and deliver proactive solutions for futuristic challenges
- **PSO-4:** Should be able to handle research problems and write dissertations.

PEOs to Mission statement mapping

PEO's	MISSION OF THE DEPARTMENT			
	M1	M2	M3	M4
PEO1	3	2	1	1
PEO2	3	2	3	1
PEO3	3	1	3	3
PEO4	2	3	1	1

Program Outcomes (POs)

PO1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Critically analyze existing literature in an area of specialization, conduct investigative research to develop innovative methodologies to tackle issues identified and contribute to the development of technological knowledge and intellectual property.

PO8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	To write and present a substantial technical report/document.
PO10	Contribute and communicate effectively in multidisciplinary and multicultural scenarios.
PO11	Critically evaluate the outcomes of one's actions and apply self corrective measures to improve the performance.
PO12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Mapping of PEO's with PO's

S. No.	***Program Educational Objectives***	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
1	To impart knowledge and skills to analyze, design, test and implement a diverse range of software.	√	√	√	√	√	√	√		√	√	√	√
2	To develop teamwork capability so that they can work on multidisciplinary and innovative projects and exhibit a high level of professional and ethical values.	√	√	√	√	√		√	√	√	√	√	√
3	To employ their skill with a strong base to prepare them for higher learning and research activities.	√	√	√	√	√		√	√	√			√
4	To interact with their peers in industry and society as engineering professionals and leaders to set up technical ambience in the society.	√	√	√	√	√		√	√	√	√		√

M. Tech. - Computer Science and Engineering

SCHEME OF EXAMINATIONS

(SEMESTER–I)

S. No.	Course Code	Course Title	Teaching Schedule			Credits
			L	T	P	
1	MT CS 101	Advanced Databases	3	1	0	4
2	MT CS 102	Advanced Computer Networks	3	1	0	4
3		PE-1	3	0	0	3
4		PE-2	3	0	0	3
5		Open Elective(GEC)	4	0	0	4
6	MT CS 103	Advanced Databases Lab	0	0	2	1
7	MT CS 104	Advanced Computer Networks Lab	0	0	2	1
8		PE Lab-1	0	0	2	1
9		PE Lab-2	0	0	2	1
10		Audit Course-1	2	0	0	0
Total						22

(SEMESTER–II)

S. No.	Course Code	Course Title	Teaching Schedule			Credits
			L	T	P	
1	MT CS 201	Machine Learning	3	1	0	4
2	MT CS 202	Advanced Algorithms	3	1	0	4
3		PE-3	3	0	0	3
4		PE-4	3	0	0	3
5	MT CS 203	Machine Learning Lab.	0	0	2	1
6	MT CS 204	Advanced Algorithms Lab.	0	0	2	1

7		PE Lab-3	0	0	2	1
8		PE Lab-4	0	0	2	1
9	MT CS 205	Research Seminar	0	4	0	4
10		Audit Course-2	2	0	0	0
Total						22

(SEMESTER–III)

S. No.	Course Code	Course Title	Teaching Schedule			Credits
			L	T	P	
1	MT CS 301	Research Methodology and IPR	3	0	0	3
2	MT CS 302	Pre-Dissertation	0	0	22*	22
3		PE-5	3	0	0	3
Total						28

(SEMESTER–IV)

S. No.	Course Code	Course Title	Teaching Schedule			Credits
			L	T	P	
1	MT CS 401	Dissertation	0	0	30*	30
Total						30

Note:

1. **The contents of all laboratories are based on the corresponding theoretical subjects only.**
2. *** These are part of Seminar/dissertation.**
3. **Student has to complete two audit courses (one each in 1st and 2nd semester).**

LIST OF PROGRAM ELECTIVES (PE)

S.No.	Subject Code	Subject Title	Credits
PE-1			
1	MT CS 105	Information Retrieval	3
2	MT CS 106	Logic & Computation	3
3	MT CS 107	Software Testing & Quality Management	3
PE-2			
4	MT CS 108	Big Data Analytics	3
5	MT CS 109	Distributed System	3
6	MT CS 110	Digital Image Processing	3
PE-3			
7	MT CS 206	Bioinformatics	3
8	MT CS 207	Cyber Security	3
9	MT CS 208	Natural Language Processing	3
PE-4			
10	MT CS 209	Cloud Computing	3
11	MT CS 210	Deep Learning	3
12	MT CS 211	Internet of Things	3
PE-5			
13	MT CS 303	Blockchain Technologies	3
14	MT CS 304	Software Project Management	3
15	MT CS 305	Remote Sensing	3
16	MT CS 306	Wireless and Mobile Networks	3

17	MT CS 307	Computer Vision	3
18	MT CS 308	Entrepreneurship	3

LIST OF PROGRAM ELECTIVES LAB (PE Lab)

S.No.	Subject Code	Subject Title	Credits
PE Lab-1			
1	MT CS 110	Information Retrieval Lab	3
2	MT CS 111	Logic & Computation Lab	3
3	MT CS 112	Software Testing & Quality Management Lab	3
PE Lab-2			
4	MT CS 113	Big Data Analytics Lab	3
5	MT CS 114	Distributed System Lab	3
6	MT CS 115	Digital Image Processing Lab	3
PE Lab-3			
7	MT CS 212	Bioinformatics Lab	3
8	MT CS 213	Cyber Security Lab	3
9	MT CS 214	Natural Language Processing Lab	3
PE Lab-4			
10	MT CS 215	Cloud Computing Lab	3
11	MT CS 216	Deep Learning Lab	3
12	MT CS 217	Internet of Things Lab	3

LIST OF AUDIT COURSE 1 & 2

S. No.	Subject Code	Subject Title	Credits

1	MT AU 101	English for Research Paper Writing	0
2	MT AU 102	Disaster Management	0
3	MT AU 103	Sanskrit for Technical Knowledge	0
4	MT AU 104	Value Education	0
5	MT AU 105	Constitution of India	0
6	MT AU 106	Pedagogy Studies	0
7	MT AU 107	Stress Management by Yoga	0
8	MT AU 108	Personality Development through Life Enlightenment Skills	0

Program Name: M. Tech.-Computer Science and Engineering

Course Code: MT CS 101	**Course Name: Advanced Databases**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Year and Semester	**1st year** **1st Semester**	**Contact hours per week:** (4 Hrs.) **Exam:** (3hrs.)
Prerequisite of course	Database Management Systems	**Evaluation**
		CIE: 30 / **TEE: 70**

Course Objectives:

1. To provide good understanding of emerging database technologies
2. To design databases in a variety of technologies like xml, object oriented etc.
3. To provide in depth information about system implementation techniques and database system architecture.

Course Outcomes: On completion of the course, students would be able to:

CO101.1	Describe different database concepts and issues related to Transaction and Concurrency control in databases.
CO101.2	Identify object-oriented, relational, parallel and distributed databases and database technologies like xml.
CO101.3	Apply various backup and recovery techniques in a database.
CO101.4	Familiarize yourself with concepts of data mining and knowledge discovery.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Introduction:** Database System Concepts and Architecture, Data Independence, Data Models, SQL: DDL, DML, DCL, Database Integrity, Normalization: 1NF, 2NF, 3NF, BCNF, 4NF, 5NF. **Advanced Transaction Processing and Concurrency Control:** Transaction Concepts, Concurrency Control: Locking Methods, Timestamping Methods, Optimistic Methods for Concurrency Control, Concurrency Control in Distributed Systems.	**10**	**CO101.1**
2	**Object Oriented and Object Relational Databases:** Object Oriented Concepts with respect to Database Systems, Object Oriented Data Model, OODB, OODBMS, ODMG, ODL, OQL, ORDBMS, ORDBMS Design, ORDBMS Query Language. **Parallel and Distributed Databases:**	**12**	**CO101.1, CO101.2**

	Parallel Databases, Distributed Databases, Differences between them, Architecture of Distributed Databases, Architecture of Parallel Databases, Key elements of Parallel Database Processing, Fragmentation, Replication and Allocation for distributed databases, Intra-query parallelism, Inter-query parallelism, Intra-operation parallelism, Inter-operation parallelism.		
3	**Backup and Recovery Techniques:** Backup and Recovery Concepts, Types of Database Failures, Types of Database Recovery, Recovery Techniques: Deferred Update, Immediate Update, Shadow Paging, Checkpoints, Buffer Management, Recovery Control in Distributed Systems. **XML and Internet Databases:** Structured, Semi Structured, and Unstructured Data, XML Hierarchical Data Model, XML Documents, DTD, XML Schema, XML Querying: XPath, XQuery.	**12**	**CO101.3**
4	**Emerging Database Technologies:** Introduction to Deductive Database Systems, Temporal Databases, Multimedia Databases, Mobile Databases, Main Memory Databases, Spatial and Multidimensional Databases. **Data Warehousing and Mining:** Introduction to OLAP, OLTP and differences between them, Data Warehouse, Data Warehouse Architecture, Data Marts, Data Mining, Data Mining Process, Knowledge Discovery.	**11**	**CO101.4**

Reference Books:

1. Date, C.J., 1975. An introduction to database systems. Pearson Education India.
2. Ramakrishnan, R., Gehrke, J. and Gehrke, J., 2003. Database management systems (Vol. 3). New York: McGraw-Hill.
3. Ramez, E., 2007. Fundamentals of Database Systems: For VTU. Pearson Education India.
4. Silberschatz, A., Korth, H.F. and Sudarshan, S., 1997. Database system concepts (Vol. 4). New York: McGraw-Hill.
5. Singh, S.K., 2009. Database systems: Concepts, design and applications. Pearson Education India.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO101.1	2		1		2			1				

CO101.2	3		2	1	3			1				
CO101.3	3		2	1	3			1				
CO101.4	2		2	1	3			1				

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO101.1	2	2	2	1
CO101.2	3	2	2	1
CO101.3	3	2	2	1
CO101.4	2	2	2	1

<table>
<tr><td rowspan="2">Course Code:
MT CS 102</td><td colspan="2" rowspan="2">Course Name: Advanced Computer Networks</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Year and Semester</td><td>1st year
1st Semester</td><td colspan="4">Contact hours per week: (4 Hrs.)
Exam: (3 Hrs.)</td></tr>
<tr><td rowspan="2">Prerequisite of course</td><td rowspan="2">Basics of Computer Networks</td><td colspan="4">Evaluation</td></tr>
<tr><td colspan="2">CIE: 30</td><td colspan="2">TEE: 70</td></tr>
<tr><td colspan="6">Course Objectives:
1. To introduce students about layered architecture of functions performed by each layer of the TCP/IP protocol suite which runs the Internet.
2. To introduce students about the MAC protocols used in various LANs, MANs, WANs
3. To make students understand how mobility is supported at the Network Layer.
4. To make students understand how the UDP and TCP transport the data.
5. To introduce students to different network security protocols used in modern networks</td></tr>
<tr><td colspan="6">Course Outcomes: On completion of the course, student would be able to:</td></tr>
<tr><td>CO102.1</td><td colspan="5">Understand the role and functions of physical layer of the TCP/IP protocol</td></tr>
<tr><td>CO102.2</td><td colspan="5">Understand the design issues and challenges arises at each of the layers below the application layer</td></tr>
<tr><td>CO102.3</td><td colspan="5">Understand the requirement of IPv6 Protocol over IPv4</td></tr>
</table>

CO102.4	Understand the basic requirement of network security

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	Introduction: Overview of computer networks, seven-layer architecture, TCP/IP suite of protocols. Review of Physical layer: Analog Signal, Digital Signal, Periodic Analog Signal: peak amplitude, period and frequency, phase, wavelength, time and frequency domain, composite signal, bandwidth, Digital Signal: Transmission of Digital Signals, bit rate, baseband transmission, Broadband transmission, Transmission impairment, Line Coding Schemes: characteristics, unipolar, bipolar, polar, Multilevel, and Multi transition.	**12**	**CO102.1**
2	Application layer HTTP, HTTP with Non-persistent and persistent connection, HTTP message format, WWW, DNS, SMTP, SNMP. Transport layer Design issues, functions, Transmission Control Protocol (TCP), Connectionless transport: User Datagram Protocol (UDP), UDP segment structure, UDP checksum, Principle of reliable data transfer, Principles of Congestion Control, .	**11**	**CO102.2**
3	Network layer: IPv4: header format, IPv4 address, classful address, classless addressing, subnet IPv6: Why IPv6, New in IPv6, IPv6 addressing, Unicast, Anycast, Multicast, Header format, transition from IPv4 to IPv6, basic protocol, extensions and options, support for QoS, security, neighbour discovery, auto-configuration, Routing Protocols- RIP, OSPF, BGP, IP over ATM.	**12**	**CO102.3**
4	MAC protocols for high-speed LANS, MANs, and wireless LANs: Aloha, CSMA, CSMA/CD, CSMA/CA, Reservation, polling, token passing Network security: Network security at various layers. Secure-HTTP, SSL, ESP, Authentication header, Key distribution protocols. Digital signatures, digital certificates.	**10**	**CO102.4**

Reference Books:

1. Forouzan Behrouz, A., Data Communication and Networking, 4th Edition, Tata McGraw Hill, 2017.
2. Keshav, S., An Engineering Approach to Computer Network, Pearson Education, 2002.

3. Kurose, J. and Ross, K.,, Computer Networking – A Top-Down Approach Featuring the Internet, 7th Edition, Pearson Education, 2016.
4. Stallings, W., Data and Computer Communications, 10th edition, Pearson Education, 2013
5. Tanenbaum, A.S., Computer Networks, 5th Edition, Pearson Education, 2013
6. Chappell, L., 1998. Introduction to Cisco router configuration. Cisco Systems.
7. Stallings, W., 1998. SNMP, SNMPv2, SNMPv3, and RMON 1 and 2. Addison-Wesley Longman Publishing Co., Inc..
8. Stallings, W., 2007. Data and computer communications. Pearson Education India.
9. Tanenbaum, A.S., 2013, Computer Networks, 3rd Ed., PHI.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO102. 1	2	2	1		2			1				
CO102. 2	2	2	1	1	2			1				
CO102. 3	2	2	1	1	2			1				
CO102. 4	2	2	1	1	2			1				

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO102.1	3	1	1	1
CO102.2	3	1	2	1
CO102.3	3	1	2	1
CO102.4	3	1	2	1

Course Code: MT CS 201	**Course Name: Machine Learning**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Year and Semester	**1st year** **2nd Semester**	**Contact hours per week:** (4 Hrs.) **Exam:** (3hrs.)	
Prerequisite of course	Nil	**Evaluation**	
		CIE: 30	**TEE: 70**

Course Objectives:

1. To design and implement machine learning solutions to classification, regression, and clustering problems
2. To evaluate and interpret the results of the algorithms.

Course Outcomes: On completion of the course, student would be able to:

CO201.1	Gain knowledge about basic concepts of Machine Learning and Identify machine learning techniques suitable for a given problem
CO201.2	understand a wide variety of learning algorithm and how to evaluate models generated from data
CO201.3	Apply the algorithm to real problems, optimize the models learned.
CO201.4	Apply Dimensionality reduction techniques.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	Introduction and Basic Concepts: Definition of ML, Taxonomy of ML, Supervised Learning, Housing Price Prediction, Regression Vs Classification, Unsupervised Learning, Clustering, Clustering Genes, Latent Semantic Analysis (LSA), Reinforcement Learning. Supervised Learning, Linear Regression, Classification and Logistic Regression, Generalized Linear Models (GLM), Constructing GLM, Discriminative Algorithms, Dataset Loading and Visualization, Gradient Descent Visualization.	**10**	**CO201.1**
2	Weighted Least Squares, Netwon's Method, Perceptron, Maximum Entropy and Exponential Families, Generative Learning algorithms, Gaussian discriminant analysis, Naive Bayes, Laplace Smoothing, Kernel Methods, Support Vector Machines. Learning End-Sem: Bias-Variance and Error Analysis, Bias/variance tradeoff, Error Analysis, Normal Equations, Variance, Gradient Descent.	**11**	**CO201.2** **CO201.3**

3	k-means clustering algorithm, Mixtures of Gaussians, Expectation Maximization algorithm, Variational inference and Variational Autoencoders, Principal Component Analysis. Independent Component Analysis. Markov Decision Process (MDP): Bellman Equations, Value iteration and policy iteration, Value function approximation.	**12**	**CO201.2 CO201.3 CO201.4**
4	Deep Learning: Neural Networks, Vectorization, Backpropagation, Forward propagation Regularization and model selection: Cross validation, Feature Selection, Bayesian statistics and regularization, Reinforcement Learning and Control: Markov decision processes, Learning a model for an MDP, Continuous state MDPs.	**12**	**CO201.2 CO201.3**

Reference Books:

1. Kubat, M., 2017. An introduction to machine learning. Springer, Cham.
2. Murphy, K.P., 2012. Machine learning: a probabilistic perspective. MIT press.
3. Shalev-Shwartz, S. and Ben-David, S., 2014. Understanding machine learning: From theory to algorithms. Cambridge university press.
4. Svensén, M. and Bishop, C.M., 2007. Pattern recognition and machine learning.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO201. 1	2											
CO201. 2	2											
CO201. 3	3	2	2		2			1				1
CO201. 4	3	2			2			1				1

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO201.1	2	1	1	1
CO201.2	2	1	1	1

CO201.3	3	2	2	1
CO201.4	3	2	2	1

Course Code: MT CS 202	**Course Name: Advanced Algorithms**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**
Year and Semester	**1st year** **2nd Semester**	**Contact hours per week:** (4 Hrs.) **Exam:** (3hrs.)			
Prerequisite of course	Data Structure & Algorithms	**Evaluation**			
		CIE: 30	**TEE: 70**		

Course Objectives:

1. To learn the performance analysis of algorithms.
2. To be familiar with runtimes of algorithms.
3. To be exposed to problem solving via different approaches .
4. To understand NP completeness and satisfiability.
5. To learn Graph and Matrix solving approaches.

Course Outcomes: On completion of the course, student would be able to:

CO202.1	Analyze the complexity/performance of different algorithms
CO202.2	Categorize the different problems in various classes according to their complexity
CO202.3	Design a solution for applying all the relevant standards and with realistic constraints.
CO202.4	Understand different classes of problems concerning their computation difficulties.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Basics Design and Analysis Techniques with comparisons: of Divide-and-Conquer, Dynamic Programming and Greedy Algorithms, Comparison of dynamic programming and Greedy algorithm with Knapsack as case study. Theoretical foundation of greedy algorithms, Matroids and Greedy methods.	**10**	**CO202.1 CO202.2**

2	Review of Graph Theory, Internal Representations, Traversal algorithms, Tree, Spanning tree generation. Maximum Flow: Flow networks, The ford-fulkerson method, Computational Geometry: Line segments properties, determining whether any pair of segment intersects, Finding a convex hull, finding the closest pair of points	**13**	**CO202.1**
3	Matrix Operations: Solving system of linear equation, Inverting Matrices, Symmetric positive-definite matrices and least square approximation. Representation of polynomials, The DFT and FFT, efficient FFT implementation ,Elementary number-theoretic notion, Greatest common divisor, modular arithmetic, solving modular linear equation, Chinese remainder theorem.	**12**	**CO202.1 CO202.3**
4	NP-Completeness, Polynomial time, Polynomial time verification, NP completeness and reducibility. Few examples NP complete problems. Approximation Algorithms- the vertex-cover problem, The Traveling-Salesman Problem, The set covering problem, Randomization and linear programming, Subset-sum problem.	**10**	**CO202.1 CO202.3 CO202.4**

Reference Books:

1. Cormen, T.H., Leiserson, C.E., Rivest, R.L. and Stein, C., 2009. Introduction to algorithms. MIT press.
2. Kleinberg, J. and Tardos, E., 2006. Algorithm design. Pearson Education India.
3. Levitin, A., 2011. Introduction To Design And Analysis Of Algorithms. Pearson Education India.
4. Skiena, S.S., 2012. Sorting and searching. In The Algorithm Design Manual (pp. 103-144). Springer, London.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO202. 1	2	3										
CO202. 2	3	1										
CO202. 3	3	2	3		2							1
CO202. 4	2											1

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO202.1	2			1
CO202.2	2			1
CO202.3	3	2	2	1
CO202.4	2		1	1

Course Code: MT CS 301	**Course Name: Research Methodology and IPR**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Year and Semester	**2nd year** **3rd Semester**	**Contact hours per week:** (3 Hrs.) **Exam:** (3hrs.)			
Prerequisite of course	Nil	**Evaluation**			
		CIE: 30	**TEE: 70**		

Course Objectives: This course is to familiarize participants with basic of research and the research process. This introduces the student to the basics of Intellectual Property Rights, Copy Right Laws Trade Marks and Issues related to Patents. The overall idea of the course is to help and encourage the student for startups and innovations.

Course Outcomes: On completion of the course, student would be able to:

CO301.1	Formulate a research problem for a given engineering domain.
CO301.2	Analyze the available literature for a given research problem.
CO301.3	Develop technical writing and presentation skills.
CO301.4	Comprehend concepts related to patents, trademark and copyright.
CO301.5	Analyze ethical and professional issues which arise in the intellectual property law context

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research	**10**	**CO301.1 CO301.2**

	problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations		
2	Effective literature studies approaches, analysis, Plagiarism, Research ethics Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee	**13**	**CO301.2** **CO301.3**
3	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	**12**	**CO301.4**
4	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs. related to patent filing, case studies- IPR of Hardware, computer software.	**10**	**CO301.5**

Reference Books:

1. Goddard, W. and Melville, S., 2004. Research methodology: An introduction. Juta and Company Ltd.
2. GONZÁLEZ, J.J.C., 1999. Ranjit Kumar. Research methodology: a step-by-step guide for beginners. Investigación Bibliotecológica: archivonomía, bibliotecología e información, 13(27).
3. Halbert, D.J., 2006. Resisting intellectual property. Routledge.
4. Ramappa, T., 2000. Intellectual Property Rights Under WTO: Tasks Before India. Wheeler Publ.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO301. 1	1	2						3				
CO301. 2	2	2	1					3		2		2

CO301.3	1	1			2			3		2		2
CO301.4	1	1			2			3		2		2
CO301.5	2	2	1					3		2		2

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO301.1	2		1	1
CO301.2	2		1	1
CO301.3	2		1	1
CO301.4	1		1	1
CO301.5	1		1	1

Syllabus of Electives Subjects

Course Code: MT CS 105	Course Name: Information Retrieval	L	T	P	C
		3	0	0	3

Year and Semester	1st year 1st Semester	Contact hours per week: (3 Hrs.) Exam: (3hrs.)
Prerequisite of course	Nil	Evaluation
		CIE: 30 / TEE: 70

Course Objectives:

1. To learn the information retrieval models.
2. To be familiar with Web Search Engine.
3. To be exposed to Link Analysis.
4. To understand Hadoop and Map Reduce.
5. To learn document text mining techniques.

Course Outcomes: On completion of the course, student would be able to:

CO105.1	Identify the different issues in informal retrieval and web searching.
CO105.2	Analyse and understand various applications of web search in the real world.
CO105.3	Use the various techniques for text mining and analyse their performance.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	Introduction: Introduction- History of IR, Components of IR, Issues, Open source Search Engine Frameworks, the impact of the web on IR, The role of artificial intelligence (AI) in IR, IR Versus Web Search, Components of a Search engine, Characterizing the web.	**10**	**CO105.1**
2	Information Retrieval: Boolean and vector-space retrieval models, Term weighting, TF-IDF weighting, cosine similarity, Preprocessing, Inverted indices, efficient processing with sparse vectors, Language Model based IR, Probabilistic IR, Latent Semantic Indexing, Relevance feedback and query expansion.	**10**	**CO105.1**
3	Web Search Engine – Introduction and Crawling: Web search overview, web structure, the user, paid placement, search engine optimization/ spam. Web size measurement, search	**12**	**CO105.2**

	engine optimization/spam, Web Search Architectures, crawling, meta-crawlers, Focused Crawling, web indexes, Near-duplicate detection, Index Compression, XML retrieval. Web Search – Link Analysis and Specialized Search: Link Analysis –hubs and authorities – Page Rank and HITS algorithms -Searching and Ranking – Relevance Scoring and ranking for Web – Similarity.		
4	Hadoop & Map Reduce – Evaluation – Personalized search – Collaborative filtering and content-based recommendation of documents and products – handling "invisible" Web – Snippet generation, Summarization, Question Answering, Cross-Lingual Retrieval. Document Text Mining: Information filtering; organization and relevance feedback, Text Mining, Text classification and clustering. Categorization algorithms: naive Bayes; decision trees; and nearest neighbor – Clustering algorithms: agglomerative clustering; k-means; expectation maximization (EM).	**13**	**CO105.3**

Reference Books:

1. Baeza-Yates, R. and Ribeiro-Neto, B., 1999. Modern information retrieval (Vol. 463). New York: ACM press.
2. Croft, W.B., Metzler, D. and Strohman, T., 2010. Search engines: Information retrieval in practice (Vol. 520, pp. 131-141). Reading: Addison-Wesley.
3. Levene, M., 2011. An introduction to search engines and web navigation. John Wiley & Sons.
4. Schütze, H., Manning, C.D. and Raghavan, P., 2008. Introduction to information retrieval (Vol. 39, pp. 234-265). Cambridge: Cambridge University Press.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO105. 1	3											1
CO105. 2	3	2		1	2			1				1
CO105. 3	3		2		2			1				1

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO105.1	3		1	1
CO105.2	3	2	2	1
CO105.3	3	1	2	1

Course Code: MT CS 106	**Course Name: Logic & Computation**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Year and Semester	**1st year** **1st Semester**	**Contact hours per week:** (3 Hrs.) **Exam:** (3hrs.)			
Prerequisite of course	Discrete Structure	**Evaluation**			
		CIE: 30	**TEE: 70**		

Course Objectives:

1. To learn proof theory and compactness
2. To be familiar with decision problems, SAT and BDDs.
3. To be exposed to reactive systems and temporal logics.
4. To understand probabilistic verification & analysis.
5. To learn Simulation and bisimulation

Course Outcomes: On completion of the course, student would be able to:

CO106.1	Understand the basics of logical computation
CO106.2	Classify the problems into various categories.
CO106.3	Analyse the algorithms based on BDD and SAT models
CO106.4	Do basic simulations and make interpretations of logical writing.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Syntax, semantics & model theory for FOL, Proof theory & its soundness, Completeness of FOL, Compactness, Lowenheim-Skolem, & related theorems, FOL as the foundations of mathematics, Undecidability of FOL & arithmetic, The decision problem	**11**	**CO106.1**
2	SAT algorithm & efficiently decidable cases, including 2SAT & HORNSAT, BDDs (Boolean Decision Diagrams), Linear	**11**	**CO106.2 CO106.3**

	arithmetic, Uninterpreted functions & equality, Combining decision procedures		
3	Reactive systems, Temporal calculi, mu-calculus, fixpoints, Temporal logics (CTL*, LTL, CTL), Explicit model checking: algorithms, probabilistic verification & analysis, Symbolic model checking: algorithms based on BDDs & SAT, Bounded model checking	**12**	**CO106.3**
4	Simulation & bisimulation, Stuttering, refinement maps, theories of refinement, Homomorphisms & conservative abstractions, Abstract interpretation	**11**	**CO106.4**

Reference Books:

1. Baader, F. and Nipkow, T., 1998. Term Rewriting and All That, Cambridge Univ. Press, Cambridge XII.
2. Ebbinghaus, H.D., Flum, J., Thomas, W. and Ferebee, A.S., 1994. Mathematical logic (Vol. 1910). New York: Springer.
3. Kaufmann, M., Manolios, P. and Moore, J.S. eds., 2013. Computer-aided reasoning: ACL2 case studies (Vol. 4). Springer Science & Business Media.
4. Robinson, A.J. and Voronkov, A. eds., 2001. Handbook of automated reasoning (Vol. 1). Elsevier.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO106. 1	2											
CO106. 2	2											
CO106. 3	2	2	2		2							1
CO106. 4	2				2							1

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO106.1	2			1
CO106.2	2			1

CO106.3	2	1		1
CO106.4	2		2	1

Course Code: MT CS 107	**Course Name: Software Testing & Quality Management**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Year and Semester	**1st year** **1st Semester**	**Contact hours per week:** (3 Hrs.) **Exam:** (3hrs.)			
Prerequisite of course	Software Engineering	**Evaluation**			
		CIE: 30	**TEE: 70**		

Course Objectives:

1. To understand various methods and techniques of software testing and quality management concepts
2. To develop error free and quality software.

Course Outcomes: On completion of the course, student would be able to:

CO107.1	Understand software testing and quality assurance as a fundamental component of software life cycle
CO107.2	Define the scope of SW T&QA projects
CO107.3	Prepare test plans and schedules for a T&QA project
CO107.4	Efficiently perform T&QA activities using modern software tools

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Introduction:** Software Engineering, Software Process Models, Management Process, Scheduling, Estimation, Software Metrics. **Software Quality:** Quality Concepts, Quality Control, Quality Assurance, Cost of Quality, SQA Activities, Total Quality Management Principles, Software Reviews, Formal Technical Reviews, Software Reliability, Software Safety, ISO Approaches to Quality Assurance Systems.	**11**	**CO107.1**
2	**Standards, Practices, Conventions and Metrics:**	**12**	**CO107.1 CO107.2**

	Quality Assurance Standards, ISO 9000, ISO 9001:2000, ISO 9126 Quality Factors, CMM, Six Sigma, Software Quality Assurance Metrics, Advantages, QA Techniques, Introduction to SPICE. **Risk and Software Configuration Management:** Software Risks, The RMMM Plan, Software Configuration Management Process: Version Control, Change Control.		
3	**Software Testing:** Testing, Test Strategies for Conventional and Object Oriented Software, Unit and Integration Testing, Validation Testing, System Testing, Metrics for Source Code, Metrics for Testing, Debugging. **Testing Techniques for Conventional and Object Oriented Software:** Black Box and White Box Testing, Basis Path Testing, Control Structure Testing, Object Oriented Testing Methods: Applicability of Conventional Test Case Design Methods, Testing Methods Applicable at the Class Level.	**11**	**CO107.3**
4	**Testing Process:** Test Plan development, Requirement Phase Testing, Design Phase Testing, Program Phase Testing, Execute Test and Record Results. **Testing Specialized Systems and Applications:** Testing Client/Server Systems, Testing Web based Systems, Testing in Multiplatform Environment, Testing Off-the-Shelf Software, Testing for Real Time Systems, Testing Security.	**11**	**CO107.4**

Reference Books:

1. Beizer, B., 2003. Software testing techniques. Dreamtech Press.
2. Godbole, N.S., 2004. Software quality assurance: Principles and practice. Alpha Science Int'l Ltd.
3. Pfleeger, S.L. and Atlee, J.M., 1998. Software engineering: theory and practice. Pearson Education India.
4. Pressman, R.S., 2005. Software engineering: a practitioner's approach. Palgrave macmillan.
5. Sommerville, I., Software Engineering: For VTU, 8/e. Pearson Education India.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO107. 1	2							2				

CO107.2	2	2										
CO107.3	2		2									2
CO107.4	2	2	2		2							2

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO107.1	2			1
CO107.2	2			1
CO107.3	2		1	1
CO107.4	2	2	2	1

Course Code: MT CS 108	**Course Name: Big Data Analytics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Year and Semester	**1st year** **1st Semester**	**Contact hours per week:** (3 Hrs.) **Exam:** (3hrs.)			
Prerequisite of course	DBMS	**Evaluation**			
		CIE: 30	**TEE: 70**		

Course Objectives:

1. To optimize business decisions and create competitive advantage with Big Data analytics
2. To explore the fundamental concepts of big data analytics.
3. To learn to analyze big data using intelligent techniques.
4. To understand the various search methods and visualization techniques.
5. To learn to use various techniques for mining data streams.
6. To understand the applications using Map Reduce Concepts.
7. To introduce programming tools PIG & HIVE in the Hadoop ecosystem.

Course Outcomes: On completion of the course, student would be able to:

CO108.1	Analyze big data challenges in different domains including social media, transportation, finance and medicine
CO108.2	Learn to use various techniques for mining data streams.

CO108.3	Understand the use of Hadoop and Map Reduce
CO108.4	Understand programming tools PIG & HIVE in the Hadoop ecosystem.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	Introduction to big data : Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis vs Reporting.	**10**	**CO108.1**
2	Mining data streams : Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis- Stock Market Predictions.	**12**	**CO108.2**
3	Hadoop: History of Hadoop- the Hadoop Distributed File System – Components of Hadoop Analysing the Data with Hadoop- Scaling Out- Hadoop Streaming- Design of HDFS-Java interfaces to HDFS Basics- Developing a Map Reduce Application-How Map Reduce Works-Anatomy of a Map Reduce Job run-Failures-Job Scheduling-Shuffle and Sort – Task execution - Map Reduce Types and Formats- Map Reduce Features- Hadoop environment	**12**	**CO108.3**
4	Frameworks: Applications on Big Data Using Pig and Hive – Data processing operators in Pig – Hive services – HiveQL – Querying Data in Hive - fundamentals of HBase and ZooKeeper - IBM InfoSphere BigInsights and Streams.	**11**	**CO108.4**

Reference Books:

1. Berthold, M. and Hand, D.J., 2003. Intelligent data analysis (Vol. 2). Berlin: Springer.
2. Franks, B., 2012. Taming the big data tidal wave: Finding opportunities in huge data streams with advanced analytics (Vol. 49). John Wiley & Sons.
3. Han, J., Pei, J. and Kamber, M., 2011. Data mining: concepts and techniques. Elsevier.
4. Myatt, G.J., 2007. Making sense of data: a practical guide to exploratory data analysis and data mining. John Wiley & Sons.
5. Rajaraman, A. and Ullman, J.D., 2011. Mining of massive datasets. Cambridge University Press.
6. Warden, P., 2011. Big data glossary. O'Reilly Media, Inc..

7. White, T., 2012. Hadoop: The definitive guide. " O'Reilly Media, Inc.".
8. Zikopoulos, P. and Eaton, C., 2011. Understanding big data: Analytics for enterprise class hadoop and streaming data. McGraw-Hill Osborne Media.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO108.1	3	2										
CO108.2	2											
CO108.3	2	1			2							1
CO108.4	2	1			2							1

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO108.1	2			1
CO108.2	2	2	2	1
CO108.3	2	1	1	1
CO108.4	2	1	1	1

Course Code: MT CS 109	**Course Name: Distributed System**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Year and Semester	**1st year** **1st Semester**	**Contact hours per week:** (3 Hrs.) **Exam:** (3hrs.)			
Prerequisite of course	Computer Network	**Evaluation**			
		CIE: 30	**TEE: 70**		

Course Objectives:

1. To learn and analyze how a set of connected computers can form a functional, usable and high-performance distributed system.
2. To learn the principles, architectures, algorithms and programming models used in distributed systems.
3. To examine state-of-the-art distributed File systems.
4. To design and implement sample distributed systems.

Course Outcomes: On completion of the course, student would be able to:

CO109.1	Learn the basic concept and functions of high-performance distributed systems.
CO109.2	Analyze algorithms for synchronization in distributed systems
CO109.3	Analyze the importance of deadlock in the context of distributed system
CO109.4	Understand the use of Distributed File System and Transaction

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Fundamentals of Distributed Systems: Introduction, Definition, Evolution of Distributed Computing System, Benefits and Needs- Parallel and Distributed Systems Hardware concepts, Design Issue and challenges, example applications of distributed Systems. Remote Procedure Calls: Introduction, Problems with Socket, The RPC Model, Implementing RPC mechanism, RPC issues, Transparency of RPC, parameter-passing and call semantic, Communication protocols for RPC's, CORBA, RMI and etc.	**11**	**CO109.1**
2	Clock Synchronization: Clock Synchronization, absence of global clock, Logical clocks, Lamport's & vectors logical clocks, Causal ordering of messages, Physical Clock Synchronization. Distributed Mutual Exclusion: Classification of distributed mutual exclusion, Token based and non-token-based algorithms, performance metric for distributed mutual exclusion algorithms.	**12**	**CO109.2**
3	Distributed Deadlock Detection: system model, deadlock prevention, avoidance, detection & resolution, distributed deadlock detection algorithm Distributed Shared Memory: Introduction, Architecture of DSM Systems Design and implementation, granularly, structure of shared memory space Consistency models, replacement strategy, Thrashing.	**11**	**CO109.3**
4	Distributed File Systems: Distributed File System Design, The File Service Interface, True file service, Directory service, Structured File, Semantics of File Sharing, File Caching Scheme, Trends in Distributed File Systems. Distributed Transaction: Flat and nested distributed transactions, Distributed Transaction Model, Atomic Commit protocols, Two Phase Commit Protocol. Case Studies of different distributed system-based application	**11**	**CO109.4**

Reference Books:

1. Coulouris, G.F., Dollimore, J. and Kindberg, T., 2009. Distributed systems: concepts and design. Pearson education.
2. Ghosh, S., 2006. Distributed systems: an algorithmic approach. Chapman and Hall/CRC.
3. Kshemkalyani, A.D. and Singhal, M., 2011. Distributed computing: principles, algorithms, and systems. Cambridge University Press.
4. Sinha, P.K., 1998. Distributed operating systems: concepts and design. PHI Learning Pvt. Ltd..
5. Tanenbaum, A. S. and Steen, M. V., 2007, Distributed Systems - Principles and Paradigms, 2nd Edition, PHI.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO109.1	2											
CO109.2	2	2	1									2
CO109.3	2	2										2
CO109.4	2											2

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO109.1	2			
CO109.2	2	1	2	1
CO109.3	2	1	2	1
CO109.4	2			

Course Code: MT CS 110	Course Name: Digital Image Processing	L	T	P	C
		3	0	-	3

Year and Semester	1st year 1st Semester	Contact hours per week: (3 Hrs.) Exam: (3hrs.)
Pre-requisite of course	Nil	Evaluation
		CIE: 30 / TEE: 70

Course Objectives:

1. To introduce the basic principles of digital images,
2. To understand the image data structures,
3. To study the image processing algorithms.

Course Outcomes: On completion of the course, student would be able to:

CO110.1	Understand the fundamental concepts of a digital image processing system
CO110.2	Analyze images in the frequency domain using various transform
CO110.3	Evaluate the techniques for image enhancement and image restoration
CO110.4	Interpret image compression standards
CO110.5	Categorize various compression techniques

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Introduction** Image Processing Fourier Transform and Z-Transform, Causality and stability, Toeplit and Circulate Matrics, orthogonal and unitary Matrices and Kroenker product, Markov Processes, KI Transform, Mean square Estimates and Orthogonal Principles Image sampling & Quantization: Band Limited Image, Sampling Versus Replication, Reconstruction of Image from samples Sampling Theorem, Sampling Theorem for Random Fields, Optimal Sampling, Non-rectangular Grid Sampling, Sampling Aperture, Display Aperture/ Interpolation Functions, Lagrange Interpolation, Moire Effect Image Quantization: Uniform Optimal Quantizer, Properties of Mean Square Quantizer, Compandor Design, Visual Quantization	**14**	**CO110.1, CO110.2**
2	**Image Transforms**	**13**	**CO110.2**

	Two Dimensional Orthogonal and Unitary Transforms and their properties, One Dimensional and Two Dimensional DFT, Cosine, Sine, Hadamard, SLANT, HAAR and KI Transforms and their properties, Approximation to KI Transforms. Image representation by stochastic models: One Dimensional Causal Models, AR, ARMA models, Spectral factorization, Non Causal Representation, Image Decomposition.		
3	**Image Enhancement and Restoration** Point Operation, Histogram Modeling, Spatial Operations, Transform Operations, Multispectral Image Enhancement. Image Filtering: Image Observation Models, Inverse and Wiener filter, FIR Wiener Filters, Filtering using Image Transform, Causal Models and recursive filtering, Maximum entropy restoration, Extrapolation of band limited signal.	**10**	**CO110.3**
4	**Image Analysis and Image Compression** Spatial feature extraction, Edge detection, Boundary extraction, Boundary representations, Region representations, Moment representations, Structures, Texture, Image Segmentation, Image Classification Image Reconstruction from Projections: Data Compression: Pixel Coding, Predictive Techniques, Transform Coding Theory, Transform coding of Image, Coding of two-tone image.	**8**	**CO110.4, CO110.5**

Text Books:

1. Dougherty, E. R. (2020). *Digital image processing methods*. CRC Press.
2. Gonzalez, R.C., and Woods, R. E., 2009. *Digital Image Processing*. Pearson 3rd Edition, Cham.
3. Jain, A.K., 1989. *Fundamentals of Digital Image Processing*. Prentice-Hall, Inc.
4. Pratt, W.K., 2007. *Digital Image Processing.* John Wiley & Sons Inc., New York.
5. Shih, F. Y. (2017). *Image processing and mathematical morphology: fundamentals and applications*. CRC press.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO110. 1	3		2	2	2	1	1			1		3
CO110. 2	3		2	1	2		1	1			1	1

CO110.3	2	2	2	3	1				1	1	1	2
CO110.4	2	2	2	1						1	1	1
CO110.5	3	2	2	3	1	2	1			1	1	2

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO110.1	2	2	2	1
CO110.2	2	2	1	1
CO110.3	1	2	2	1
CO110.4	2	2	2	1
CO110.5	2	2	1	1

Course Code: MT CS 206	Course Name: Bioinformatics	L	T	P	C
		3	0	0	3

Year and Semester	1st year 2nd Semester	Contact hours per week: (3 Hrs.) Exam: (3hrs.)
Prerequisite of course	Nil	Evaluation
		CIE: 30 / TEE: 70

Course Objectives:

1. To provide students with the basics of bioinformatics algorithms that have been applied over various types of biological data.
2. To provide hands on training on various computational tools and techniques employed in Biological sequence analysis
3. To bring exposure to multiple sequence alignment and protein functional annotation

Course Outcomes: On completion of the course, student would be able to:

CO206.1	Describe about the different types of Biological databases
CO206.2	Describe about pairwise sequence alignment , algorithms and tools for pairwise alignment
CO206.3	Describe about protein folding and its significance
CO206.4	Apply algorithms and analysis methods to the real-world problems

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Introduction to Bioinformatics:** What is a Database, Types of Databases, Biological Databases, Pitfalls of Biological Databases, Information Retrieval from Biological Databases. Introduction to Bioinformatics Tools: BLAST, FASTA, RasMol.	**11**	**CO206.1**
2	**Sequences:** Problem statement, Edit distance and substitution matrices, HMMs and pairwise HMMs, Global and local alignments, Spliced alignment, Space-efficient sequence alignment, Multiple alignment, Database searching tools, Sequence by hybridization, Profile HMMs.	**12**	**CO206.2**

3	**Structures:** Protein structure alignment, Protein Structure Prediction: Methods for predicting the secondary and tertiary structure of proteins. Techniques: neural networks, SVMs, genetic algorithms and stochastic global optimization.	**10**	**CO206.3**
4	**Transcriptomics:** Methods for analysing gene expression and microarray data. Techniques: clustering, SVMs. Agent-based Genome Analysis: Automation of genome analysis using intelligent software agents. Drug Discovery Informatics: Approaches to drug discovery using bioinformatics techniques.	**12**	**CO206.4**

Reference Books:

1. Compeau, P. and Pevzner, P., 2018. Bioinformatics algorithms: an active learning approach. La Jolla, California: Active Learning Publishers.
2. Jones, N.C., Pevzner, P.A. and Pevzner, P., 2004. An introduction to bioinformatics algorithms. MIT press.
3. Krawetz, S.A. and Womble, D.D. eds., 2003. Introduction to bioinformatics: a theoretical and practical approach. Springer Science & Business Media.
4. Lesk, A., 2019. Introduction to bioinformatics. Oxford university press.
5. Mandoiu, I. and Zelikovsky, A., 2008. Bioinformatics algorithms: techniques and applications (Vol. 3). John Wiley & Sons.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO206.1	2	1	1	1								
CO206.2	2	2	1	1	2			1				
CO206.3	2	2	2	1	2		1	1				
CO206.4	2	2	2	2	2		1	1				1

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO206.1	2	1	1	1
CO206.2	2	2	1	1
CO206.3	2	2	1	1
CO206.4	3	2	2	1

Course Code: MT CS 207	Course Name: Cyber Security	L	T	P	C
		3	0	0	3

Year and Semester	1st year 2nd Semester	Contact hours per week: (3 Hrs.) Exam: (3hrs.)
Prerequisite of course	Cryptography/ Network Security	Evaluation
		CIE: 30 / TEE: 70

Course Objectives:

1. To learn Public Key cryptography.
2. To be familiar with elliptic curve cryptography.
3. To be exposed Knowledge proofs
4. To understand Email & cloud security.
5. To learn encryption techniques.

Course Outcomes: On completion of the course, student would be able to:

CO207.1	Understand the requirements of the basics of cyber security
CO207.2	Identify the need of PKI and security Protocols
CO207.3	Recognize the underlying technology behind attribute based encryption
CO207.4	Design and implement new ways of security methods for digital space.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	Overview of Public Key Cryptography, Symmetric Cryptography, Digital Signature, Encryption/Decryption Algorithms, Public Key Infrastructure, Internet Key Exchange Protocol	**10**	**CO207.1**
2	Elliptic curve operations, computational hardness of elliptic curve (ECDLP, ECFP, CDHP, DDHP), elliptic curve digital signature algorithm (ECDSA), elliptic curve Diffie-Hellman protocol, elliptic curve PKI, Security protocols in real life applications (research articles)	**13**	**CO207.2**
3	Zero knowledge proof system, pairing based cryptography, bilinear mapping, chosen ciphertext security models, identity-based encryption, attribute-based encryption, different access control models	**12**	**CO207.3**

4	Email Security, PGP and S-MIME, Cloud security through PKI, Application in e-commerce, e-business, e-payment, e-health and mobile applications	**10**	**CO207.4**

Reference Books:

1. Bloch, M. and Barros, J., 2011. Physical-layer security: from information theory to security engineering. Cambridge University Press.
2. Goldreich, O., 2009. Foundations of cryptography: volume 2, basic applications. Cambridge university press.
3. Katz, J. and Lindell, Y., 2020. Introduction to modern cryptography. CRC press.
4. Stinson, D.R., 2005. Cryptography: theory and practice. Chapman and Hall/CRC.
5. Weise, J., 2001. Public key infrastructure overview. Sun BluePrints OnLine, August, pp.1-27.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO207.1	2											
CO207.2	2	2										2
CO207.3	2	2										2
CO207.4	2		3		2							2

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO207.1	2			
CO207.2	2		2	1
CO207.3	2		2	1
CO207.4	2	3	2	1

Course Code: MT CS 208	**Course Name: Natural Language Processing**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Year and Semester	**1st year** **2nd Semester**	**Contact hours per week:** (3 Hrs.) **Exam:** (3hrs.)			
	Nil	**Evaluation**			

Prerequisite of course		CIE: 30	TEE: 70

Course Objectives:

1. To introduce the fundamental concepts and techniques of natural language processing
2. To give students a clear understanding of linguistics methods, various tools and aspects of NLP
3. To gain an in-depth understanding of the computational properties of natural languages and the commonly used algorithms for processing linguistic information

Course Outcomes: On completion of the course, student would be able to:

CO208.1	Describe the challenges involved in developing NLP solutions
CO208.2	Develop the linguistics and their application to part-of-speech tagging
CO208.3	Develop background to various tools and aspects of NLP like syntax and semantic analysis, parsing, machine translation, information retrieval and statistical discourse processing
CO208.4	Analyse and develop the classification model of speech

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	Introduction: NLP tasks in syntax, semantics, and pragmatics. Applications such as information extraction, question answering, and machine translation. The problem of ambiguity. The role of machine learning. Brief history of the field.	**10**	**CO208.1**
2	N-gram Language Models: The role of language models. Simple N-gram models. Estimating parameters and smoothing. Evaluating language models. Part of Speech Tagging and Sequence Labeling: Lexical syntax. Hidden Markov Models (Forward and Viterbi algorithms and EM training)	**12**	**CO208.2**
3	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 Semantic Analysis: Lexical semantics and word-sense disambiguation. Compositional semantics. Semantic Role Labeling and Semantic Parsing.	**11**	**CO208.3**
4	Mechanics of Speech: Speech Production Mechanism, Nature of Speech Signal, Discrete Time Modeling of Speech	**12**	**CO208.4**

	Production, Representation of Speech Signals, Classification of Speech Sounds, Phones, Phonemes, Phonetics, IPA and Phonetic Alphabets, Articulatory Features, Auditory Perceptions, Anatomical Pathways from Ear to the Perception of Sound Peripheral Auditory System.		

Reference Books:

1. Hapke, H., Howard, C. and Lane, H., 2019. Natural Language Processing in Action: Understanding, analyzing, and generating text with Python. Simon and Schuster.
2. Jurafsky, D. and Martin, J.H., 2020, Speech and Language Processing, Pearson.
3. Manning, C. and Schutze, H., 1999. Foundations of statistical natural language processing. MIT press.
4. Rabiner, L.R. and Juang, B.H., 2009. B. Yegnanarayana, Fundamentals of Speech Recognition.
5. Thanaki, J., 2017. Python natural language processing. Packt Publishing Ltd.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO208.1	2	1	1									
CO208.2	2	1	1		2							
CO208.3	3	2	2	2	2			1				2
CO208.4	3	2	2	2	2			1				2

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO208.1	2	1	1	1
CO208.2	2	1	1	1
CO208.3	3	2	2	1
CO208.4	3	2	2	1

Course Code: MT CS 209	**Course Name: Cloud Computing**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Year and Semester	**1st year** **2nd Semester**	**Contact hours per week:** (3 Hrs.) **Exam:** (3hrs.)			

Prerequisite of course	Distributed System	**Evaluation**	
		CIE: 30	**TEE: 70**

Course Objectives:

1. To understand the basics of Cloud Computing.
2. To understand the cloud architecture and virtualization technology
3. To learn about the deployment of cloud service
4. To learn about cloud security

Course Outcomes: On completion of the course, student would be able to:

CO209.1	Identify cloud services for application
CO209.2	Understand the requirement of virtualization for cloud Computing
CO209.3	Analyze authentication, confidentiality and privacy issues in the Cloud computing environment.
CO209.4	Understand the requirements of cloud federation

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Introduction** **Definition of Cloud Computing**: Defining a Cloud, Cloud Types – NIST model, Cloud Cube model, Deployment models, Service models, Cloud Reference model, Characteristics of Cloud Computing, Benefits and advantages of Cloud Computing; **Cloud Architecture**: A brief introduction on Infrastructure, Platforms, Virtual Appliances, Communication Protocols, Applications, Connecting to the Cloud by Clients; Services and Applications by Type: IaaS, PaaS, SaaS, IDaaS and CaaS.	**12**	**CO209.1**
2	**Virtualization**: Definition, Understanding and Benefits of Virtualization. Implementation Level of Virtualization, Virtualization Structure/Tools and Mechanisms, Hypervisor, VMware, KVM, Xen. Virtualization of CPU, Memory, I/O Devices, Virtual Cluster and Resources Management, Virtualization of Server, Desktop, Network, and Virtualization of data-center.	**12**	**CO209.2**
3	**Service Deployment**: Understanding the deployment of different cloud service using the services provided by Amazon Ec2, Google App Engine, Microsoft Azure and etc	**10**	**CO209.3**

	Cloud Security: Cloud security concerns, Security boundary, Security service boundary, Security of data, Identity management.		
4	**Case Study on Open Source & Commercial Clouds**: Eucalyptus, Microsoft Azure, Amazon EC2, VM ware. **Cloud Federation**: Need of cloud federation, Advantages, Cloud federation Architecture, Pricing Model, Different Federation Formation Frameworks, Load balancing.	**11**	**CO209.4**

Reference Books:

1. Buyya, R., Vecchiola, C. and Selvi, S.T., 2013. Mastering cloud computing: foundations and applications programming. Newnes.
2. Miller, M., 2008. Cloud computing: Web-based applications that change the way you work and collaborate online. Que publishing.
3. Moyer, C.M., 2011. Building Applications in the Cloud: Concepts, Patterns, and Projects. Pearson Education India.
4. Sosinsky, B., 2012. Cloud Computing Bible WILEY INDIA Pvt. Ltd ISBN: 9788126529803 Reprint.
5. Velte, A.T., Velte, T.J. and Elsenpeter, R., 2019. Cloud Computing: A Practical Approach. ISSN, 2278, p.0181.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO209. 1	2											
CO209. 2	2				1							
CO209. 3	2	2	1	2								2
CO209. 4	2	2										2

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO209.1	2			1
CO209.2	2			1
CO209.3	2	1	2	1

CO209.4	2		2	1

Course Code: MT CS 210	**Course Name: Deep Learning**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Year and Semester	**1st year** **2nd Semester**	**Contact hours per week:** (3 Hrs.) **Exam:** (3hrs.)			
Prerequisite of course	Discrete Structures	**Evaluation**			
		CIE: 30	**TEE: 70**		

Course Objectives:

1. To introduce major deep learning algorithms and the problem settings
2. To familiarize yourself with applications to solve real world problems.

Course Outcomes: On completion of the course, student would be able to:

CO210.1	Identify the deep learning algorithms, which are more appropriate for various types of learning tasks in various domains.
CO210.2	Apply scaling up deep learning techniques and associated computing techniques and technologies
CO210.3	Recognize various ways of selecting suitable model parameters for different applications.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Introduction to Deep Learning: History of Deep Learning, Deep Learning revolution, Perspectives and Issues in deep learning framework, review of fundamental learning techniques. Difficulty of training deep neural networks, Greedy layerwise training. Limitations of deep learning	**10**	**CO210.1**
2	Artificial Neural Networks: Neural Network Representation, Activation functions, Thresholding, cost functions, hypotheses and tasks; training data; maximum likelihood based cost, cross entropy, MSE cost; sigmoid units; Backpropagation, Random Initialization, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Gradient Descent, Feedforward Neural Networks, Backpropagation, Gradient Descent (GD).	**11**	**CO210.1**

3	Convolutional Neural Networks: Building blocks of CNNs, Architectures, convolution / pooling layers, Padding, Strided convolutions, Convolutions over volumes, Softmax regression, Deep Learning frameworks, Training and testing on different distributions, Bias and Variance with mismatched data distributions, Transfer learning, Multi-task learning, end-to-end deep learning, CNN models: LeNet – 5, AlexNet, VGG – 16, Residual Networks.	**12**	**CO210.2 CO210.3**
4	Recurrent Neural Networks: Recurrent Neural Network Model, Vanishing gradients with RNNs, Gated Recurrent Unit (GRU), LSTM (long short term memory), Encoder Decoder architectures, Deep Unsupervised Learning: Autoencoders (standard, sparse, demising, contractive, etc), Variational Autoencoders, Adversarial Generative Networks, Autoencoder and Deep Boltzmann Machine.	**12**	**CO210.3**

Reference Books:

1. Bengio, Y., Goodfellow, I.J. and Courville, A., 2015. Deep Learning.(2015). Book in preparation for MIT Press, 99, p.100.
2. Buduma, N. and Locascio, N., 2017. Fundamentals of deep learning: Designing next-generation machine intelligence algorithms. " O'Reilly Media, Inc.".
3. Hochreiter, S. and Schmidhuber, J., 1997. Long short-term memory. Neural computation, 9(8), pp.1735-1780.
4. Patterson, J. and Gibson, A., 2017. Deep learning: A practitioner's approach. " O'Reilly Media, Inc.".
5. Svensén, M. and Bishop, C.M., 2007. Pattern recognition and machine learning.
6. Yegnanarayana, B., 2009. Artificial neural networks. PHI Learning Pvt. Ltd..
7. Zocca, V., Spacagna, G., Slater, D. and Roelants, P., 2017. Python deep learning. Packt Publishing Ltd.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO210. 1	2											1
CO210. 2	2		2		2			1				2
CO210. 3	2	2	2									2

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO210.1	2		2	1
CO210.2	2	2	2	1
CO210.3	2		2	1

Course Code: MT CS 211	**Course Name: Internet of Things**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Year and Semester	**1st year** **2nd Semester**	**Contact hours per week:** (3 Hrs.) **Exam:** (3hrs.)			
Prerequisite of course	Computer Networks	**Evaluation**			
		CIE: 30	**TEE: 70**		

Course Objectives:

1. To enable students to build an IoT system from the ground up.
2. To gain the necessary knowledge to use cloud services for processing and storage of the data produced by the IoT devices.
3. To develop knowledge and critical understanding of the underlying principles of Cloud Computing and IoT systems, and the commercial and business implications of technical advances in this area.

Course Outcomes: On completion of the course, student would be able to:

CO211.1	Apply the subject related concepts and develop analytical skills of contemporary issues
CO211.2	Explore the relationship between IoT, cloud computing, and big data
CO211.3	Design a component or a product applying all the relevant standards and with realistic constraints.
CO211.4	Write the microcontroller programming on Raspberry Pi /Arduino /Equivalent platform

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**

1	**Introduction To Internet of Things:** Definition & Characteristics of IoT - Challenges and Issues - Physical Design of IoT, Logical Design of IoT - IoT Functional Blocks, Security. **Components In Internet of Things:** Control Units Communication modules Bluetooth Zigbee Wifi GPS- IOT Protocols, MQTT, Wired Communication, Power Sources.	**11**	**CO211.1**
2	**Technologies Behind IoT:** Four pillars of IOT paradigm, - RFID, Wireless Sensor Networks, SCADA (Supervisory Control and Data Acquisition), M2M - IOT Enabling Technologies - BigData Analytics, Cloud Computing, Embedded Systems.	**11**	**CO211.2**
3	**Programming The Microcontroller For IoT:** Working principles of sensors IOT deployment for Raspberry Pi /Arduino /Equivalent platformReading from Sensors, Communication: Connecting microcontroller with mobile devices, communication through Bluetooth, wifi and USB - Contiki OS. **Resource Management in IoT:** Clustering, Clustering for Scalability, Clustering Protocols for IOT.	**12**	**CO211.3** **CO211.4**
4	**IoT Applications and case studies:** Business models for the internet of things, Smart city, smart mobility and transport, smart buildings and infrastructure, smart health, environment monitoring and surveillance.	**11**	**CO211.3**

Reference Books:

1. Bahga, A. and Madisetti, V., 2014. Internet of Things: A hands-on approach. Vpt.
2. Doukas, C., 2012. Building Internet of Things with the ARDUINO. CreateSpace Independent Publishing Platform.
3. Uckelmann, D., Harrison, M. and Michahelles, F. eds., 2011. Architecting the internet of things. Springer Science & Business Media.
4. Vermesan, O. and Friess, P. eds., 2014. Internet of things-from research and innovation to market deployment (Vol. 29). Aalborg: River publishers.
5. Weber, R.H. and Weber, R., 2010. Internet of things (Vol. 12). Heidelberg: Springer.
6. Holler, J., Tsiatsis, V., Mulligan, C., Karnouskos, S., Avesand, S. and Boyle, D., 2014. Internet of Things. Academic Press.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2

CO211.1	2	2	1					1				
CO211.2	2	1										
CO211.3	2	2	3	1	2			1				
CO211.4	2	2	3		2			1				1

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO211.1	2	1	1	1
CO211.2	2	1		1
CO211.3	2	2	1	1
CO211.4	2	2	2	1

Course Code: MT CS 303	**Course Name: Blockchain Technologies**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Year and Semester	**2nd year** **3rd Semester**	**Contact hours per week:** (3 Hrs.) **Exam:** (3hrs.)			
Prerequisite of course	Cryptography/ Network Security	**Evaluation**			
		CIE: 30	**TEE: 70**		

Course Objectives:

1. To learn the concept of blockchain.
2. To be familiar with recent advancement in blockchain
3. To be exposed to various usage of blockchains.
4. To understand smart contracts and associated vulnerabilities.
5. To learn implementation of blockchain.

Course Outcomes: On completion of the course, student would be able to:

CO303.1	Understand the requirements of the basic design of blockchain
CO303.2	Identify the need of blockchains to find the solution to the real-world problems

CO303.3	Recognize the underlying technology of transactions, blocks, proof-of-work, and consensus building
CO303.4	Design and implement new ways of using blockchain for applications other than cryptocurrency

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	Blockchain concepts, evolution, structure, characteristics, a sample blockchain application, the blockchain stack, benefits and challenges, Public Ledgers, Blocks in a Blockchain, Blockchains as public ledgers, Transactions, Distributed consensus. Building a block: Elements of Cryptography-Cryptographic Hash functions, Merkle Tree, Elements of Game Theory	**12**	**CO303.1**
2	Design methodology for blockchain applications, blockchain application templates, blockchain application development, Ethereum, Solidity, Sample use cases from Industries, Business problems.	**11**	**CO303.2**
3	Smart contract, structure of a contract, interacting with smart contracts using Geth client and Mist wallet, smart contract examples, smart contract patterns, Byzantine fault tolerance, proof-of-work vs proof-of-stake, Security and Privacy of Blockchains, smart contract vulnerabilities, Scalability of Blockchains	**12**	**CO303.3**
4	Blockchain Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Blockchain.	**10**	**CO303.4**

Reference Books:

1. Bambara, J.J., Allen, P.R., Iyer, K., Madsen, R., Lederer, S. and Wuehler, M., 2018. Blockchain: A practical guide to developing business, law, and technology solutions. McGraw Hill Professional.
2. Dhillon, V., Metcalf, D. and Hooper, M., 2017. Blockchain enabled applications. Berkeley, CA: Apress.
3. Mougayar, W., 2016. The business blockchain: promise, practice, and application of the next Internet technology. John Wiley & Sons.
4. Singhal, B., Dhameja, G. and Panda, P.S., 2018. Beginning Blockchain: A Beginner's Guide to building Blockchain solutions. Apress.

5. Wattenhofer, R., 2019. Blockchain science: Distributed ledger technology. Inverted Forest Publishing.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO303. 1	2											
CO303. 2	2	2										2
CO303. 3	2	2			1							1
CO303. 4	2		2		2			2				2

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO303.1	2			1
CO303.2	2		1	1
CO303.3	2		2	1
CO303.4	2	2	2	1

Course Code: MT CS 304	**Course Name: Software Project Management**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Year and Semester	**2nd year** **3rd Semester**	**Contact hours per week:** (3 Hrs.) **Exam:** (3hrs.)			
Prerequisite of course	Software Engineering	**Evaluation**			
		CIE: 30	**TEE: 70**		

Course Objectives: 1. To introduce the primary important concepts of project management related to managing software development projects. 2. To be familiar with the different activities involved in Software Project Management. 3. To successfully plan and implement a software project management activity	
Course Outcomes: On completion of the course, student would be able to:	
CO304.1	Identify the different project contexts and suggest an appropriate management strategy.
CO304.2	Practice the role of professional ethics in successful software development.
CO304.3	Identify and describe the key phases of project management.
CO304.4	To perform the Project Scheduling, tracking, Risk analysis, Quality management and Project Cost estimation using different techniques

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Introduction to project management:** Introduction, Importance of software project management, Project and different types of project, What is management?, Problems with software projects, Environmental Appraisal with Projects, Requirement Specification, Management Control, Steps in project planning	**11**	**CO304.1**
2	**Programme management and project evaluation:** Programme Management, Managing resources within programme, Strategic programme management, Aids to programme management, Evaluation / Assessment of projects, Cost-benefit Analysis, Cash flow forecasting, Cost-benefit evaluation techniques, Risk evaluation	**11**	**CO304.2** **CO304.3**
3	**Project approach and Software effort estimation:** Selection of an appropriate project technology, Choice of process model, Data Structure, Delivery Model, Basis for software estimation, Problem with over and under estimates, Estimation Techniques, Expert judgment, Albrecht Function Point Analysis, Function points Mark II, COSMIC Function point, COCOMO Model	**12**	**CO304.3**
4	**Activity Planning:** Objective of Planning, Project Schedule, Activities – Sequencing and Scheduling, Development of Project Network,	**11**	**CO304.4**

	Time Estimation, Forward and backward Pass, Critical Path and Activities. Risk Management Risk, Risk categories, identification, assessment, planning, management PERT and CPM Models, Monte Carlo Simulation		

Reference Books:

1. Chandra, P., 2009. Projects 7/E. Tata McGraw-Hill Education.
2. Cotterell, M. and Hughes, B., Software Project Management, 2017, Tata McGraw Hill Publication.
3. Futrell, R.T., Shafer, D.F. and Shafer, L., 2002. Quality software project management. Prentice Hall Professional.
4. Morris, P.W. and Pinto, J.K. eds., 2010. The Wiley guide to project organization and project management competencies (Vol. 8). John Wiley & Sons.
5. Stellman, A. and Greene, J., 2005. Applied software project management. " O'Reilly Media, Inc.".

COURSE ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO304.1	3	2	1	1	1			2	2			
CO304.2	3	2	2	2	1			2	2			
CO304.3	3	2	1	2	2			2	2			
CO304.4	3	2	2	2	1			2	2			

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO304.1	3	1	1	1
CO304.2	3	2	2	1
CO304.3	3	2	2	1
CO304.4	3	2	2	1

Course Code: MT CS 305	**Course Name:** Remote Sensing	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Year and Semester	**2nd year** **3rd Semester**	**Contact hours per week:** (3 Hrs.) **Exam:** (3hrs.)	
Prerequisite of course	Nil	**Evaluation**	
		CIE: 30	**TEE: 70**

Course Objectives:

1. To apply principles of Remote sensing to collect, map and retrieve spatial information
2. To learn to identify different earth surface features from satellite images
3. To understand the uses of Data Acquisition Sensors, Electro optical sensors, Thermal sensors

Course Outcomes: On completion of the course, student would be able to:

CO305.1	Select the type of remote sensing technique / data for required purpose
CO305.2	Identify the earth surface features from satellite images
CO305.3	Describe the use of Data Acquisition Sensors, Electro optical sensors, Thermal sensors
CO305.4	Analyze the Data and its characteristics

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Physics of Remote Sensing:** Sources of Energy, Active and Passive Radiation, Electromagnetic Radiation - Reflectance, Transmission, Absorption, Thermal Emissions, Interaction with Atmosphere, Atmospheric windows, Spectral reflectance of Earth's surface features, Multi concept of Remote Sensing.	**10**	**CO305.1**
2	**Data Acquisition Platforms:** Various types of platforms, different types of aircraft, manned and unmanned space crafts used for data acquisition - characteristics of different types of platforms - LANDSAT, SPOT, IRS, ERS, INSAT and other platforms.	**12**	**CO305.2**
3	D**ata Acquisition Sensors (Visible & Infrared):** Photographic products, Resolving power of lenses and films, Optomechanical / Electro optical sensors - spatial, spectral and radiometric resolution, Thermal sensors, Geometric Characteristics of thermal imagery, calibration of thermal scanner, signal to noise ratio.	**11**	**CO305.3**

4	**Data Analysis:** Data Products and Their Characteristics, Data Preprocessing – Atmospheric, Radiometric, Geometric Corrections - Basic Principles of Visual Interpretation, Equipment for Visual Interpretation, Ground Truth, Ground Truth Equipment. Applications: Geosciences, Water Resources, Land use – Land cover, Transportation Engineering.	**12**	**CO305.4**

Reference Books:

1. Campbell, J.B. and Wynne, R.H., 2011. Introduction to remote sensing. Guilford Press.
2. Elachi, C. and Van Zyl, J.J., 2021. Introduction to the physics and techniques of remote sensing. John Wiley & Sons.
3. Lillesand, T., Kiefer, R.W. and Chipman, J., 2015. Remote sensing and image interpretation. John Wiley & Sons.
4. Mätzler, C. ed., 2006. Thermal microwave radiation: applications for remote sensing (Vol. 52). Iet.
5. Rees, W.G., 2013. Physical principles of remote sensing. Cambridge university press.

COURSE ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO305.1	3	2	1		1							
CO305.2	3	2				1	2	1				
CO305.3	3	1		2	2							
CO305.4	1	3		1		2						1

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO305.1	2		1	1
CO305.2	2	2		1
CO305.3	2			1
CO305.4	2	2	2	1
CO305.5				1

Course Code: MT CS 306	Course Name: Wireless and Mobile Networks	L	T	P	C
		3	0	0	3

Year and Semester	2nd year 3rd Semester	Contact hours per week: (3 Hrs.) Exam: (3hrs.)
Prerequisite of course	Nil	Evaluation
		CIE: 30 / TEE: 70

Course Objectives:

1. To learn about basic communication technology
2. To analyze the working principle of MAC protocol
3. To design and analyze routing protocols for multi-hop wireless networks
4. To learn about wireless sensor network

Course Outcomes: On completion of the course, student would be able to:

CO306.1	Identify issues related to environment, communication, protocols in mobile computing
CO306.2	Analyze the performance of mac protocols for wired and wireless networks
CO306.3	Analyze performance of transport layer protocols in mobile Ad-hoc networks
CO306.4	Understand the concept of wireless sensor network

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	Basic communication Technologies, Introduction to Mobile Networks, Types of Wireless networks (MANET: Mobile ad-hoc networks, WSN: Wireless Sensor Networks, VANET: Vehicular Ad-hoc Networks, PAN: Personal Area Networks, DTN: Delay Tolerant Network), Wireless Communication Fundamentals, Cellular Wireless Networks, Mobile Ad-hoc Networks	**12**	**CO306.1**
2	Medium Access Control Layer: MACA, MACAW, Wireless LAN, Mobile Network Layer (Mobile IP), DHCP	**11**	**CO306.2**
3	Routing in Mobile Ad hoc Networks (MANET): AODV (Ad-hoc On-Demand Distance Vector Routing Protocol), DSR (Dynamic Source Routing), Secure routing protocols in MANET	**11**	**CO306.3**

4	Wireless Sensor Networks: (Routing protocols, Localization methods, Sensor Deployment Strategies), Delay Tolerant Networks, Vehicular Ad-hoc Networks, Wireless Access Protocol, GPS, RFID.	**11**	**CO306.4**

Reference Books:

1. Cordeiro, C.D.M. and Agrawal, D.P., 2011. Ad hoc and sensor networks: theory and applications. World Scientific Publishing Company.
2. Schiller, J.H., 2003. Mobile communications. Pearson education.
3. Schwartz, M., 2005. Mobile wireless communications (Vol. 25). Cambridge: Cambridge University Press.
4. Talukder, A.K., Yavagal, R.R. and Talukder, A.K., 2005. Mobile Computing. Tata McGraw-Hill Education.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO306.1	2											
CO306.2	2	2										2
CO306.3	2	2										2
CO306.4	2											2

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO306.1	2			1
CO306.2	2		2	1
CO306.3	2		2	1
CO306.4	2		2	1

Course Code: MT CS 307	**Course Name: Computer Vision**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Year and Semester	**1st year** **2nd Semester**	**Contact hours per week:** (3 Hrs.) **Exam:** (3hrs.)	
Prerequisite of course		**Evaluation**	
		CIE: 30	**TEE: 70**

Course Objectives:

1. To recognize and describe both the theoretical and practical aspects of computing with images.
2. To describe the foundation of image formation and image analysis.
3. To understand the geometric relationships between 2D images and the 3D world.
4. To have gained exposure to motion, matching, recognition, extraction, and categorization from images.

Course Outcomes: On completion of the course, student would be able to:

CO307.1	Understand the basics of 2D and 3D Computer Vision.
CO307.2	Design and describe various methods used for motion, registration, alignment, detection, recognition and matching in images.
CO307.3	Build computer vision applications.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Introduction and Digital Image Formation:** Overview, Fundamentals of Image Formation, What is computer vision? A brief history. **Image Formation and Image Models:** Geometric Camera Models, Geometric Camera Calibration, Radiometry, Measuring Light, Shadows and shading, Color. **Early Vision - Multiple Images:** The Geometry of Multiple Views, Stereopsis, Affine Structure from Motion, Projective Structure from Motion. **Feature Detection and Matching:** Points and patches, Edges, Lines.	**12**	**CO307.3**

2	**Mid Level Vision:** Segmentation by Clustering, Segmentation by Fitting a Model, Segmentation and Fitting using Probabilistic Methods, Tracking with Linear Dynamic Models. **Feature-Based Alignment:** 2D and 3D feature-based alignment, Pose estimation, Geometric intrinsic calibration. **High Level Vision – Geometric Methods:** Model-Based Vision, Smooth Surfaces and their Outlines, Aspect Graphs, Range Data. **Structure from Motion:** Triangulation, Two-frame structure from motion, Factorization, Bundle adjustment, Constrained structure and motion.	**12**	**CO307.1**
3	**High Level Vision -Probabilistic and Inferential Methods:** Recognition by Relations between Templates, Geometric Templates from Spatial Relations, Application, Image Based Rendering. **Dense Motion Estimation:** Translational alignment, Parametric motion, Spline-based motion, Optical flow, Layered motion.	**10**	**CO307.2**
4	**3D Reconstruction:** Shape from X, Active range finding, Surface representations, Point-based representations - Volumetric representations - Model-based reconstruction - Recovering texture maps. **Recognition:** Object detection, Face recognition, Instance recognition, Category recognition, Context and scene understanding.	**11**	**CO307.3**

Reference Books:

1. Forsyth, D. and Ponce, J., 2011. Computer vision: A modern approach (p. 792). Prentice hall.
2. Gonzalez, R.C. and Woods, R.E., 2002. Digital image processing, Pearson.
3. Gupta, M., Konar, D., Bhattacharyya, S. and Biswas, S., 2020. Computer Vision and Machine Intelligence in Medical Image Analysis. Springer Singapore.
4. Prince, S.J., 2012. Computer vision: models, learning, and inference. Cambridge University Press.
5. Szeliski, R., 2010. Computer vision: algorithms and applications. Springer Science & Business Media.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO307. 1	2											

CO307.2	2	2			1							2
CO307.3	2	2	2		2			2				2

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO307.1	2			1
CO307.2	2	1	2	1
CO307.3	2	2	2	1

Course Code: MT CS 308	**Course Name: Entrepreneurship**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Year and Semester	**2nd year** **3rd Semester**	**Contact hours per week:** (3 Hrs.) **Exam:** (3hrs.)			
Prerequisite of course		**Evaluation**			
		CIE: 30	**TEE: 70**		

Course Objectives:

1. To acquire necessary knowledge and skills required for organizing and carrying out entrepreneurial activities
2. To develop the ability of analysing and understanding business situations in which entrepreneurs act.
3. To master the knowledge necessary to plan entrepreneurial activities.
4. To contribute to their entrepreneurial and managerial potentials.

Course Outcomes: On completion of the course, student would be able to:

CO308.1	Understand the role of Entrepreneurship in Economic development
CO308.2	Classify among various types of Entrepreneurship and business ownerships
CO308.3	Interpret various entrepreneurial motivation theories and competencies
CO308.4	Plan Business Start ups
CO308.5	Identify various agencies for entrepreneurial training, financing, marketing support and consultancy

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	Introduction to the Concept of Entrepreneur & Entrepreneurship; Evolution to the Concept of Entrepreneur; Role of Entrepreneurship in Economic development; Characteristics of successful Entrepreneurs; Need for an Entrepreneur; Functions of Entrepreneur; Types of Entrepreneurs –Women, Rural, Tourism, Agri-Preneurship and Social Entrepreneurship; Entrepreneur Vs a Manager; Entrepreneurial decision process; Factors affecting Entrepreneurship growth.	**12**	**CO308.1 & CO308.2**
2	Entrepreneurial Motivation: Meaning, motivating factors, Theories of Entrepreneurial motivation; Entrepreneurial Motivation Behaviour's motives: Creativity, Self efficacy, Locus of Control, Risk taking, Leadership, Communication; Entrepreneurial Competencies: Meaning, Major Entrepreneurial Competencies; International Entrepreneurship – Opportunities and challenges; Forms of Business Ownerships.	**11**	**CO308.2 & CO308.3**
3	Business Start ups – Introduction, characteristics and types; Micro and Small Enterprises: meaning, importance, features and characteristics, Rationale behind micro and small enterprises, Scope of Micro and Small Enterprises; Entrepreneurship Project Development: Idea generation – sources & techniques, Identifying Opportunity, Business Plan Formulation, Project Appraisal, Developing a Marketing Plan, Business Plan Failures.	**12**	**CO308.4**
4	Govt. Support to new enterprises: Entrepreneurship Development Programmes (EDPs), Role of Central and State Government in promoting Entrepreneurship, Financing of an Enterprise, Agencies for Marketing Support, Agencies for Consulting, Training and other Support, Taxation benefits to small scale enterprises. MSME policy in India.	**10**	**CO308.5**

Reference Books:

1. Dutta, B. (2009). *Entrepreneurship Management (Text and Cases)* (1 ed.). New Delhi: Excel Book
2. Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2017). *Entrepreneurship*. (10 ed.). Chennai: McGraw Hill Education (India) Private Limited.
3. Khanka, S.S. (2016). *Entrepreneurial Development* (4 ed.). New Delhi: S. Chand & Company Ltd.
4. Scarborough, N.M., & Cornwall, J.R. (2014). *Essentials of Entrepreneurship and Small Business Management.* (8 ed.). New Delhi: Prentice Hall.

COURSE ARTICULATION MATRIX

COs	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO308. 1						2					1	1
CO308. 2						2					2	2
CO308. 3						2					2	2
CO308. 4						3				1	3	3
CO308. 5						3				1	3	3

MAPPING OF COs WITH PSOs

COs	PSO 1	PSO2	PSO3	PSO4
CO308.1				
CO308.2				
CO308.3		2	3	
CO308.4		2	3	2
CO308.5		2	3	