SANJEEV AGRAWAL GLOBAL EDUCATIONAL (SAGE) UNIVERSITY, BHOPAL

Scheme

for

Master of Technology (Computer Science and Engineering)

School of Engineering & Technology

Program Educational Objectives (PEOs)

PEO-1: Students shall have the ability to apply knowledge across the disciplines and in emerging areas of Computer Science for higher studies, research, employability, product development and handle the realistic problems.

PEO-2: To understand the mathematical fundamentals that is prerequisites for a variety of courses like Data mining, Network protocols, analysis of Web traffic, Computer Security, Software Engineering, Operating Systems, Distributed Systems, Bioinformatics, Machine learning.

PEO-3: Students shall possess academic excellence with innovative insight, soft skills, managerial skills, leadership qualities, knowledge of contemporary issues and understand the need for lifelong learning for a successful professional career.

PEO-4: To keep abreast with latest area and research in Computer Science and Engineering and its application in all allied areas

PEO-5: To acquire professional integrity, ethics of research, consideration of the impact of research outcomes and an understanding of responsibility to contribute to the community for sustainable development of society,

Program Outcomes (POs):

PO-1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO-2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO-3: Design/development of solutions: 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.

PO-4: Conduct investigations of complex problems: 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.

PO-5: Modern tool usage: 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.

PO-6: The engineer and society: 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.

PO-7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO-8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO-9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO-10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO-11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO-12: Life-long learning: 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.

First Semester																	
Course Code	**Course Title**	**Contact Hours Per Week**			**Credits**	**ESE Duration (Hours)**	**Theory**						**Practical**			**GT**
		L	**T**	**P**			**MSE**	**ASG**	**TA**	**ATTD**	**ESE**	**Tot**	**CE**	**ESE**	**Tot**	
MA20M101	Advanced Mathematics	3	1	-	4	3	30	05	05	10	50	100	-	-	-	100
CS21M102	Advanced Data Structure	2	1	2	4	3	30	05	05	10	50	100	20	30	50	150
CS21M103	Advanced Operating System	3	-	2	4	3	30	05	05	10	50	100	20	30	50	150
Table-1	DSE-I	3	-	2	4	3	30	05	05	10	50	100	20	30	50	150
Table-1	DSE-II	3	1	-	4	3	30	05	05	10	50	100	-	-	-	100
AI20M104	Software Lab-I	-	-	4	2	2	-				-	-	20	30	50	50
PB20M101	Project Based Learning-I	-	-	4	2		-				-	-	50^	50	100	100
		Total			**24**											**800**

L-Lecture, T-Tutorial, P-Practical, MSE-Mid Semester Exam, ASG-Assignment, TA-Teacher's Assessment, ATTD-Attendance, CE-Continuous Evaluation, ESE-End Semester Exam, Tot-Total, GT- Grand Total. ^ - 2 assessments by panel of Experts

Second Semester																
Course Code	**Course Title**	**Contact Hours per Week**			**Credits**	**ESE Duration (Hours)**	**Theory**						**Practical**			**GT**
		L	**T**	**P**			**MSE**	**ASG**	**TA**	**ATTD**	**ESE**	**Tot**	**CE**	**ESE**	**Tot**	
CS21M201	Soft Computing and Techniques	3	1	-	4	3	30	05	05	10	50	100	-	-	-	100
CS21M202	Research Methodology & IPR	2	1	2	4	3	30	05	05	10	50	100	20	30	50	150
CS21M203	Software Quality and Testing	3	-	2	4	3	30	05	05	10	50	100	20	30	50	150
Table-1	DSE-III	3	-	2	4	3	30	05	05	10	50	100	20	30	50	150
Table-1	DSE-IV	3	1	-	4	3	30	05	05	10	50	100	-	-	-	100
AI20M204	Software Lab-II	-	-	4	2	2	-				-	-	20	30	50	50
PB20M201	Project Based Learning-II	-	-	4	2		-				-	-	50^	50	100	100
		Total			**24**											**800**

L-Lecture, T-Tutorial, P-Practical, MSE-Mid Semester Exam, ASG-Assignment, TA-Teacher's Assessment, ATTD-Attendance, CE-Continuous Evaluation, ESE-End Semester Exam, Tot-Total, GT- Grand Total. ^ - 2 assessments by panel of Experts

Third Semester																	
Course Code	**Course Title**	**Contact Hours per Week**			**Credits**	**ESE Duration (Hours)**	**Theory**						**Practical**			**GT**
		L	**T**	**P**			**MSE**	**ASG**	**TA**	**ATTD**	**ESE**	**Tot**	**CE**	**ESE**	**Tot**	
	MOOC-1	-	-	8	4	-	-	-	-	-	-	-	50	50	100	100
	MOOC-2	-	-	8	4	-	-	-	-	-	-	-	50	50	100	100
CS21M301	Dissertation Phase-I	-	-	24	12	2	-				-	-	150^	150	300	300
		Total			**20**											**500**

L-Lecture, T-Tutorial, P-Practical, MSE-Mid Semester Exam, ASG-Assignment, TA-Teacher's Assessment, ATTD-Attendance, CE-Continuous Evaluation, ESE-End Semester Exam, Tot-Total, GT- Grand Total. ^ - 2 assessments by panel of Experts

Fourth Semester																
Course Code	**Course Title**	**Contact Hours per Week**			**Credits**	**ESE Duration (Hours)**	**Theory**						**Practical**			**GT**
		L	**T**	**P**			**MSE**	**ASG**	**TA**	**ATTD**	**ESE**	**Tot**	**CE**	**ESE**	**Tot**	
CS21M401	Dissertation Phase-II	-	-	32	16	2					-	-	250^	250	500	500
		Total			**16**											**500**

L-Lecture, T-Tutorial, P-Practical, MSE-Mid Semester Exam, ASG-Assignment, TA-Teacher's Assessment, ATTD-Attendance, CE-Continuous Evaluation, ESE-End Semester Exam, Tot-Total, GT- Grand Total. ^ - 2 assessments by panel of Experts

Curriculum Components

Components	Credits
Program Core (08 Courses)	**28**
PROGRAM ELECTIVES (DISCIPLINE SPECIFIC ELECTIVES) (04 COURSES)	**16**
Project Based Learning (PBL)/MOOCs (04 courses)	**12**
Project (02 Courses)	**28**
Total	**84**

Distribution of credits across all components

SEM No.	Prog. Core	Discipline Specific Electives (DSE)	Project Based Learning (PBL)/ MOOCs	Project	Total Credit
I.	14	08	02	-	**24**
II.	14	08	02	-	**24**
III.	-	-	08	12	**20**
IV.	-	-	-	16	**16**
Total	**28**	**16**	**12**	**28**	**84**

Table-1
List of Discipline Specific Electives (DSE)

SN	Course Code	DSE-I
1.	**AI20M106**	Internet of Things
2.	**AI20M107**	Knowledge Engineering & Expert System
3.	**CS21M108**	Cloud Computing
SN	**Course Code**	**DSE-II**
1.	**AI20M109**	Data Mining & Warehousing
2.	**CS21M110**	Network Security
3.	**CS21M111**	Business Analytics
SN	**Course Code**	**DSE-III**
1.	**DS20M201**	Natural Language Processing
2.	**AI20M208**	Embedded System
3.	**CS21M209**	Machine Learning and Techniques
SN	**Course Code**	**DSE-IV**
1.	**CS21M210**	Data Science
2.	**CS21M211**	Web Engineering
3.	**CS21M212**	Mobile Computing

SANJEEV AGRAWAL GLOBAL EDUCATIONAL (SAGE) UNIVERSITY, BHOPAL

Proposed Scheme & Syllabus

for

Master of Technology (Computer Science and Engineering)

I Semester

School of Engineering and Technology

COURSE CODE	ADVANCED MATHEMATICS	Total Lecture : 60 Theory : 45 Tutorial : 15
MA20M101	(LTP=3 – 1 – 0 = 4)	

Course Objectives:

- To introduce students to the theoretical distributions, sampling distributions and their applications
- To introduce the students to the solution of partial differential equation
- Demonstrate an understanding to the theory and applications of linear algebra
- To extend the concept of the computer algorithms related to dimensionality reduction and feature extraction.
- To introduce the concepts of Stochastic process and Markov process transition.

UNIT	CONTENTS	HOURS
I.	Probability, compound probability and discrete random variable. Binomial, Normal and Poisson's distributions, Sampling distribution, elementary concept of estimation and theory of hypothesis, recurred relations.	8
II.	Solution of Partial Differential Equation (PDE) by separation of variable method, numerical solution of PDE (Laplace, Poisson's, Parabola) using finite difference methods, Elementary properties of FT, DFT, WFT, Wavelet transform, Haas transform.	10
III.	Finite differences: forward, backward and central difference operators, polynomial interpolation: equally spaced and unequally spaced data; Numerical Differentiation, Numerical integration- Trapezoidal and Simpson1/3rd and 3/8th rules; Initial value problems - Taylor series method, Euler and modified Euler methods, Runge- Kutta methods.	10
IV.	Solution of Linear systems– Gaussian elimination method, LU factorization method, Cholesky's factorization method. Linear least-squares problems - Normal equations, QR method (or Gram Schmidt Ortho- normalization), Singular value decomposition (SVD) for linear least-squares problems, numerical rank determination via SVD, Principal Component Analysis.	10
V.	Stochastic process, Markov process transition probability transition probability matrix, just and higher order Markov process, Application of Eigen value problems in Markov Process, Markov chain. Queuing system, transient and steady state, traffic intensity, distribution queuing system, concepts of queuing models (M/M/1: Infinity/ Infinity/ FC FS), (M/M/1: N/ Infinity/ FC FS), (M/M/S: Infinity/ Infinity/ FC FS)	07

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	Be able to **understand**[2] probability, sampling distribution and discrete random variable.
CO 2	**Understand**[2] the terms and their applications of Solution of Partial Differential Equations
CO 3	**Understand**[2] the numerical methods and their use in obtaining approximate solutions to otherwise intractable linear/non-linear system of equations and differential equations.
CO 4	**Analyse**[4] the fundamental use of matrices in the computer algorithms related to dimensionality reduction and feature extraction.
CO 5	**Implement**[3] Stochastic process, Markov process transition probability transition probability matrix and Markov process.
Text Books	• Gupta S C, Kapoor V K (2014): **Fundamentals of Mathematical Statistics**, Delhi: Sultan Chand & Sons. • Jimmie Gilbert (2010): **Linear Algebra And Matrix Theory,** London: Elsevier India. • Grewal B S (2014): **Numerical Methods in Engineering & Science**: **With Programs in C, C++ & MATLAB** 10th Edition, Delhi: Khanna Publishers.
Reference Books	• Rohatgi, V.K., Saleh, A.K., Md. Ehsanes (2009): **An introduction to probability and statistics**, 2nd Edition, New Delhi: Wiley. • Trefethen L. N., David Bau (1997): **Numerical Linear Algebra**, SIAM, Philadelphia.

COURSE CODE	ADVANCED DATA STRUCTURE	Total Lecture : 60 Theory : 45 Practical : 15
CS21M102	(LTP= 3 – 0 – 2 = 4)	

Course Objectives:

- The student should be able to choose appropriate data structures, understand the ADT/libraries, and use it to design algorithms for a specific problem
- Students should be able to understand the necessary mathematical abstraction to solve problems.
- To familiarize students with advanced paradigms and data structure used to solve algorithmic problems.
- Student should be able to come up with analysis of efficiency and proofs of correctness.
- Make student able to learn various concepts, and algorithms used in various techniques for solving real world problems.

UNIT	CONTENTS	HOURS
I.	Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing	6
II.	Skip Lists: Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists	6
III.	Trees: Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees	6
IV.	Text Processing: Sting Operations, Brute-Force Pattern Matching, The Boyer-Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.	6
V.	Computational Geometry: One Dimensional Range Searching, Two Dimensional Range Searching, constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quad trees, kD Trees. Recent Trends in Hashing, Trees, and various computational geometry methods for efficiently solving the new evolving problem	6

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO 1	**Demonstrate**[2] the implementation of symbol table using hashing techniques.
CO 2	**Apply**[3] suitable data structures and develop algorithms for computational geometry problems.

CO 3	**Demonstrate**[2] and analyze algorithms for red-black trees, B-trees and Splay trees.
CO 4	**Understand**[2] various hashing techniques
CO 5	**Demonstrate**[2] algorithms for text processing applications.
Text Books	• Weiss Mark Allen (2004): **Data Structures and Algorithm Analysis in C++,** 2nd Edition, Pearson. • Goodrich M T, Tamassia Roberto (2002): **Algorithm Design,** New Jersey: John Wiley.
Reference Books	• Brass Peter (2008): **Advanced Data structure** New York: Cambridge University Press.

COURSE CODE	ADVANCED OPERATING SYSTEM	Total Lecture : 60 Theory : 45 Practical : 15
CS21M103	(LTP= 3 – 0 – 2 = 4)	

Course Objectives:

- Students should be able to understand different classes of problems concerning their computation difficulties,
- to study, learn, and understand the main concepts of advanced operating systems (parallel processing
- systems, distributed systems, real time systems, network operating systems, and open source operating systems)
- To learn hardware and software features that supports these systems.

UNIT	CONTENTS	HOURS
I.	**Architecture of Distributed Systems:** Types, Distributed Operating System, Issues in Distributed Operating Systems, Theoretical Foundations: Global Clock, Lamport's Logical Clock, Vector Clocks, Global State, and Termination Detection.	10
II.	**Distributed Mutual Exclusion:** Classification, requirement, performance, non-token based algorithms, Lamport's algorithm, the Richart-Agarwala algorithm, token-based algorithm-Suzuki Kasami's broadcast algorithm, Singhal's heuristic algorithm. **Deadlock Detection:** Resource Vs Communication deadlock, A graph- theoretic model, prevention, avoidance, detection, control organization, centralized deadlock-detection algorithm, the completely centralized algorithm, the Ho-Ramamoorthy algorithm. Distributed deadlock detection algorithm - path -pushing, edge-chasing, hierarchical deadlock detection algorithm, menace-muntz and Ho-Ramamoorthy algorithm. Agreement Protocols: The system model, the Byzantine agreement, and the consensus problem.	10
III.	**Distributed File System:** Mechanisms, Design Issues, **Case Studies:** Sun NFS, Sprite File System, DOMAIN, Coda File System. **Distributed Shared Memory:** Algorithms for Implementing DSM, Memory Coherence, Coherence Protocols, Design Issues, **Case Studies**: IVY, Mirage, Clouds. **Distributed Scheduling**: Issues in Load Distribution, Components of Algorithm, Stability Load Distributing Algorithm, Performance.	10
IV.	**Failure Recovery:** Backward, Forward Error Recovery in Concurrent Systems, Consistent Set of Check Points, Synchronous and Asynchronous Check Pointing and Recovery. **Fault Tolerance:** Commit Protocols, Non-Blocking Commit Protocols, Voting **Protocols. Protection and Security**: Access Matrix, Private Key, Public key, and Kerberos System.	8
V.	**Multiprocessor Operating Systems:** Motivation, Basic Multiprocessor System Architecture, Interconnection Networks for Multiprocessor Systems, Caching, Hypercube Architecture. Threads, Process Synchronization, Processor Scheduling,	7

	and Memory Management. **Database Operating System** :Concurrence Control, Distributed Databases, and Concurrency Control Algorithms	

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	**Understand**[2] the design approaches of advanced operating systems
CO 2	**Understand**[2] the concept of different algorithms of mutual exclusion
CO 3	**Experiment**[5] the solutions to schedule the real time applications.
CO 4	**Apply**[3] the design issues of multi-processor operating systems
CO 5	**Create**[6] the requirements of database operating systems.
Text Books	• Singhal M, Shivaratri N.G. (1994): **Advanced Concepts in Operating Systems**, New York: McGraw-Hill Intl. • Sinha Pradeep K (2002): **Distributed Operating Systems Concepts and Design** 1st Edition, Delhi: PHI.
Reference Books	• Tanenbaum Andrew S (2011): **Distributed Operating Systems**, 1st Edition, Delhi Pearson Education India. • Coulouris George, Dollimore Jean, Kindberg Tim, Blair Gordon (2011): **Distributed Operating Systems Concepts and Design** 5th Edition, United States Addison Wesley.

COURSE CODE	DSE-I INTERNET OF THINGS	Total Lecture : 60 Theory : 45 Practical : 15
AI20M106	(LTP= 3 – 0 – 2 = 4)	

Course Objectives

- To Understand the Architectural Overview of IoT
- To Understand the IoT Reference Architecture and Real World Design Constraints
- To Understand the various IoT Protocols (Data link, Network, Transport, Session, Service)
- To understand security aspect in IoT.
- To design an IoT application.

UNIT	CONTENTS	HOURS
I.	Evolution of IoT: Review of computer communication concepts (OSI layers, components, packet communication, Networks, TCP-IP, subnetting, IPV4 addressing and challenges): IPV6 addressing. IoT architecture reference layer.	10
II.	Introduction to IoT components: Characteristics IoT sensor nodes, Edge computer, cloud and peripheral cloud, single board computers, open source hardwares, Examples of IoT infrastructure	10
III.	IoT protocols and softwares: MQTT, UDP, MQTT brokers, publish subscribe modes, HTTP, COAP, XMPP and gateway protocols, IoT Communication Pattern, IoT protocol Architecture, Selection of Wireless technologies (6LoWPAN, Zigbee, WIFI, BT, BLE, SIG, NFC, LORA, Lifi, Widi)	10
IV.	IoT security: Need for encryption, standard encryption protocol, light weight cryptography, Quadruple Trust Model for IoT-A – Threat Analysis and model for IoT-A, Cloud security. open source IoT platforms, cloud dashboards.	8
V.	IoT application and its Variants: Case studies: IoT for smart cities, health care, agriculture, smart meters.M2M, Web of things, Cellular IoT, Industrial IoT, Industry 4.0, IoT standards.	7

List of Practicals

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection
4. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
6. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
7. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
8. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF

when '1'/'0' is received from smartphone using Bluetooth.

9. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thingspeak cloud.
10. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thingspeak cloud.
11. To install MySQL database on Raspberry Pi and perform basic SQL queries.
12. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.
13. Write a program on Arduino/Raspberry Pi to subscribe to MQTT broker for temperature data and print it.
14. Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
15. Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested.

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	**Understand**[2] the definition and significance of the Internet of Things
CO 2	**Understand**[2] the architecture, operation, and business benefits of an IoT solution
CO 3	**Understand**[2] various layers and Examine the potential business opportunities that IoT can uncover
CO 4	**Interpret**[2] the relationship between IoT, cloud computing, and big data
CO 5	**Identify**[1] how IoT differs from traditional data collection systems
Text Books	• Holler Jan, Tsiatsis Vlasios, Mulligan Catherine, Avesand Stefan, Stamatis, Boyle David (2014): **From Machine-to-Machine to the Internet of Things:Introduction to a New Age of Intelligence**, 1st Edition, United states: Academic Press. • Reiter Bernd Scholz, Michahelles Florian (2011): **Architecting the Internet of Things,** ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2: Springer. • Madisetti Vijay, Bahga Arshdeep (2014): **Internet of Things (A Hands-on Approach),** 1st Edition, New York: VPT. • http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html.
Reference Books	• Daniel Minoli: **Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications**, ISBN: 978-1-118-47347-4: Wiley Publications. • Waher Peter (2015): **Learning Internet of Things**, Mumbai: PACKT publishing, Birmingham.

COURSE CODE	DSE-I KNOWLEDGE ENGINEERING AND EXPERT SYSTEM	Total Lecture : 60 Theory : 45 Practical : 15
AI20M107	(LTP= 3 – 0 – 2 = 4)	

Course Objectives:

- The students will design an expert system using appropriate knowledge-based software tools.
- To enable students to search for knowledge (acquisition) and to specify it clearly (validation)
- To enable students to design a knowledge structure integrated with production planning, quality control and other subsystems of an industrial organization.
- To introduce the features of a feasible expert system.
- Apply AI techniques to the problem of acquisition and representation of expert knowledge for problem solving in the expert's domain

UNIT	CONTENTS	HOURS
I.	Overview: Introduction to rule-based expert systems. Background, general introduction, Forward and backward chaining, conict resolution, Uses: structured selection, configuration, diagnosis, and business rules.	10
II.	Rule-based expert systems: Uncertainty, fuzzy logic and belief nets, Expert System Shells	10
III.	Other expert system paradigms: PIES example system (Pan and Tenenbaum), OOPs, frames, Case-based reasoning and help desks, Recommend or systems (CD Now Case Study)Scheduling (Steelmaking example: Dorn and Slany)	10
IV.	Building expert systems: CLUES example system (Talebzadeh, Mandutianu and Winner), Building expert systems, Discussion of shells, Knowledge Management (Wiki web case study)	8
V.	Machine learning and data-base mining: Data Mining, Decision Trees, Neural Networks, Text Mining, Web mining	7

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO 1	**Understand**[2] the introduction to expert systems.
CO 2	**Understand**[2] the reasoning that resembles human.
CO 3	**Understand**[2] other expert system and case study.
CO 4	**Creating**[5] expert systems.

CO 5	**Demonstrate**[2] about machine learning and data mining works.
Text Books	• Gonzalez A.J., Dankel D. D. (1993): **The Engineering of Knowledge-based Systems**, New Jersey: Prentice Hall. • Gonzalez Avelino J., Dankel Douglas D. (2000): **Engineering of Knowledge-Based Systems,** New Jersey: Prentice Hall ISBN-10: 0130189731. • Giarratano Joseph C., Rilez Gary D. (2004): **Expert Systems: Principles and Programming**, 4th Edition, ISBN-10: 0534384471, Boston: Course Technology.
Reference Books	• Martin James , Oxman Steven (1988): **Building Expert Systems** New Jersey: Prentice-Hall. • Hasan M.K. (2019): **Fuzzy Sets and Fuzzy Logic with Applications Imprecision, Uncertainty and Vagueness** Illustrated edition, Scholars' Press. • Dennis Merritt (1989): **Building Expert Systems in Prolog**.

COURSE CODE	DSE-I CLOUD COMPUTING	Total Lecture : 60 Theory : 45 Practical : 15
CS21M108		(LTP= 3 – 0 – 2 = 4)

Course Objectives:

- To discuss the fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges;
- The basic ideas and principles in data center design; cloud management techniques and cloud software deployment considerations.
- Different CPU, memory and I/O virtualization techniques that serve in offering software, Computation and storage services on the cloud; Software Defined Networks (SDN) and Software Defined Storage (SDS):
- Cloud storage technologies and relevant distributed file systems, NoSQL databases and object storage;
- The variety of programming models and develops working experience in several of them.

UNIT	CONTENTS	HOURS
I.	Introduction, Benefits and challenges, Cloud computing services, Resource Virtualization, Resource pooling sharing and provisioning	10
II.	Scaling in the Cloud, Capacity Planning, Load Balancing, File System and Storage	10
III.	Multi-tenant Software, Data in Cloud, Database Technology, Content Delivery Network, Security Reference Model, Security Issues, Privacy and Compliance Issues	10
IV.	Portability and Interoperability Issues, Cloud Management and a Programming Model Case Study, Popular Cloud Services	8
V.	Enterprise architecture and SOA, Enterprise Software, Enterprise Custom Applications, Workflow and Business Processes, Enterprise Analytics and Search, Enterprise Cloud Computing Ecosystem	7

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO 1	Able to **Identify**[2] various cloud computing services for solving novel problem;
CO 2	**Apply**[3] fundamental concepts in cloud infrastructures to understand the trade-offs in power, efficiency and cost, and then study how to leverage and manage single and multiple datacenters to build and deploy cloud applications that are resilient, elastic and cost-efficient
CO 3	**Illustrate**[3] the fundamental concepts of cloud storage and demonstrate their use in storage systems such as Amazon S3 and HDFS. the correctness of an algorithm.
CO 4	Learn and **Analyze**[2] various cloud programming models and apply them to solve problems on the cloud.

CO 5	**Analyze**[4] Enterprise Custom Applications.
Text Books	• Bhowmik Sandeep (2017): **Cloud Computing** Cambridge: Cambridge University Press. • Gautam Shroff (2016): **Enterprise Cloud Computing - Technology, Architecture, Applications**, Cambridge: Cambridge University Press.
Reference Books	• Hwang Kai, Fox Geoffrey C., Dongarra Jack J (2012): **Distributed and Cloud Computing from Parallel Processing to the Internet of Things,** Elsevier. • Buyya Rajkumar, Broberg James, Goscinski Andrej (2011): **Cloud Computing Principles and paradigms** New Delhi: Wiley.

COURSE CODE	DSE-II DATA MINING AND WAREHOUSING	Total Lecture : 60 Theory : 45 Tutorial : 15
AI20M109	(LTP= 3 – 1– 0 = 4)	

Course Objectives:

- Understand the components, architecture and other important tools of data warehousing.
- To understand data pre-processing and data visualization techniques.
- To study algorithms for finding hidden and interesting patterns in data.
- To understand and apply various classification and clustering techniques using tools.
- To understand types of association rules & algorithms.

UNIT	CONTENTS	HOURS
I.	**Introduction to DWH :** Data warehouse (DWH) Need, Definition, Advantages of DWH, OLTP Vs DWH, 3-tier Architecture, DWH Design Process, ETL Process, DWH Back-end Tools and Utilities, Metadata Repository, Models of DWH: Enterprise Warehouse, Data Mart, Virtual Warehouse, Comparison.	10
II.	**Dimensional Modeling:** Dimensional Model Vs ER Model, DWH Schemas: Star, Snowflake, Fact Constellation, their Comparison, Techniques to Handle Changing Dimensions, Aggregation, Families of Fact Tables, Fact Less Fact Tables; Data Warehouse Indexing: Factors used to select an Indexing Technique, Properties of a Good Indexing Technique for DWH, Indexing Techniques: Projection Index, Bitmap Index (Pure and Encoded), Join Index and their Comparison.	10
III.	**Data Mining and Functionalities:** Need of Data Mining, Knowledge Discovery in Database (KDD), Architecture of Data Mining System, Data Mining on Different kind of Data, Data Mining Functionalities; Data Preprocessing: Need, Cleaning, Integration, Transformation, Reduction, Discretization, Concept Hierarchy Generation.	10
IV.	**Cluster Analysis**: Categories of Clustering methods, Partitioning methods: k-Means, k-Medoids; Prediction: Numerical Prediction, Linear, Non-Linear Regression; Outlier Analysis: Applications, Techniques.	8
V.	**Classification:** Decision Tree Classifier, Rule Based Classification, Bayesian Classification, Neural Network Classification: Back Propagation Algorithm, Lazy Learner: kNN Classifier, Case-Based Reasoning, Other: Fuzzy Set Approach, Classifier Accuracy Measures, Techniques for Evaluating Classifier Accuracy; **Frequent Itemset Mining:** Interesting Item Set Mining: Market Basket Analysis, APriori Algorithm, Generating Association Rules, Types of Association Rules, Correlation Analysis. Data Mining on different Databases: Multimedia Data Mining, Web Mining, Text Mining, Spatial Data Mining, Mining on Social Networks, Multi-relational Data Mining.	7

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	**Construct**[6] an end-to-end data warehousing solution.
CO 2	**Evaluate**[5] various data processing algorithms in their applicability to different problems.
CO 3	**Display**[4] the process of converting data into a user defined format required for particular analysis.
CO 4	**Utilize**[2] statistical tools in deriving insights from data.
CO 5	**Describe**[1] various techniques for clustering and classification. Apply various techniques to solve real-world data analysis problems
Text Books	• Kimball, Reeves, Ross, Waite Thornth, John Wiley (2002): **The Data Warehouse Lifecycle Toolkit**, ISBN 9971-51-415-X. • Han Jiawei, Kamber Micheline, Kaufman Morgan, **Data Mining: Concepts and Techniques**, 2nd Edition, ISBN 978-81-312-0535-8.
Reference Books	• Mallach Efrem G (2009): **Decision Support and Data Warehouse Systems**, ISBN 978-0070486843, Tata McGraw Hill. • Berry M, Linoff G., Wiley John (2008): **Mastering Data Mining: The art and science of customer relationship management,** I st Edition, New Delhi: Wiley India Pvt. Ltd.

COURSE CODE	DSE-II NETWORK SECURITY	Total Lecture : 60 Theory : 45 Tutorial : 15
CS21M110		(LTP= 3 – 1 – 0 = 4)

Course Objectives:

- To learn about the threats of network security.
- To understand what causes these threats by studying how vulnerabilities arise in the development and uses of computer system.
- To understand the architecture of network security.
- To narrate and evaluate the design principles of conventional encryption and decryption techniques.
- To analyse the concepts of public key encryption and public key algorithm.

UNIT	CONTENTS	HOURS
I.	**Introduction:** Attributes of Security, Integrity, Authenticity, Non-repudiation, Confidentiality Authorization, Anonymity, Types of Attacks, DoS, IP Spoofing, Replay, Man-in-the-Middle attacks, General Threats to Computer Network, Worms, Viruses, -Trojans.	10
II.	**Secret Key Cryptography:** DES, Triple DES, AES, Key distribution, Attacks Public Key Cryptography: RSA, ECC, Key Exchange (Diffie-Hellman), Java Cryptography Extensions, Attacks	10
III.	**Integrity, Authentication and Non-Repudiation:** Hash Function (MD5, SHA5), Message Authentication Code (MAC), Digital Signature (RSA, DSA Signatures), Biometric Authentication	10
IV.	**PKI Interface:** Digital Certificates, Certifying Authorities, POP Key Interface, System Security using Firewalls and VPN's. Smart Cards: Application Security using Smart Cards, Zero Knowledge Protocols and their use in Smart Cards, Attacks on Smart Cards.	8
V.	**Applications:** Kerberos, Web Security Protocols (SSL), IPSec, Electronic Payments, E-cash, Secure Electronic Transaction (SET), Micro Payments, Case Studies of Enterprise Security (.NET and J2EE).	7

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO 1	**Analyse**[4] and determine for any organization the security requirements and appropriate solutions
CO 2	**Protect**[5] system from different types of threats, malicious software's vulnerabilities and attacks.
CO 3	**Describe**[1] symmetric and public key encryption algorithms like DES, AES, RSA etc.
CO 4	**Narrate**[3] the Authentication of digital certificates. Differentiate MAC and hashing techniques needed for authentication

CO 5	**Distinguish**[2] and analyse available network and protocols such as SSL, IPSes, TLS, etc.
Text Books	• Stallings William (2009): **Cryptography and Network Security**, 4th Edition, Delhi: Pearson. • Forouzan Behrouz A (2009): **Cryptography and Network Security**, Noida: TMH.
Reference Books	• Kizza Joseph Migga (2010): **A Guide to Computer Network Security**, Springer. • Cataiano Dario (2010): **Contemporary Cryptology**, Springer.

COURSE CODE	DSE-II BUSINESS ANALYTICS	Total Lecture : 60 Theory : 45 Tutorial : 15
CS21M111		(LTP= 3 – 1– 0 = 4)

Course Objectives:

- Understand the role of business analytics within an organization.
- Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
- To become familiar with processes needed to develop, report, and analyze business data
- Use decision-making tools/Operations research techniques.
- Manage business process using analytical and management tools.
- Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.
- Student will able to understand the basic rules of research formulation and procedure for obtaining patent rights.

UNIT	CONTENTS	HOURS
I.	**Business analytics:** Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. **Statistical Tools:** Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.	10
II.	**Trendiness and Regression Analysis:** Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology	10
III.	**Organization Structures of Business analytics:** Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	10
IV.	**Forecasting Techniques:** Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.	8
V.	**Decision Analysis:** Formulating Decision Problems, Decision Strategies with the without 8 Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent Trends in Embedded and collaborative business intelligence, Visual data 4 recovery, Data Storytelling and Data journalism.	7

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	Students will **demonstrate**[2] knowledge of data analytics
CO 2	Students will **demonstrate**[2] the ability of think critically in making decisions based on data mining methodologies.
CO 3	Students will **analyse**[4] the various management issues.
CO 4	Students will **analyse**[4] the various statistical forecasting models.
CO 5	Students will **demonstrate**[2] the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
Text Books	• James Evans (2019): **Business Analytics,** London: Persons Education. • Schniederjans Marc J., Schniederjans Dara G., Starkey Christopher M. (2014): **Business analytics Principles, Concepts, and Applications**, Pearson FT Press.
	• Albright S. Christian, Winston Wayne L. (2019): **Business Analytics Data Analysis and Decision Making** 7th edition. • Bartlett Randy (2013): **A practitioner's Guide to business Analytics,** Noida: McGrawHill**.**

COURSE CODE	PROJECT BASED LEARNING-I	Total Lecture:30 Practical:30
PB20M101		(LTP=0-0-4=2)
Learning Objectives:	• Integrating the knowledge and skills of various courses on the basis of multidisciplinary projects • Develop the skill of critical thinking and evaluation. • To develop 21st century success skills such as critical thinking, problem solving, communication, collaboration and creativity/innovation among the students. • To enhance deep understanding of academic, personal and social development in students. • Employ the specialized vocabularies and methodologies.	
Course Outcome		
At the end of the course the students will be able to:		
Course Outcomes:	• **Apply**[3] a sound knowledge/skills to select and develop their topicand project respectively. • **Develop**[6] plans and allocate roles with clear lines of responsibilityand accountability. • **Design**[6] solutions to complex problems following a systematicapproach like problem identification, formulation and solution. • **Collaborate**[6] with professionals and the community at large inwritten and in oral forms. • **Correlate**[4] the knowledge, skills and attitudes of a professional.	
General Guidelines:	• PBL will be an integral part of UG/PG Programs at different levels. • Each semester offering PBL will provide a separate Course Code, twocredits will be allotted to it. • Faculty will be assigned as mentor to a group of 30 students minimum byHoS. • Faculty mentor will have 4 hours/week to conduct PBL for assigned students. • Student will select a topic of their choice from syllabus of any course offered in respective semester (in-lines with sustainable development goals). • Student may work as a team maximum 3 or minimum 2 members for single topic. • For MSE, student's performance will be assessed by panel of three experts either from other department/school, or from same department/school based on chosen topic. This will be comprised of apresentation by student followed by viva-voce. It will be evaluated for 30 marks. • 20 marks would be allotted for continuous performance assessment by concerned guide/mentor. For ESE, student will need to submit a project report in prescribed format, duly signed by concerned guide/mentor and head of the school. The report should be comprised of following components: 1. Introduction	

	2. Review of literature 3. Methodology 4. Result and Discussion 5. Conclusion and Project Outcomes 6. References • Student will need to submit three copies for 1. Concerned School 2. Central Library 3. Self • The integrity of the report should be maintained by student. Any malpractice will not be entertained. • Writing Ethics to be followed by student, a limit of 10 % plagiarism is permissible. Plagiarism report is to be attached along with the report. • Project could be a case study/ analytical work /field work/ experimentalwork/ programming or as per the suitability of the program.

SANJEEV AGRAWAL GLOBAL EDUCATIONAL (SAGE) UNIVERSITY, BHOPAL

Proposed Scheme & Syllabus

for

Master of Technology (Computer Science and Engineering)

II Semester

School of Engineering and Technology

COURSE CODE	SOFT COMPUTING AND TECHNIQUES	Total Lecture : 60 Theory : 45 Tutorial : 15
CS21M201	(LTP= 3 – 1 – 0 = 4)	

Course Objectives:

- To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario.
- To implement soft computing based solutions for real-world problems.
- To give students knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.
- To provide student hand-on experience on Python to implement various strategies.

UNIT	CONTENTS	HOURS
I.	**Introduction to Soft Computing and Neural Networks:** Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence: Machine Learning Basics	10
II.	**Fuzzy Logic:** Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.	10
III.	**Neural Networks:** Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks: Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks.	10
IV.	**Genetic Algorithms:** Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning: Machine Learning Approach to Knowledge Acquisition.	8
V.	**Matlab/Python Lib:** Introduction to Matlab/Python, Arrays and array operations, Functions and Files, Study of neural network toolbox and fuzzy logic toolbox, Simple implementation of Artificial Neural Network and Fuzzy Logic. Recent Trends in deep learning, various classifiers, neural networks and genetic algorithm. Implementation of recently proposed soft computing techniques.	7

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO 1	**Understand**[2] the relations between the most important evolutionary algorithms presented in the course, new algorithms to be found in the literature now or in the future, and other search and optimization techniques.
CO 2	**Understand**[2] the fuzzy logic.

CO 3	**Determine**[1] the appropriate parameter settings to make different learning algorithms work well.
CO 4	**Design**[6] new evolutionary operators, representations and fitness functions for specific practical and scientific applications.
CO 5	**Understand**[2] and implement various proposed soft computing techniques.
Text Books	• Jang J.S.R., Sun C.T., Mizutani E. (2015): **Neuro-Fuzzy and Soft Computing,** Pearson Education. • Klir George J., Yuan Bo (1995): **Fuzzy Sets and Fuzzy Logic: Theory and Applications,** Delhi: Prentice Hall.
Reference Books	• MATLAB Toolkit Manual • Pratihar D.K. (2015): **Soft Computing: Fundamentals and Applications,** New Delhi: Narosa.

COURSE CODE	REASEARCH METHODOLOGY AND IPR	Total Lecture:60 Theory: 45 Practical:15
CS21M202	(LTP= 3 – 0 – 2 = 4)	

Course Objectives:

- Motivate to choose research as career
- formulate the research problem, prepare the research design
- Identify various sources for literature review and data collection report writing
- Equip with good methods to analyze the collected data
- Know about IPR copyrights

UNIT	CONTENTS	HOURS
I.	**Research Methodology:** Objectives and Motivation of Research, Types of Research, research approaches, Significance of Research, Research Methods Verses Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general. Defining the Research Problem: Selection of Research Problem, Necessity of Defining the Problem.	10
II.	**Literature Survey and Report writing:** Importance and purpose of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Need of Review, Guidelines for Review, Record of Research Review. **Report writing:** Meaning of interpretation, layout of research report, Types of reports, Mechanism of writing a report. Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal	10
III.	**Research Design:** Meaning of Research Design, Need of Research Design, Feature of a Good Design, Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Steps in sample design, types of sample designs.	10
IV.	**Data Collection and Analysis:** Methods of data collection, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Importance of Parametric, nonparametric test, testing of variance of two normal populations, use of Chi-square, ANOVA, F-test, z-test	8
V.	**Intellectual Property Rights:** Meaning, Nature, Classification and protection of Intellectual Property, The main forms of Intellectual Property, Concept of Patent, Patent document, Invention protection, Granting of patent, Rights of a patent, Licensing, Transfer of technology	7

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO 1	Develop a basic **understanding**[2] of research problem, review and asses the quality of literature from various sources
CO 2	**Choose**[4] an appropriate style and format of writing a report for technical paper/ Journal report, understand and develop various research designs
CO 3	**Understand**[2] the different concept of research design.

CO 4	Develop an ability to **analyze**[4] problem by statistical techniques: ANOVA, F-test, Chi-square
CO 5	**Develop/demonstrate**[2] the concept of patent and copyrights
Text Books	• Kothari C.R. (2004): **Research Methodology, Methods & Technique**‖, New Delhi: New Age International Publishers. • Ganesan R. (2011): **Research Methodology for Engineers**‖, MJP Publishers.
Reference Books	• Agarwal Y.P. (2004): **Statistical Methods: Concepts, Application and Computation**‖, New Delhi: Sterling Publications Pvt. Ltd. • Reddy G.B. (2005): **Intellectual Property Rights and the Law** 5th Edition, Gogia Law Agency. • Parulekar Ajit, D'Souza Sarita (2006): **Indian Patents Law – Legal & Business Implications,** Macmillan India Ltd.

COURSE CODE	SOFTWARE QUALITY AND TESTING	Total Lecture : 60 Theory : 45 Practical : 15
CS21M203		(LTP= 3 – 0 – 2 = 4)

Course Objectives:

- Understand the importance of Software Quality
- Understand the use of various tools and approaches in software Quality
- Understand a range of different Software Testing Techniques and Strategies.
- Able to apply a specific (automated) unit testing methods.

UNIT	CONTENTS	HOURS
I.	The Software Quality Challenge, Introduction Software Quality Factors, The Components of the Software Quality Assurance System – Overview, Development and Quality Plans.	10
II.	Integrating Quality Activities in the Project Life Cycle, Assuring the Quality of Software Maintenance Components, CASE Tools and their effect on Software Quality, Procedure and Work Instructions, Supporting Quality Devices, Configuration Management, Documentation Control, Project Progress Control.	10
III.	Software Quality Metrics, Costs of Software Quality, Quality Management Standards - ISO 9000 and Companion ISO Standards, CMM, CMMI, PCMM, Malcom Balridge, 3 Sigma, 6 Sigma, SQA Project Process Standards – IEEE Software Engineering Standards.	10
IV.	Building a Software Testing Strategy, Establishing a Software Testing Methodology, Determining Your Software Testing Techniques, Eleven – Step Software Testing Process Overview, Assess Project Management Development Estimate and Status, Develop Test Plan, Requirements Phase Testing, Design Phase Testing, Program Phase Testing, Execute Test and Record Results, Acceptance Test, Report Test Results, Test Software Changes, Evaluate Test Effectiveness.	8
V.	Testing Client / Server Systems, Testing the Adequacy of System Documentation, Testing Web-based Systems, Testing Off – the – Shelf Software, Testing in a Multiplatform Environment, Testing Security, Testing a Data Warehouse, Creating Test Documentation, Software Testing Tools, Taxonomy of Testing Tools, Methodology to Evaluate Automated Testing Tools, Load Runner, Win Runner and	7

	Rational Testing Tools, Java Testing Tools, JMetra, JUNIT and Cactus.	

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	Gain **knowledge**[1] about various quality factors and various methodologies for assuring quality.
CO 2	**Analyze**[4] the use of CASE tools.
CO 3	**Use**[3] the various methodologies for assuring Quality.
CO 4	**Build**[4] a tool for any testing methodology.
CO 5	**Design**[6] and test a web based system
Text Books	• Galin Daniel (2004): **Software Quality Assurance – From Theory to Implementation**, London: Pearson Education. • Menachem Mordechai Ben, Marliss Garry S. (2014): **Software Quality – Producing Practical, Consistent Software**, BS Publications.
Reference Books	• Perry William E. (2000): **Effective Methods for Software Testing,** 2nd Edition, Wiley. • Srinivasan Desikan, Gopalaswamy Ramesh (2006): **Software Testing, Principles and Practices**, London: Pearson Education. • Prasad K.V.K.K. (2007): **Software Testing Tool**, Dreamtech Press.

COURSE CODE	DSE-III NATURAL LANGUAGE PROCESSING	Total Lecture : 60 Theory : 45 Practical : 15
DS20M201	(LTP= 3 – 0 – 2 = 4)	

Course Objectives:

- Students will learn how to process written text from basic of fundamental knowledge starts with Finite automata, Regular expression and probabilistic model with n-grams.
- This NLP course will boost student knowledge to research level where they can conduct new level of research. It really helpful for undergraduate students.
- To get introduced to language processing technologies for processing the text data.
- To acquire knowledge on text data analytics using language model.
- To understand the role of Information Retrieval and Information Extraction in Text Analytics.

UNIT	CONTENTS	HOURS
I.	**Introduction:** Natural Language Processing tasks in syntax, semantics, and pragmatics, Issues, Applications. The role of machine learning, Probability Basics, Information theory, Collocations Ngram Language Models, Estimating parameters and smoothing - Evaluating language models.	10
II.	**Morphology and part of speech tagging:** Linguistic essentials, Lexical syntax, Morphology and Finite State Transducers, Part of speech Tagging, Rule-Based Part of Speech Tagging, Markov Models, Hidden Markov Models, transformation based Models, Maximum Entropy Models, Conditional Random Fields.	10
III.	**Syntax Parsing:** Syntax Parsing, Grammar formalisms and tree banks, Parsing with Context Free Grammars, Features and Unification, Statistical parsing and probabilistic CFGs (PCFGs), Lexicalized PCFGs.	10
IV.	**Semantic Analysis:** Representing Meaning, Semantic Analysis, Lexical semantics, Word sense disambiguation, Supervised, Dictionary based and Unsupervised Approaches Compositional semantics, Semantic Role Labeling and Semantic Parsing, Discourse Analysis.	8
V.	NLP and Information retrieval and ranked information retrieval, semantics, word senses, word similarity, word relations, word net and other thesauri, automatic text summarization, summarizing single document, summarizing multiple documents, question answering systems.	7

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO 1	**Understand**[2] Natural Language Processing.

CO 2	**Applying**[3] Hidden Markov model and Speech Recognition.
CO 3	**Understand**[2] application of context free grammar and language parsing
CO 4	**Understand**[2] the concept of syntax parsing.
CO 5	Make of NLP concepts to **solve**[3] Information retrieval problems.
Text Books	• Jurafsky Daniel, Martin James H. (2008): **Speech and Language Processing**, 2nd Edition, New Delhi: Prentice Hall. • Aggarwal Charu C. (2018): **Machine Learning for Text,** Ist Edition, Springer. • Manning Christopher D, Schuetze Hinrich (1999): **Foundations of Statistical Natural Language Processing**, MIT press.
Reference Books	• Hausser Roland R. (2011): **Foundations of Computational Linguistics:Human-Computer Communication in Natural Language,** Paperback, MIT press. • Bird Steven, Klein Ewan, Loper Edward.(2009): **Natural Language Processing with Python,** Ist Edition, California: O'Reilly Media.

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COURSE CODE	DSE-III EMBEDDED SYSTEM	Total Lecture : 60 Theory : 45 Practical: 15
AI20M208		(LTP= 3 – 0– 2 = 4)

Course Objectives:

- To introduce the difference between embedded systems and general purpose systems
- To optimize hardware designs of custom single-purpose processors.
- To compare different approaches in optimizing general-purpose processors.
- To introduce different peripheral interfaces to embedded systems.
- To understand the design tradeoffs made by different models of embedded systems.

UNIT	CONTENTS	HOURS
I.	**Introduction To Embedded Systems:** Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.	10
II.	**Typical Embedded System: Core of the Embedded System:** General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces.	10
III.	**Embedded Firmware:** Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.	10
IV.	**RTOS Based Embedded System Design:** Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling.	8
V.	**Task Communication:** Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.	7

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO 1	**Understand**[2] the basics of an embedded system.

CO 2	**Create**[6] program in embedded system.
CO 3	**Design**[6]**,** implement and test an embedded system.
CO 4	**Introduce**[1] different peripheral interfaces to embedded systems.
CO 5	**Understand**[2] the design tradeoffs made by different models of embedded systems.
Text Books	• Vahid Frank, Givargis Tony (2006): **Embedded System Design**, Ist Edition, New Jersey: John Wiley. • Kamal Raj (2017): **Embedded Systems,** 3rd Edition, Noida: McGraw Hill.
Reference Books	• Shibu K.V. (2017): **Introduction to Embedded Systems,** 2nd Edition, McGraw Hill. • Lyla (2013): **Embedded Systems : An Integrated Approach,** Pearson. • Simon David E (2002): **An Embedded Software Primer,** Pearson.

COURSE CODE	DSE-III MACHINE LEARNING AND TECHNIQUES	Total Lecture : 60 Theory : 45 Tutorial : 15
CS21M209	(LTP= 3 – 1– 0 = 4)	

Course Objectives:

- To learn the concept of how to learn patterns and concepts from data correlation.
- To design and analyze various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
- Explore supervised and unsupervised learning paradigms of machine learning.
- To explore Deep learning technique and various feature extraction strategies.

UNIT	CONTENTS	HOURS
I.	Supervised Learning (Regression/Classification) - Basic methods: Distance-based methods, NearestNeighbours, Decision Trees, Naive Bayes, Linear models: Linear Regression, Logistic Regression, Generalized Linear Models, Support Vector Machines, Nonlinearity and Kernel Methods, Beyond Binary Classification: Multi-class/Structured Outputs, Ranking.	10
II.	Unsupervised Learning - Clustering: K-means/Kernel K-means, Dimensionality Reduction: PCA and kernel PCA, Matrix Factorization and Matrix Completion, Generative Models (mixture models and latent factor models)	10
III.	Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)	10
IV.	Sparse Modelling and Estimation, Modelling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning.	8
V.	Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference. Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications	7

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO 1	**Extract**[3] features that can be used for a particular machine learning approach in various applications..
CO 2	**Compare**[2] and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach
CO 3	Mathematically **analyze**[4] various machine learning approaches and paradigms
CO 4	**Implement** k-means and find out the promising value of k using suitable method.

CO 5	D**emonstrate**[2] the use of PCA and Kernel PCA using suitable example.
Text Books	• Murphy Kevin (2012): **Machine Learning: A Probabilistic Perspective**, MIT Press. • Hastie Trevor, Tibshirani Robert, Friedman Jerome (2009): **The Elements of Statistical Learning,** Springer(freely available online).
Reference Books	• Bishop Christopher (2007): **Pattern Recognition and Machine Learning**, Springer. • Bonaccorso Giuseppe (2018): **Mastering Machine learning algorithms**, Mumbai: Packt.

COURSE CODE	DSE-IV DATA SCIENCE	Total Lecture : 60 Theory : 45 Tutorial : 15
CS21M210	(LTP= 3 – 1– 0 = 4)	

Course Objectives

- Provide you with the knowledge and expertise to become a proficient data scientist.
- Demonstrate an understanding of statistics and machine learning concepts that are vital for data science;
- Produce R/Python code to statistically analyze a dataset
- Critically evaluate data visualizations based on their design and use for communicating stories from data

UNIT	CONTENTS	HOURS
I.	**Introduction to core concepts and technologies**: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications.	10
II.	**Data collection and management**: Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, Using multiple data sources	10
III.	**Data analysis:** Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT Data Pre-process: Data Cleaning, Consistency checking, Heterogeneous and missing data, Data Transformation & Segmentation, Machine Learning algorithms- Linear Regression, SVM, Naïve Bayes	10
IV.	**Data visualization:** Introduction, Types of data visualization, Data for visualization: Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings.	8
V.	Applications of Data Science, Technologies for visualization, Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.	7

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO 1	**Demonstrate**[4] data science toolkit.
CO 2	**Apply**[3] techniques of data collection
CO 3	**Understand**[2] the concept of statistics
CO 4	**Demonstrate**[4] types of data visualization
CO 5	**Demonstrate**[4] technologies of visualization.

Text Books	• Cathy O'Neil, Schutt Rachel (2013): **Doing Data Science, Straight Talk from the Frontline**. California: O'Reilly. • Leskovek Jure, Rajaraman Anand and Ullman Jeffrey(2014): **Mining of Massive Datasets.** v2.1, Cambridge: Cambridge University Press.
Reference Books	• VanderPlas Jake (2016): **Python Data Science Handbook: Essential Tools for Working with Data**, California**:** O'Reilly Media. • Grolemund Garrett, Wickham Hadley (2016): **R for Data Science,** California**:** O'Reilly Media.

COURSE CODE	DSE-IV MOBILE COMPUTING	Total Lecture : 60 Theory : 45 Tutorial : 15
CS21M211	(LTP= 3 – 1– 0 = 4)	

Course Objectives:

- To impart fundamental awareness of mobile hardware devices structure and strategies along with basic concepts of mobile computing.
- Illustrate concepts of broadcast systems along with various mobile communications architectures.
- Perception towards various concepts IEEE 802.11 and Bluetooth architectures.
- Understand of Mobile IP, concepts of routing protocols in MANET and Classical TCP improvements.
- Learn file system support for mobility and mobile transactions and commerce.

UNIT	CONTENTS	HOURS
I.	**Introduction:** Wireless Transmission, Frequencies for Radio Transmission, Signals, Antennas, Signal Propagation, Multiplexing, Modulations, Spread Spectrum, MAC, SOMA, FDMA, TDMA, CDMA, Cellular Wireless Networks.	10
II.	**Telecommunication Systems:** GSM, GPRS, Satellite Networks, Basics, Parameters and Configurations, Capacity Allocation, FAMA and DAMA, Broadcast Systems, DAB, DVB, CDMA and 3G	10
III.	**Wireless LAN:** IEEE 802.11 Architecture, Services, MAC – Physical Layer, IEEE 802.11a – 802.11b standards, Bluetooth	10
IV.	**Routing Ad-hoc Network Routing Protocols**: Ad-hoc Network Routing Protocols, Destination Sequenced Distance Vector Algorithm, Cluster Based Gateway Switch Routing, Global State Routing, Fish-eye state Routing, Dynamic Source Routing, Ad-hoc on-demand Routing, Location Aided Routing, Zonal Routing Algorithm. Mobile IP - Dynamic Host Configuration Protocol. Traditional TCP - Classical TCP Improvements – WAP, WAP 2.0	8
V.	**Publishing & Accessing Data in Air:** Pull and Push Based Data Delivery models, Data Dissemination by Broadcast, Broadcast Disks, Directory Service in Air, Energy Efficient Indexing scheme for Push Based Data Delivery. **File System Support for Mobility:** Distributed File Sharing for Mobility support, Coda and other Storage Manager for Mobility Support. **Mobile Transaction and Commerce:** Models for Mobile Transaction, Kangaroo and Joey transactions, Team Transaction, Recovery Model for Mobile Transactions, Electronic Payment and Protocols for Mobile Commerce.	7

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO 1	**Understand**[2] characteristics and limitations of mobile hardware devices including their user-interface modalities.
CO 2	Identify important issues of GSM, Satellite systems GPRS for mobile communications and broadcast

CO 3	**Demonstrate**[4] knowledge of WLAN, IEE802.11 and Bluetooth architectures and protocols
CO 4	**Motivate**[5] the need for Mobile IP, Mobile Adhoc Networks, and configuring hosts using DHCP, Traditional TCP and Classical TCP improvements and WAP architectures
CO 5	**Enumerate**[1] various data Dissemination mechanisms and mobile transaction models
Text Books	• Jochen Schiller (2009): **Mobile Communications**, 2nd Edition, London: Pearson Education. • Garg Kurnkum (2010): **Mobile Computing**, London: Pearson Education.
Reference Books	• Talukder Asoke K, Yavagal Roopa R (2008): **Mobile Computing,** Noida: TMH. • Kamal Raj (2009): **Mobile Computing**, Lucknow: Oxford University Press. • Acharya S., Franklin M., Zdonil S. (1997): Balancing Push and Pull for Data Broadcast**, Proceedings of the ACM SIGMOD**, Tuscon, AZ. • Acharya S., Alonso R., Franklin M., Zdonik S. (1995): Broadcast Disks: Data Management for Asymmetric Communication Environments, **Proceedings of the ACM SIGMOD Conference**, San Jose, CA.

COURSE CODE	DSE-IV WEB ENGINEERING	Total Lecture : 60 Theory : 45 Tutorial : 15
CS21M212		(LTP= 3 – 1– 0 = 4)

Course Objectives:

- To learn Web Intelligence.
- To learn Knowledge Representation for the Semantic Web.
- To learn Ontology Engineering.
- To learn Semantic Web Applications, Services and Technology.
- To learn Social Network Analysis and semantic web.

UNIT	CONTENTS	HOURS
I.	**Web Intelligence:** Thinking and Intelligent Web Applications, The Information Age, The World Wide Web, Limitations of Today's Web, The Next Generation Web, Machine Intelligence, Artificial Intelligence, Ontology, Inference engines, Software Agents, Berners-Lee www, Semantic Road Map, Logic on the semantic Web.	10
II.	**Knowledge Representation for the Semantic Web:** Ontologies and their role in the semantic web, Ontologies Languages for the Semantic Web –Resource Description Framework(RDF) / RDF Schema, Ontology Web Language(OWL), UML, XML/XML Schema.	10
III.	**Ontology Engineering**: Ontology Engineering, Constructing Ontology, Ontology Development Tools, Ontology Methods, Ontology Sharing and Merging, Ontology Libraries and Ontology Mapping, Logic, Rule and Inference Engines.	10
IV.	**Semantic Web Applications, Services and Technology:** Semantic Web applications and services, Semantic Search, e-learning, Semantic Bioinformatics, Knowledge Base, XML Based Web Services, Creating an OWL-S Ontology for Web Services, Semantic Search Technology, Web Search Agents and Semantic Methods.	8
V.	**Social Network Analysis and semantic web:** What is social Networks analysis, development of the social networks analysis, Electronic Sources for Network Analysis – Electronic Discussion networks, Blogs and Online Communities, Web Based Networks. Building Semantic Web Applications with social network features.	7

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:

CO 1	**Understand**[2] the concept structure of the semantic web technology.

CO 2	**Understand**[2] the concepts of Web Science, semantics of knowledge and resource, ontology.
CO 3	**Applying**[3] ontology engineering approaches in semantic applications
CO 4	**Understand**[2] logic semantics and inference with OWL.
CO 5	**Understand**[2] social Networks analysis
Text Books	• Lee Berners, Godel, Turing (2008): **Thinking on the Web**, Wiley Inter Science. • Mika Peter (2007): **Social Networks and the Semantic Web,** Springer.
Reference Books	• Davies J, Studer R, Warren P (2006): **Semantic Web Technologies, Trends and Research in Ontology Based Systems,** New Jersey: John Wiley & Sons. • Lu Liyang (2017): **Semantic Web and Semantic Web Services,** Chapman & Hall/CRC Publishers, Taylor & Francis Group. • Schmidt Heiner Stucken, Harmelen Frank Van, Information sharing on the semantic Web, Springer Publications. • Segaran T, Evans C, Taylor J (2009): **Programming the Semantic Web**, California: O'Reilly SPD.

COURSE CODE	PROJECT BASED LEARNING-II	Total Lecture:30 Practical:30
PB20M201		(LTP=0-0-4=2)
Learning Objectives:	• Integrating the knowledge and skills of various courses on the basis of multidisciplinary projects • Develop the skill of critical thinking and evaluation. • To develop 21st century success skills such as critical thinking, problem solving, communication, collaboration and creativity/innovation among the students. • To enhance deep understanding of academic, personal and social development in students. • Employ the specialized vocabularies and methodologies.	
Course Outcome		
At the end of the course the students will be able to:		
Course Outcomes:	• **Apply**[3]a sound knowledge/skills to select and develop their topicand project respectively. • **Develop**[6] plans and allocate roles with clear lines of responsibilityand accountability. • **Design**[6] solutions to complex problems following a systematicapproach like problem identification, formulation and solution. • **Collaborate**[6] with professionals and the community at large inwritten and in oral forms. • **Correlate**[4]the knowledge, skills and attitudes of a professional.	
General Guidelines:	• PBL will be an integral part of UG/PG Programs at different levels. • Each semester offering PBL will provide a separate Course Code, twocredits will be allotted to it. • Faculty will be assigned as mentor to a group of 30 students minimum by HoS. • Faculty mentor will have 4 hours/week to conduct PBL for assigned students. • Student will select a topic of their choice from syllabus of any course offered in respective semester (in-lines with sustainable development goals). • Student may work as a team maximum 3 or minimum 2 members for single topic. • For MSE, student's performance will be assessed by panel of three experts either from other department/school, or from samedepartment/school based on chosen topic. This will be comprised of apresentation by student followed by viva-voce. It will be evaluated for 30 marks. • 20 marks would be allotted for continuous performance assessment by concerned guide/mentor. For ESE, student will need to submit a project report in prescribed format, duly signed by concerned guide/mentor and head of the school. The report should be comprised of following components:	

	1. Introduction 2. Review of literature 3. Methodology 4. Result and Discussion 5. Conclusion and Project Outcomes 6. References • Student will need to submit three copies for 1. Concerned School 2.Central Library 3. Self • The integrity of the report should be maintained by student. Any malpractice will not be entertained. • Writing Ethics to be followed by student, a limit of 10 % plagiarism is permissible. Plagiarism report is to be attached along with the report. • Project could be a case study/ analytical work /field work/ experimentalwork/ programming or as per the suitability of the program.

COURSE CODE	MOOC-1/ MOOC-2	Total Lecture: Practical:60
		(LTP=0-0-8=4)
Learning Objective:	• Integrating the knowledge and skills of various courses available in online mode. • Develop the skills of critical thinking and evaluation. • To make students to learn themselves by choosing the course as per there area of interest.	
	CONTENTS	**HOURS**
General Guidelines:	• This course creates an excellent opportunity for students to acquire the necessary skill set for research, employability through massive open online courses (MOOCs) where the rare expertise of world famous experts from academics and industry are available. • The basket for MOOCs will be a dynamic one, as courses keep on updating with time. • In this semester 8 credits will have to be acquired with online courses (MOOCs). Students will have to complete 2 MOOC's of their choice in the third semester. • The MOOC-1 and MOOC-2 each carries internal marks of 50, which will be attained after he/she gets the MOOC certificate for which he/she got himself/herself enrolled. For end sem evaluation a Viva-Voce examination shall be conducted and it will carrie 50 marks.	60

GUIDELINES FOR M. TECH. DISSERTATION/ THESIS

Phase-1

- Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Dissertation Review Committee (DRC).
- A Dissertation Review Committee shall be constituted with the Head of the Department as Chairperson, Dissertation Supervisor and one senior faculty member of the Department offering the M. Tech. programme.
- Candidate has to present in Dissertation Work Review I, in consultation with his Dissertation Supervisor, the title, objective and plan of action of his dissertation work to the Dissertation Work Review Committee (DRC) for approval within four weeks from the commencement of Second year First Semester. The Dissertation Work Review I carries internal marks of 100. Evaluation should be done by the DRC for 50 marks and the Supervisor will evaluate the review for the other 50 marks. Only after obtaining the approval of the DRC can the student initiate the Dissertation work.
- If a candidate wishes to change his/her supervisor or topic of the dissertation, he/she can do so with the approval of the DRC. However, the DRC shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of dissertation proposal. If yes, his/her date of registration for the dissertation work starts from the date of change of Supervisor or topic as the case may be.
- A candidate shall submit his dissertation progress report in two stages at least with a gap of three months between them.
- The work on the dissertation shall be initiated at the beginning of the II year and the duration of the dissertation is two semesters. A candidate is permitted to submit thesis only after successful completion of all theory and practical courses with the approval of DRC not earlier than 40 weeks from the date of approval of the dissertation work. For the approval of DRC the candidate shall submit the draft copy of thesis to the Head of the Department and make an oral presentation before the DRC.
- The Dissertation Work Review II in II Year III Sem. carries internal marks of 100. Evaluation should be done by the DRC for 50 marks and the Supervisor will evaluate the work for the other 50 marks. The Supervisor and DRC will examine the Problem Definition, Objectives, Scope of Work, Literature Survey in the same domain and progress of the Dissertation Work. A candidate has to secure a minimum of 70% of marks to be declared successful in Dissertation Work Review II. If he fails to obtain the minimum required marks, he has to reappear for Dissertation Work Review-II as and when conducted.
- One paper in third semester has to be published in any one journal of UGC care, SCOPUS or SCI.
- After successful completion of Dissertation Work Review II, it will be further adjudicated by an external examiner selected by the University. For this, the Principal of the College/School/Institute shall submit name of examiners from among the list of experts in the

relevant specialization as submitted by the supervisor concerned and Head of the Department. It will carries external marks of 200.

Phase-2

- The Dissertation Work Review III in II Year IV Sem. carries 250 internal marks. Evaluation should be done by the DRC for 125 marks and the Supervisor will evaluate it for the other 125 marks. The DRC will examine the overall progress of the Dissertation Work and decide whether or not the Dissertation is eligible for final submission. A candidate has to secure a minimum of 70% of marks to be declared successful in Dissertation Work Review III. If he fails to obtain the required minimum marks, he has to reappear for Dissertation Work Review III as and when conducted. For Dissertation Evaluation (Viva Voce) in II Year II Sem. there are external marks of 250 and it is evaluated by the external examiner. The candidate has to secure a minimum of 50% marks in Dissertation Evaluation (VivaVoce) examination.
- One paper in fourth semester has to be published in any one journal of UGC care, SCOPUS or SCI.
- Dissertation Work Reviews II and III shall be conducted in phase I (Regular) and Phase II (Supplementary). Phase II will be conducted only for unsuccessful students in Phase I. The unsuccessful students in Dissertation Work Review II (Phase II) shall reappear for it at the time of Dissertation Work Review III (Phase I). These students shall reappear for Dissertation Work Review III in the next academic year at the time of Dissertation Work Review II only after completion of Dissertation Work Review II, and then Dissertation Work Review III follows. The unsuccessful students in Dissertation Work Review III (Phase II) shall reappear for Dissertation Work Review III in the next academic year only at the time of Dissertation Work Review II (Phase I).
- After approval from the DRC, a soft copy of the thesis should be submitted for ANTIPLAGIARISM check and the plagiarism report should be submitted to the University and be included in the final thesis. The Thesis will be accepted for submission, if the similarity index is less than 30%. If the similarity index has more than the required percentage, the student is advised to modify accordingly and re-submit the soft copy of the thesis after one month. The maximum number of re-submissions of thesis after plagiarism check is limited to TWO. The candidate has to register for the Dissertation work and work for two semesters. After three attempts, the admission is liable to be cancelled. The college authorities are advised to make plagiarism check of every soft copy of theses before submissions.
- Three copies of the Dissertation thesis certified by the supervisor shall be submitted to the College/School/Institute, after submission of a 2 research paper related to the dissertation work in a UGC care, SCOPUS or SCI journal. A copy of the submitted research paper shall be attached to thesis.
- The thesis shall be adjudicated by an external examiner selected by the University. For this, the Principal of the College/School/Institute shall submit a panel of three examiners from among the list of experts in the relevant specialization as submitted by the supervisor concerned and Head of the Department.

- If the report of the external examiner is unsatisfactory, the candidate shall revise and resubmit the Thesis. If the report of the examiner is unsatisfactory again, the thesis shall be summarily rejected. Subsequent actions for such dissertations may be considered, only on the specific recommendations of the external examiner and /or Dissertation work Review Committee. No further correspondence in this matter will be entertained, if there is no specific recommendation for resubmission.
- If the report of the examiner is satisfactory, the Head of the Department shall coordinate and make arrangements for the conduct of Dissertation Viva- Voce examination. The Dissertation VivaVoce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the external examiner who adjudicated the Thesis, with an external marks of 250. The candidate has to secure a minimum of 50% of marks in Dissertation Evaluation (Viva-Voce) examination.
- If he fails to fulfill the requirements as specified in previous point he will reappear for the Viva-Voce examination only after three months. In the reappeared examination also, if he fails to fulfill the requirements, he will not be eligible for the award of the degree, unless he is asked to revise and resubmit his dissertation work by the board within a specified time period (within four years from the date of commencement of his first year first semester).
- The Dissertation Viva-Voce External examination marks must be submitted to the University on the day of the examination.