SANJEEV AGRAWAL GLOBAL EDUCATIONAL (SAGE) UNIVERSITY, BHOPAL

Scheme

for

Master of Technology (Internet of Things)

School of Advanced Computing

Program Educational Objectives (PEOs)

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

PEO-2: To design and develop innovative products and services in the field of IoT and smart systems.

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: Students will attain intellectual leadership skills to cater to the changing needs of power industry, academia, society and environment

PEO-5: Promote Design, Research, and implementation of products and services in the field of Internet of Things through strong communication and entrepreneurial skills.

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.

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**

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
IO21M101	IoT Architecture and Protocol	2	1	2	4	3	30	05	05	10	50	100	20	30	50	150
IO21M102	Wireless Sensor Network and Programming	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	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, ^ - Two assessment by panel of Expert

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**	
IO21M201	Principles of Sensor and Signal Conditioning	3	1	-	4	3	30	05	05	10	50	100	-	-	-	100
IO21M202	RFID And Microcontrollers	2	1	2	4	3	30	05	05	10	50	100	20	30	50	150
IO21M203	Cloud Architecture and Computing	3	-	2	4	3	30	05	05	10	50	100	20	30	50	150
Table-1	DSE-III	3	1	-	4	3	30	05	05	10	50	100				100
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	2	-				-	-	50^	50	100	100
		Total			**24**											**750**

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, ^ - Two assessment by panel of Expert

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
IO21M301	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, ^ - Two assessment by panel of Expert

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**	
IO21M401	Dissertation Phase-II	-	-	32	16	-					-	-	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, ^ - Two assessment by panel of Expert

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.	**IO21M103**	IoT Application and Web Development
2.	**AI20M202**	Deep Learning
3.	**AI20M203**	Big Data Analytics
SN	**Course Code**	**DSE-II**
1.	**IO21M104**	Fog Computing
2.	**IO21M105**	Embedded System and Real Time Operating System
3.	**DS20M110**	Advanced Distributed System
SN	**Course Code**	**DSE-III**
1.	**IO21M204**	Computer Network and Management
2.	**IO21M205**	RF and Microwave Sensors
3.	**IO21M206**	Wearable Computing, Mixed Reality and Internet of Everything
SN	**Course Code**	**DSE-IV**
1.	**IO21M207**	Smart Convergent Technologies
2.	**IO21M208**	Machine Learning
3.	**IO21M209**	Privacy and Security in IoT

SANJEEV AGRAWAL GLOBAL EDUCATIONAL (SAGE) UNIVERSITY, BHOPAL

Syllabus

for

MTech (Internet of Things)

School of Advanced Computing

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	07

	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)	

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	**Understand**[2] probability, sampling distribution and discrete random variable.
CO 2	**Interpret**[2] the terms and their applications of Solution of Partial Differential Equations
CO 3	**Relate**[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,** New Delhi Elsevier. • Grewal B S (2014): **Numerical Methods in Engineering & Science: With Programs in C, C++ & MATLAB,** 10th Edition: Khanna Publishers.
Reference Books	• Rohatgi, V.K., Saleh, Md. Ehsanes A.K. (2009): **An introduction to probability and statistics,** 2nd Edition, New Delhi: Wiley India. • Trefethen L. N., David Bau (1997): **Numerical Linear Algebra,** Philadelphia SIAM.

COURSE CODE	IoT ARCHITECTURE AND PROTOCOL	Total Lecture:60 Theory:30 Tutorial:15 Practical:15
IO21M101		(LTP=2-1-2=4)

Course Objectives:

- To Understand the Architectural Overview of IoT
- To Understand the IoT Reference Architecture and RealWorld Design Constraints
- To Understand the various IoT Protocols (Datalink, Network, Transport, Session, Service)

UNIT	CONTENTS	HOURS
I	OVERVIEW: IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management	7
II	REFERENCE ARCHITECTURE: IoT Architecture-State of the Art – Introduction, State of the art, Reference Model and architecture, IoT reference Model - IoT Reference Architecture-Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints-Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control.	7
III	IOT DATA LINK LAYER & NETWORK LAYER PROTOCOLS: PHY/MAC Layer(3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART,ZWave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP	6
IV	TRANSPORT & SESSION LAYER PROTOCOLS: Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session LayerHTTP, CoAP, XMPP, AMQP, MQTT	5
V	SERVICE LAYER PROTOCOLS & SECURITY: Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4 , 6LoWPAN, RPL, Application Layer	5

Course Outcomes as per Bloom's Taxonomy

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

CO1	**Infer**[2] the technology behind the IoT and associated technologies
CO2	**Analyze**[4] various IoT Application layer Protocols.
CO3	**Design**[6] IoT-based systems for real-world problem
CO4	**Uunderstand**[2] the state of the art methodologies in IoT application domains.
CO5	**Apply**[3] IP based protocols and Authentication Protocols for IoT.
Text Books	• Holler Jan, Tsiatsis Vlasios, Mulligan Catherine, Avesand Stefan, Stamatis Karnouskos, David Boyle (2014): **From Machine-to-Machine to the Internet of**

	Things: Introduction to a New Age of Intelligence, 1st Edition, Academic Press, • Waher Peter (2015): **Learning Internet of Things**, Birmingham, Mumbai: PACKT publishing. • Scholz-Reiter Bernd, Michahelles Florian, **Architecting the Internet of Things**, Springer.
Reference Books	• Daniel Minoli (2013): **Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications**, New Jersey: Willy Publications. • Madisetti Vijay, Bahga Arshdeep (2014): **Internet of Things (A Hands-onApproach)**, 1 st Edition: VPT.

COURSE CODE	WIRELESS SENSOR PROTOCOLS AND PROGRAMMING	Total Lecture: 60 Theory:45 Practical:15
IO21M102		(LTP=3–0–2=4)

Course Objectives:

- Understand basic sensor network concepts
- Know physical layer issues, understand and analyze Medium Access Control Protocols
- Comprehend network and transport layer characteristics and protocols and implement conventional protocols
- Understand the network management and Middleware services

UNIT	CONTENTS	HOURS
I	FUNDAMENTALS OF SENSOR NETWORKS: Introduction to computer and wireless sensor networks and Overview of the syllabus Motivation for a network of Wireless Sensor nodes- Sensing and sensors-challenges and constraints - node architecture-sensing subsystem, processor subsystem communication interfaces- prototypes, Application of Wireless sensors-Introduction of Tiny OS Programming and TOSSIM Simulator.	10
II	COMMUNICATION CHARACTERISTICS AND DEPLOYMENT MECHANISMS: Wireless Transmission Technology and systems-Radio Technology Primer-Available Wireless Technologies - Hardware- Telosb, Micaz motes- Time SynchronizationClock and the Synchronization Problem - Basics of time synchronization-Time synchronization protocols - Localization- Ranging Techniques- Range based Localization-Range Free Localization- Event driven Localization	10
III	MAC LAYER: Overview-Wireless Mac Protocols-Characteristics of MAC protocols in Sensor networks – Contention free MAC Protocols- characteristics- Traffic Adaptive Medium Access-Y-MAC, Low energy Adaptive Clustering - Contention based MAC ProtocolsPower Aware Multi-Access with signaling, Sensor MAC-Timeout MAC-Data gathering MAC- Case study –Implementation and Analysis of MAC player protocol in TinyOS.	10
IV	ROUTING IN WIRELESS SENSOR NETWORKS: Design Issues in WSN routing- Data Dissemination and Gathering-Routing Challenges in WSN - Flooding-Flat Based Routing – SAR, Directed Diffusion, Hierarchical Routing- LEACH, PEGASIS - Query Based Routing- Negotiation Based Routing- Geographical Based Routing- Transport layer- Transport protocol Design issuesPerformance of Transport Control Protocols.Case study-Implementation and analysis of Routing protocol or transport layer protocol in Tiny OS	8
V	MIDDLEWARE AND SECURITY ISSUES: WSN middleware principles-Middleware architecture-Existing middleware - operating systems for wireless sensor networks-performance and traffic management - Fundamentals of network security-challenges and attacks - Protocols and mechanisms for security. Case study- Handling attacks in Tiny OS.	7

Course Outcomes as per Bloom's Taxonomy

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

CO1	**Evaluate**[5] the performance of schedule based and random Medium Access Control protocols for power consumption, fairness, channel utilization and control packet overhead.
CO2	**Evaluate**[5] the performance of Geographic routing protocols for power consumption, scalability and latency parameters.
CO3	**Relate**[4] the performance of transport control protocols for congestion detection and avoidance, reliability and control packet overhead parameters.
CO4	**Understand**[2] about the Routing Challenges in WSN
CO5	**Classify**[2] the security issues in wireless network
Text Books	• Dargie Waltenegus, Poellabauer Christian (2011): **Fundamentals of Wireless Sensor Networks, Theory and Practice**: Wiley Series on wireless Communication and Mobile Computing. • Sohraby Kazem, Manoli Daniel (2010): **Wireless Sensor networks- Technology, Protocols and Applications,** New Jersey: Wiley Inter Science Publications.
Reference Books	• Krishnamachari Bhaskar (2005): **Networking Wireless Sensors**, Cambridge: Cambridge University Press. • Raghavendra C.S., Sivalingam Krishna M., Taiebznati (2004): **Wireless Sensor Networks**: Springer Science.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-I	Total Lecture:60 Theory:45 Practical:15
IO21M103	IoT APPLICATION AND WEB DEVELOPMENT	(LTP= 3-0-2=4)

Course Objectives:

- To acquire specific scripting knowledge to develop interactive applications.
- To understand the basics of android application development.
- To apply the programming skills in developing application pertaining to Industrial, medical, agricultural, etc.

UNIT	CONTENTS	HOURS
I	Introduction to Markup language, HTML document structure, HTML forms, Style (CSS), Multiple CSS stylesheets, DHTML, Tools for image creation and manipulation, User experience design, IoT development using charts	8
II	Introduction to JavaScript, Functions, DOM, Forms, and Event Handlers, Object Handlers, Input validation, J2ME, application design using J2ME , IoT development using Real time rules, platforms, alerts	8
III	Mobile app development: Android Development environment, Simple UI Layouts and layout properties, GUI objects, Event Driven Programming, opening and closing a Database, IoT Fundamentals and Components, Industrial Manufacturing, Monitoring, Control, Optimization and Autonomy, Introduction to Hadoop and big data analytics	10
IV	Smart Farming: Weather monitoring, Precision farming, Smart Greenhouse, Drones for pesticides, Energy Consumption Monitoring, Smart Energy Meters, Home automation, Smart Grid and Solar Energy Harvesting, Intelligent Parking, Data lake services scenarios.	10
V	Architecture of IoT for Healthcare, Multiple views coalescence, SBC-ADL to construct the system architecture. Use Cases : Wearable devices for Remote monitoring of Physiological parameter, ECG, EEG, Diabetes and Blood Pressure.	9

List of Practical

1.	Design and development of wireless video surveillance robot.
2.	Design and implementation of wearable glove to enable sign to speech conversation.
3.	IoT based home automation with security features.
4.	Smart farming : IoT based system for smart agriculture.
5.	IoT application to improvise industrial automation.
6.	Smart Energy meters to minimize power consumptions with a statistical approach.
7.	Bringing intelligence body area network – Smart Healthcare systems.

Course Outcomes as per Bloom's Taxonomy

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

CO1	**Understand**[2] the basic of HTML & CSS
CO2	**Implement**[3] the form by using HTML & JavaScript
CO3	**Interpret**[2] the fundamental of mobile development
CO4	**Relate**[3] use of smart farming and **Apply**[3] on various fields like farming, home automation etc.
CO5	**Reframe**[5] the use of IOT in healthcare system.
Text Books	• John Dean (2018), **Web Programming with HTML5, CSS and JavaScript**, Jones and Bartlett Publishers Inc., ISBN-10: 9781284091793 • DiMarzio J. F. (2016), **Beginning Android Programming with Android Studio**, 4th ed., Wiley, ISBN-10: 9788126565580.

Reference Books	• Fadi Al-Turjman (2019), **Intelligence in IoT- enabled Smart Cities**,1st edition, CRC Press, ISBN-10: 1138316849 • Giacomo Veneri, and Antonio Capasso (2018), Hands-on Industrial Internet of Things: Create a powerful industrial IoT infrastructure using Industry 4.0, Packt Publishing. • Subhas Chandra Mukhopadhyay (2012**), Smart Sensing Technology for Agriculture and Environmental Monitoring**, Springer, ISBN-10: 3642276377

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-I	Total Lecture:60 Theory: 45 Practical:15
AI20M202	DEEP LEARNING	(LTP= 3–0–2=4)

Course Objectives:

- Understand and learn to implement them in Keras and TensorFlow.
- Build convolutional networks for image recognition, recurrent networks for sequence generation, generative adversarial networks for image generation, and more.
- Understand the implementation of RNN.
- Understand the methods & implementation of CNN.
- Become an expert in neural networks.

UNIT	CONTENTS	HOURS
I.	Introduction To Neural Networks, Implementing Gradient Descents, Training Neural Networks, Sentiment Analysis, Keras, Tensorflow.	10
II.	Convolutional Neural Network, CNNs in Tensorflow, Weight Initialization, Autoencoders, Transfer Learning In Tensorflow, Deep Learning For Cancer Detection.	10
III.	Recurrent Neural Networks, Long Short-Term Memory Network, Implementation Of RNN And LSTM, Hyperparameters, Embeddings And Word2vec, Sentiment Prediction RNN.	10
IV.	Generative Adversarial Network, Deep Convolutional GANs, Generate Faces, Semi-Supervised Learning, The RL Framework: The Problem, The RL Framework: The Solution, Dynamic Programming.	8
V.	Monte Carlo Methods, Temporal-Difference Methods, RL In Continuous Spaces, Deep Q-Learning, Policy Gradients, Actor-Critic Methods.	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 the building blocks of AI as presented in terms of intelligent agents.
CO 2	C**hoose**[4] an appropriate problem-solving method and knowledge-representation scheme.
CO 3	Develop an ability to **analyze**[4] and formalize the problem (as a state space, graph, etc.) and select the appropriate search method.
CO 4	**Design**[6] simple intelligent systems
CO 5	**Develop**[2] various classical problems using different AI techniques.

Text Books	• Stuart Russell and Peter Norvig: **Artificial Intelligence: A Modern Approach**, IInd Edition, Pearson Education. • Elaine Rich, Kevin Knight, Nair B Shivshankar: **Artificial Intelligence**, McGraw Hill, IIIrd Edition. • Elaine Rich, Knight Kevin: **Artificial Intelligence**, IInd Edition, Tata McGraw Hill.
Reference Books	• Lugar George, (2002): **AI-Structures and Strategies for Complex Problem Solving**, IVth Edition, Pearson Education. • Nilsson J Nils: **Principles of Artificial Intelligence**, Narosa Publication. • Patrick H Winston: **Artificial Intelligence**, IIIrd edition, Pearson Education. • Khemani Deepak (2013): **A First Course in Artificial Intelligence**, Ist Edition, McGraw Hill Publication.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-I	Total Lecture:60 Theory:45 Practical:15
AI20M203	BIG DATA ANALYTICS	(LTP= 3–0–2=4)

Course Objectives:

- To understand Big Data Analytics for different systems like Hadoop.
- To learn the design of Hadoop File System.
- To learn how to analyze Big Data using different tools.
- To understand the importance of Big Data in comparison with traditional databases.
- Understand the concept of Hive Shell.

UNIT	CONTENTS	HOURS
I.	Introduction To Big Data And Hadoop: About database analytics,Database, Design, Model, Functions, Tools. Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Infosphere BigInsights and Big Sheets.	10
II.	HDFS(Hadoop Distributed File System): The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.	10
III.	Map Reduce Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.	10
IV.	Hadoop Eco System Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive: Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase HBasics, Concepts, Clients, Example, Hbase Versus RDBMS. Big SQL : Introduction	8
V.	Data Analytics with R Machine Learning: Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR.	7

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 working of Hadoop File System.
CO 2	C**orrelate**[4] Big Data using different tools.
CO 3	**Build**[4] a complete business data analytics solution
CO 4	**Design**[6] efficient algorithms for mining the data from large volumes

CO 5	**Aanalyze**[4] Hive Shell.
Text Books	• White Tom (2012): **Hadoop: The Definitive Guide**, IIIrd Edition, O'Reilly Publications. • De-Roos Dirk, Eaton Chris, Lapis George, Zikopoulos Paul, Deutsch Tom (2012): **Understanding Big Data Analytics for Enterprise Class Hadoop and Streaming Data**, Ist Edition, TMH.
Reference Books	• Marconi Katherine Hardcover, Lehmann Harold: **Big Data and Health Analytics** • Baesens Bart: **Analytics in a Big Data World: The Essential Guide to Data Science and its Applications**, Wiley Publications.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-II	Total Lecture:60 Theory:45 Tutorial:15
IO21M104	FOG COMPUTING	(LTP=3–1–0=4)

Course Objectives:

- Become familiar with the concepts of Fog.
- Understand the architecture and its components and working of components and its performance.
- Explore Fog on security, multimedia and smart data.
- Model the fog computing scenario.

UNIT	CONTENTS	HOURS
I	INTRODUCTION TO FOG COMPUTING Fog Computing-Definition-Characteristics-Application Scenarios - Issues -Fog Computing and Internet of Things-Pros and Cons-Myths of Fog Computing -Need and Reasons for Fog Computing Fog Computing and Edge Computing-IoT , FOG, CloudBenefits	10
II	ARCHITECTURE Working Procedure -Performance Evaluation Components-Software Systems – Architecture-Modeling and Simulation –Challenges	9
III	FOG PROTOCOLS Fog Protocol-Fog Kit- Proximity Detection Protocols-DDS/RTPS computing protocols –	9
IV	MANAGEMENT OF DATA AND SECURITY ANALYSIS Smart Management of Big Data-Smart Data-Structure of Smart Data- Smart Data Life Cycle-System Architecture-Multi-dimensional Payment Plan- -Security and Privacy Issues-Multimedia Fog Computing-Architecture-Deduplication-Hybrid Secure Deduplication- Security Challenges-Security Requirements	9
V	CASE STUDY Case Study: Wind Farm - Smart Traffic Light System, Wearable Sensing Devices, Wearable Event Device ,Wearable System, Demonstrations , Post Application Example ,Event Applications Example .	8

Course Outcomes as per Bloom's Taxonomy

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

CO1	**Understand** [2] the fundamental concepts in Fog
CO2	**Analyze**[4] the architectures available in Fog
CO3	Know and **explain**[2] the Protocols related to Fog.
CO4	**Comprehend**[2] the Data Management and Security Principles
CO5	**Examine**[5] the case studies of Fog.
Text Books	• Buyya, Rajkumar, Srirama Satish Narayana (2019): **Fog and edge computing: principles and paradigms**, 1st Edition, New Jersey: John Wiley & Sons. • Bilay John Mutumba , Gutsche Peter, Krimmel Mandy, Stiehl Volker (2019): **SAP Cloud Platform Integration: The Comprehensive Guide**, 2nd edition: Rheinwerg publishing.
Reference Books	• Bahga, Arshdeep, Madisetti Vijay (2013): **Cloud computing: A hands-on approach**, 1st Edition: CreateSpace Independent Publishing Platform. • Ovidiu Vermesan, Peter Friess (2014): **Internet of Things –From Research and Innovation to Market Deployment,** 1st Edition: River Publishers. • Missbach Michael, Staerk Thorsten, Gardiner Cameron, McCloud Joshua, Madl Robert, Tempes Mark, Anderson George (2016): **SAP on Cloud**, 1st Edition: Springer.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-II	Total Lecture:60 Theory:45 Tutorial : 15
IO21M104	EMBEDDED SYSTEM AND REAL TIME OPERATING SYSTEM	3–1–0=4

Course Objectives:

- Understand the concepts of embedded system design and analysis
- Learn the architecture and programming of ARM processor
- Be exposed to the basic concepts of embedded programming
- Learn the real time operating systems

UNIT	CONTENTS	HOURS
I	**INTRODUCTION TO EMBEDDEDSYSTEM DESIGN :**Complex systems and micro processors– Embedded system design process –Design example: Model train controller- Design methodologies- Design flows – Requirement Analysis – Specifications-System analysis and architecture design – Quality Assurance techniques -Designing with computing platforms – consumer electronics architecture –platform-level performance analysis.	10
II	**ARM PROCESSOR AND PERIPHERALS** ARM Architecture Versions – ARM Architecture – Instruction Set – Stacks and Subroutines – Features of the LPC 214X Family – Peripherals – The Timer Unit – Pulse Width Modulation Unit – UART – Block Diagram of ARM9 and ARM Cortex M3 MCU.	8
III	**EMBEDDED PROGRAMMING:**Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.	9
IV	**REAL TIME SYSTEMS**:Structure of a Real Time System — Estimating program run times – Task Assignment and Scheduling – Fault Tolerance Techniques – Reliability, Evaluation – Clock Synchronisation.	8
V	**PROCESSES AND OPERATING SYSTEMS**:Introduction – Multiple tasks and multiple processes – Multirate systems- Preemptive real□ time operating systems- Priority based scheduling- Interprocess communication mechanisms – Evaluating operating system performance- power optimization strategies for processes – Example Real time operating systems-POSIX-Windows CE. – Distributed embedded systems – MPSoCs and shared memory multiprocessors. – Design Example – Audio player, Engine control unit – Video accelerator.	10

Course Outcomes as per Bloom's Taxonomy

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

CO1	**Understand** [2] the basics of embedded system
CO2	**Develop**[6] real time systems that are highly time bounded.
CO3	**Apply**[3] various real time algorithms in building embedded systems.
CO4	**Implement**[6] the RTOS development tools in building real time embedded systems.
CO5	**Interpret** [2] the process of different task.
Text Books	• Marilyn Wolf (2012): **Computers as Components - Principles of Embedded Computing System Design**‖, 3rd Edition: Morgan Kaufmann Publisher (An imprint from Elsevier). • Liu Jane W.S. (2003): **Real Time Systems‖, Pearson Education**, 3rd: Indian

	Reprint.
Reference Books	• Lyla B.Das (2013): **Embedded Systems : An Integrated Approach**: Pearson Education. • Valvano Jonathan W (2012): **Embedded Microcomputer Systems Real Time Interfacing**, 3rd Edition: Cengage Learning. • Simon David. E (2007): An Embedded Software Primer, 1st Edition, Fifth Impression: Addison Wesley Professional. • Buhr Raymond J.A., Bailey Donald L (1999): **An Introduction to Real-Time Systems- From Design to Networking with C/C++**: Prentice Hall. • Krishna C.M., Shin Kang G.(1997): **Real-Time Systems, International Editions**, Noida : Mc Graw Hill. • Prasad K.V.K.K. (2005): **Embedded Real-Time Systems: Concepts, Design & Programming**: Dream Tech Press. • Iyer Sriram V, Gupta Pankaj (2004): **Embedded Real Time Systems Programming**, Noida: Tata Mc Graw Hill.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-II	Total Lecture:45 Tutorial: 15
DS20M110	**ADVANCED DBMS**	3-1-0=4

Course Objectives:

- Learn the data structures used in the implementation of physical layer of a DBMS.
- To understand the basic concepts and terminology related to DBMS and Relational Database Design.
- Tell how the various relational operators are evaluated in a DBMS.
- Compare the Relational DBMS with Object Databases and Distributed Databases.
- Outline the security and authorization used in a DBMS.
- To understand advanced DBMS techniques to construct tables and write effective queries, forms, and reports.

Unit	Contents	Hours
I	Introduction: Overview of storage and indexing, disks and files:Data on external storage; File organizations and indexing; Index data structures; Comparison offile organizations; Indexes and performance tuning. Memory hierarchy; RAID; Disk spacemanagement; Buffer manager; Files of records; Page formats and record formats.Tree structured indexing: Indexed Sequential Access Method(ISAM).	10
II	Hash Based Indexing: Static hashing; Extendible hashing, Linear hashing, comparisons.External Sorting: When does a DBMS sort data, A simple two-way merge sort; Externalmerge sort, Using B+ trees for sorting.Evaluating Relational Operators.	10
III	Query Optimization: Using Heuristics in Query Optimization, Using selectivity and costestimates in Query Optimization, Overview of Query optimization in Oracle, Semantic Query Optimization.Physical Database Design and Tuning: Clustering and indexing; Indexes that enable index-only plans; Overview of database tuning;Choices in tuning the conceptual schema; Choices in tuning queries and views.	10
IV	Object Databases: Concepts for Object Databases: Overview of Object-Oriented Concepts, Object Identity,Object Structure, and Type Constructors, Encapsulation of Operations, Methods, andPersistence, Type and Class Hierarchies and Inheritance, Complex Objects;Object Database Standards, Languages, and Design: Overview of the Object Model ofODMG, The Object Definition Language ODL, The Object Query Language OQL, Object-Relational and Extended-Relational Systems: Overview of SQL and its Object Relational features, Object-Relational Features of Oracle.	8
V	Distributed Databases: Distributed Database concepts; Data Fragmentation, Replication, and Allocation Techniques forDistributed Database Design; Types of Distributed Database Systems; Query Processing inDistributed Databases; Overview of Concurrency Control and Recovery in Distributeddatabases; Distributed databases in Oracle. Security and Authorization:Discretionary Access Control, Mandatory Access Control,Role of the Database Administrator.	7

Course Outcomes as per Bloom's Taxonomy

At the end of the course the students should be able to:	
CO 1	**Analyze**[4] the data structures used in the implementation of physical layer of a DBMS.
CO 2	**Understand**[2] an optimized DBMS query so that the result will be faster.
CO 3	**Describe**[1] how the various relational operators are evaluated in a DBMS.
CO 4	**Compare**[4] the Relational DBMS with Object Databases and Distributed Databases.
CO 5	**Contrast**[4] the security and authorization used in a DBMS.
Text Books	• Khicha Arihant, Kapoor Neeti **(**2018), **Advance Database Management System**, Genius Publications Pvt. Ltd. • Kim Won (2008), **Introduction to Object-oriented Databases**, The M.I.T. Press.
Reference Books	• Jarke Matthias, "**Query Optimization in Database Systems**", Springer. • Khicha Arihant, Kapoor Neeti **(**2018), **Advance Database Management System**, Genius Publications Pvt. Ltd.

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 Outcomes		
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 ispermissible. 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

Syllabus

For

MTech (Internet of Things)

Semester-II

School of Advanced Computing

COURSE CODE	PRINCIPLES OF SENSOR AND SIGNAL CONDITIONING	Total Lecture:60 Theory:45 Tutorial:15
IO21M201		(LTP=3–1–0=4)

Course Objectives:

- Understanding various input interfacing techniques for different kind of sensors like resistive, capacitive, inductive etc.
- Leaning non-idealities of amplifiers, improvement, reduction of noise, improvement of system performance etc.

UNIT	CONTENTS	HOURS
I	Introduction: Instrumentation and measurement system, Sensors, Primary sensing principles, Sensor performance characteristics, Sensor interfacing and signal conditioning circuit, integrated sensor system.	10
II	Signal Conditioning Circuits: Signal conditioning circuits for resistive, capacitive, and inductive sensors, electromagnetic and self-generating sensors, Error and Non-linearity reduction, Differential measurements.	9
III	Signal Amplifiers: Non-idealities of Op-Amp, Effect of Non-idealities, Differential Amplifier, Trans-impedance Amplifier, Cascaded Amplifiers, CMRR, Performance Analysis of Amplifiers, Instrumentation amplifier, Charge amplifier, Programmable gain amplifier, Switched apacitor amplifier.	9
IV	Interference and Noise: Interference types and reduction, Signal circuit grounding, Shield grounding, Isolation amplifier. Types of Noise and Noise Sources, Offset and Noise reduction techniques: Auto-zeroing (AZ), Chopper-stabilization (CHS), Correlated double sampling (CDS), Sigma-Delta (S?) modulation.	10
V	Packaging and Integration: Packaging and Encapsulation, Die and wafer level bonding, Types of packages, Sensor and Circuit integration: PCB, hybrid, monolithic, SOC and SIP.	7

Course Outcomes as per Bloom's Taxonomy

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

CO1	**Apply**[4] research and development in the area of advanced instrumentation and signal conditioning.
CO2	**Review**[5] with the sensor characteristics, basic signal conditioning circuits and sensor interfaces.
CO3	**Analyze**[4] and design different kinds of signal amplifiers, their non-idealities, and performances.
CO4	**Examine**[4] and design noise and interference reduction circuits and improve the system performance.
CO5	**Solve**[6] practical and state of the art problems related to sensor interfacing circuits and serve the related industries.
Text Books	• Pallás-Areny Ramon , Webster John G. (2012): **Sensors and Signal Conditioning**, 2nd Edition • Das Apurba (2012): **Signal Conditioning**, 1st edition, Springer-Verlag Berlin Heidelberg
Reference Books	• Pallas-Areny R. and Webster J. (1994) : **Sensors and Signal Conditioning**, ISBN0-471-54565-1

COURSE CODE	RFID AND MICROCONTROLLERS	Total Lecture:60 Theory:30 Tutorial:15 Practical:15
IO21M202		(LTP=2–1–2=4)

Course Objectives:

- To learn the basics of RFID and 8051 microcontrollers.
- Interfacing RFID with microcontrollers.
- To develop real time applications based on microcontrollers.
- Analyze different case studies.

UNIT	CONTENTS	HOURS
I	BAR CODES AND RFID: Bar codes and RFID basics- Components of an RFID system-Data -Tags-Antennas Connectors- Cables- Readers- encoder/ printers for smart labels- Controllers software- RFID advantages over Bar codes.	6
II	MICROCONTROLLERS: Intel 8051 - architecture- memory organization- special function registers- timing and control- port operation- memory interfacing - I/O interfacing- Programming the 8051 resources- interrupts- Measurement of frequency, period and pulse width of a signal power down operation.	6
III	INTEL 8051 MICROCONTROLLER- INSTRUCTION SET AND PROGRAMMING: Programmers model of Intel-Operand types- Operand addressing- Data transfer instructions- Arithmetic Instructions - Logic instructions- Control transfer instructions.- 8051 Interfacing and applications.	6
IV	RFID APPLICATIONS: Short range RFID applications- access control - personal identification - Transportation ticketing- blood , tissue and organ identification- fleet management personal identification- car body production-passport security. Long range RFID applications- supply chain management- Mail and shipping- Clothing Tags.	6
V	CASE STUDIES: Reading RFID cards using 8051- RFID in the supply chain- Vehicles parking using RFID- library management system- electronic toll payment- smart shipping containers fleet monitoring and management.	6

Course Outcomes as per Bloom's Taxonomy

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

CO1	**Understand**[2] the basic of bar codes & RFID
CO2	**Analyse**[4] the use of Microcontroller 8051.
CO3	**Apply**[3] the basic of Microcontroller programming.
CO4	**Examine**[4] the use of RFID application.
CO5	**Illustrate**[2] the use of RFID in supply chain.
Text Books	• Brown Dennis E. (2007): **RFID implementation,** Tata McGraw - Hill • Shepard Steven: **RFID: Radio frequency and Identification**, Tata McGraw - Hill.
Reference Books	• Pal Ajit (2011): **Microcontrollers- principles and applications**, India: Prentice hall. • Kant Krishna (2011): **Microprocessors and Microcontrollers**, India: Prentice hall.

COURSE CODE	CLOUD ARCHITECTURE AND COMPUTING	Total Lecture:60 Theory:45 Practical:15
IO21M203		(LTP=3–0–2=4)

Course Objectives:

- To understand the differences between traditional deployment and cloud computing.
- To determine whether existing applications to the cloud makes technical and business sense.
- To analyze and compare the long-term costs of cloud services.
- To learn how to build a transactional web application for the cloud or migrate one to it.
- Change your perspective on application scaling in cloud environment for quality metrics.

UNIT	CONTENTS	HOURS
I	CLOUD ARCHITECTURE BASICS: The Cloud -Hype cycle-metaphorical interpretation-cloud architecture standards and interoperability- Cloud types; IaaS, PaaS, SaaS. Benefits and challenges of cloud computing, public, private clouds community cloud, role of virtualization in enabling the cloud.	9
II	END TO END DESIGN: Requirement analysis: strategic alignment and architecture development cycle strategic impact-Risk impact-financial impact-Business criteria-technical criteria-cloud opportunities –evaluation criteria and weight-End to end design-content delivery networks-capacity planning-security architecture and design	9
III	CLOUD APPLICATION ARCHITECTURES: Development environments for service development; Amazon, Azure, Google Appcloud platform in industry	9
IV	HOW TO MOVE APPLICATION INTO THE CLOUD: Web Application Design- Machine Image Design-privacy design –Database management	9
V	SPECIALIZED CLOUD ARCHITECTURE: Workload distribution architecture-Dynamic scalability-Cloud bursting-hypervisor clustering-service quality metrics & SLA.	9

Course Outcomes as per Bloom's Taxonomy

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

CO1	**Classify**[2] between traditional deployment and cloud computing.
CO2	**Determine**[3] whether existing applications to the cloud makes technical and business sense.
CO3	**Analyze**[4] and compare the long-term costs of cloud services.
CO4	**Build**[3] a transactional web application for the cloud or migrate one to it.
CO5	**Understanding**[2] of cloud architecture & its Environment.
Text Books	• Reese, G. (2009): **Cloud Application Architectures: Building Applications and Infrastructure in the Cloud**, Sebastopol, CA: O'Reilly Media, Inc. • Rhoton John (2013): **Cloud Computing Explained: Handbook for Enterprise Implementation**, recursive press.
Reference Books	• Buyya Rajkumar, Vecchiola Christian, Thamarai Selvi S. (2013): **Mastering Cloud Computing: Foundations and Applications Programming** ,Elsevier publication, • Erl Thomas, Mahmood Zaigham, and Puttini Ricardo (2013): **Cloud Computing Concepts, Technology & Architecture**, Prentice Hall.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-III	Total Lecture:60 Theory:45 Tutorial:15
IO21M204	COMPUTER NETWORKS AND MANAGEMENT	(LTP=3–1–0=4)

Course Objectives:

- To study the different kinds of network.
- Effects of congestion and congestion control in networks
- Learn the different approaches to support the provision of Quality of service
- To study about SNMP application and network management tools.

UNIT	CONTENTS	HOURS
I	Internet - The network edge- The network core- Delay , Loss and Throughput in packet switched networks- protocol layers and their service models- TCP/IP protocol architecture- Frame relay networks- ATM networks- protocol architecture- ATM logical connections- ATM cell.	9
II	Effects of congestion - Congestion control - Traffic management - Congestion control in packet switching networks - Frame relay- Congestion control -TCP flow control and TCP congestion control.	9
III	Integrated services architecture - Queuing discipline- Random early detection - Differentiated service - Resource reservation -RSVP- multiprotocol label switching Real time transport protocol.	9
IV	Network management - architecture and organization- network management perspectives-NMS platform- SNMPv3 - architecture- applications- Management information base- Remote monitoring- RMON1 - RMON2.	9
V	System utilities for Management - Network statistics measurement systems- NMS design- Network management systems- Configuration management - fault management - fault management- performance management .	9

Course Outcomes as per Bloom's Taxonomy

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

CO1	**Understand**[2] the different layer & their protocol.
CO2	**Analyze**[4] the effects of congestion and its control.
CO3	**Interpret**[3] about the architecture of integrated services.
CO4	**Demonstrate**[2] different protocol of network management.
CO5	**Survey**[4] the utilities of network management.
Text Books	• William Stallings(2011), **Computer Networking with Internet protocols and Technology, Pearson Education**, 6th printing. • Mani Subramanian(2012), **Network Management Principles and Practice** , second edition, Pearson education.
Reference Books	• William Stallings(2012), **High speed networks and Internet**, second edition, Pearson Education.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-III	Total Lecture:60 Theory:45 Tutorial:15
IO21M205	RF AND MICROWAVE SENSORS	(LTP=3–1–0=4)

Course Objectives:

- To introduce the students with different RF and Microwave sensors,
- To familiarize antenna design with a good understanding of their parameters and applications.
- To introduce comprehensive knowledge of wearable antenna.
- To explore and understand basics of RFID technology.

UNIT	CONTENTS	HOURS
I	RF Sensors Microwave Antenna-Introduction, types of Antenna, fundamental parameters of antennas, radiation mechanism, Fresnel and Fraunhofer regions. Antenna for communication and Antenna for sensing, radiometer and radar	9
II	Antenna for personal area communication: Concepts of Printed Antennas, Broadband Microstrip Patch Antennas, Antennas for Wearable Devices, Design Requirements, Modeling and Characterization of Wearable Antennas, WBAN Radio Channel Characterization and Effect of Wearable Antennas, Domains of Operation, Sources on the Human Body, Compact Wearable Antenna for different applications.	8
III	Radar Introduction to RADAR, RADAR range equation, MTI and pulse Doppler RADAR, Tracking RADAR, SAR pulse RADAR, CW RADAR. Applications of Radar Automotive, remote sensing, agriculture, medicine, detection of buried objects, NDT, defense factors affecting the performance of RADAR, RADAR transmitters, Receivers,	10
IV	Radiometers Radiative transfer theory, SMMR, Types of radiometers - and Bolometers, Applications in automotive, agriculture, medicine, weather forecasting .	8
V	Microwave power Sensors Diode Sensors: Diode detector principles, dynamic range average power sensors, signal waveform effects on the measurement uncertainty of diode sensors. Thermocouple Sensors: Principles of Thermocouple sensor, power meters for thermocouple sensors.	10

Course Outcomes as per Bloom's Taxonomy

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

CO1	Select a proper antenna **design**[6] to be used in the RF spectral region.
CO2	**Apply**[4] the basic knowledge in the measurement of RF radiation
CO3	**Understand**[2] about the RADAR and It's application.
CO4	**Correlate**[4] the principle behind different radar systems and determine various applications based on the radar systems.
CO5	**Interpret**[2] about the power sensor and diode sensor.
Text Books	• Klaus Finkenzeuer (2011): **RFID Handbook**, 3rd edition, New Jersey: John Wiley and Sons. • Balanis Constantine A. (2016): **Antenna Theory Analysis and Design** , 4th Edition, New Jersey: John Wiley and Sons.
Reference Books	• Whitehouse O. (2014): **Security of things: An implementers' guide to cyber-security for internet of things devices and beyond**, 1st Edition: NCC Group. • DaCosta, Francis, Byron Henderson (2013): **Rethinking the Internet of Things: a scalable approach to connecting everything**, 1st edition: Springer Nature.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-III	Total Lecture:60 Theory:45 Tutorial:15
IO21M206	WEARABLE COMPUTING, MIXED REALITY AND INTERNET OF EVERYTHING	3–1–0=4

Course Objectives:

- Understand advanced and emerging technologies.
- Obtain skills to do advanced research and programming.
- Learn how to use software programs to perform varying and complex tasks.
- Expand upon the knowledge learned and apply it to solve real world problems.

UNIT	CONTENTS	HOURS
I	**INTRODUCTION** Introduction – History - Creative Coding Platforms - Open Source Platforms – PIC - Arduino, Sketch, Raspberry Pi, Iterative coding methodology – Python Programming - Mobile phones and similar devices - Arm Devices - Basic Electronics (circuit theory,measurements, parts identification) Sensors and Software: Understanding Processing Code Structure, variables and flow control, Interfacing to the Real World	9
II	**SOFTWARE HARDWARE FRAMEWORKS** Software: openFrameworks as our IDE (C/C++) - "Arduino" Language (C/C++) -Hardware: Desktop / Laptop / Raspberry Pi - How to approach a programming problem?Representing "reality" with computers.Digital vs. Analog circuits, audio, communication, etc.Analog to Digital Conversion (ADC) - Digital to Analog Conversion (DAC)– Microcontrollers - Communication – Serial& Parallel - Hardware to Hardware Communication - I2C/IIC (Inter-Integrated Circuit) - SPI (Serial Peripheral Interface) –Serial UART Communication	9
III	**CYBERNETICS AND HUMANISTIC INTELLIGENCE** Wearables - Augmented Reality – Mixed Reality.Case studies, Oculus Rift (2012,2013), AR versus VR - IoT and Wearables: Smart Cites and Wearable Computing as a form of urban design - Advanced I/O - openFrameworks:Live Network feeds (push and pull) - Data persistence (saving data and preferences) - Database interface (MySQL, sqLite, XML, PHP/Web) - Arduino:Wired/Wireless Networking (hardware vs. USB proxy) - Software serial (RS-232) talking to other devices - Advanced sensor/device communication SPI - Advance IC interfacing / Bitbanging (bitwise operators) - Linux –GPIO	9
IV	**THE WORLD OF THE FUTURE – INTERNET OF EVERYTHING** Humanistic Intelligence, Mann 1998. Wearable Computing and IoT (Internet of Things) The scalespace theory; sur/sousveillance; integrity; eillanceContract; Humanistic Intelligence; MedialityAxis? Overview of Mobile and Wearable Computing, Augmented Reality, and Internet of Things. The fundamental axes of the Wearables + IoT + AR space - Free-roaming AR: Wearable Computing, Wireless, Sensing, and Metasensing with light bulbs Phenomenal Augmented Reality: Real world physical phenomena as the fundamental basis of mobile and wearable AR.	9
V	**FUTURE AND PERSPECTIVES** Internet of Everything – The Future and perspectives – Challenges	9

Course Outcomes as per Bloom's Taxonomy

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

CO1	**Understand**[2] advanced and emerging technologies

CO2	**Interpret**[2] skills to do advanced research and programming.
CO3	**Contrast**[2] cybernetics and humanistic intelligence to perform varying and complex tasks
CO4	**Apply**[3] the concept of the world of the future – internet of everything
CO5	**Implement**[3] the knowledge learned and apply it to solve real world problems
Text Books	• Woodrow Barfield (2015): **Fundamentals of Wearable Computers and Augmented Reality**, Second Edition. • Ramon, Manoel (2014) : **Intel Galileo and Intel Galileo Gen 2API Features and Arduino Projects for Linux Programmers** .
Reference Books	• Scherz Paul and Monk Simon (2016) : **Practical Electronics for Inventors**, Third Edition. • Tickoo Omesh, Iyer Ravi (2016) : **Making Sense of Sensors: End-to-End Algorithms and Infrastructure Design Programming.**

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-IV	Total Lecture:60 Theory:45 Tutorial:15
IO21M207	SMART CONVERGENT TECHNOLOGIES	3–1–0=4

Course Objectives:

- Describe the various technologies used in telecommunications
- Explain the application of technologies, architectures, and protocols used in the telecommunications industry.
- Describe 1G, 2G, 3G, 4G, LTE, WiMAX and their role in present and future Mobility.

UNIT	CONTENTS	HOURS
I	**INTRODUCTION TO TELECOMMUNICATIONS AND TRANSMISSION :** Human–Machine Interactions - Embedded Devices - Intelligent Wearable - Traffic Patterns - The Electromagnetic Spectrum - Analog and Digital, Multiplexing Media: Twisted-Pair - Coaxial Cable- Microwave – Satellites - Fiber Optics – Data Communication Traffic - Data Transmission - OSI and TCP/IP Reference Models	9
II	**INTRODUCTION TO THE INTERNET AND IP TELEPHONY :** Internet and Routing Protocols- Internet Architecture, and Infrastructure - Subnetting:IPv4, IPv6; DNS, QoS- Service Providers - IPT Network Architecture, QoS - VoIP Call Signaling Protocols - Digital Voice, ENUM- VPNs: Layer 3, 2, Security- Unified communications- IP voice and IPTV- The Broadband Infrastructure - Quality of Service-Virtualization- Cloud Computing	9
III	**FIBRE OPTIC NETWORKS, WIRED AND WIRELESS BROADBAND :-** Optical Networking Elements : Switches, Edge, Core - DSL - Cable TV Networks, Packet Cable- Fiber Solutions- Wireless Broadband- HANs PANs, CANs, MANs- Broadband PLT - Antennas- Wireless Bandwidth - Spectrum Utilization- Spread Spectrum	9
IV	**CELLULAR SERVICES AND STANDARDS :** Cellular: 2G, 2,5G, 3G, 4G. 5G - WiMax,LTE - mobile security - Digital Cellular Radio - Enhanced Data Services - Broadband Wireless 3G Standards : : UMTS, TDSCDMA,CDMA Solutions	9
V	**WIRELESS NETWORK ARCHITECTURE, WIRELESS AND MOBILITY :** BFWA- WLANs -IEEE 802.11a,b,g,n - IEEE 802.16, WiMax, WiBro and Mobile-Fi - VoWLAN - Integration of WLANs and Cellular Networks, RFIDMesh Networks - Mobile IP, IP Multimedia Subsystem - Applications, Mobile Video, Mobile TV, and Content	9

Course Outcomes as per Bloom's Taxonomy

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

CO1	**Understand**[2] the fundamental theory and concepts telecommunications and transmission
CO2	**Demonstrate**[2] internet and IP telephony Architecture, and Infrastructure
CO3	**Relate**[3] the fundamental theory fibre optic networks, wired and wireless broadband
CO4	**Apply**[3] cellular services and standards in telecommunications and transmission
CO5	**Analyze**[4] wireless network architecture, wireless and mobility and Applications Tools
Text Books	Goleniewski Lillian (2007): **LIDO Telecommunications Essentials,** 2nd edition, Addison-Wesley Professional.
Reference Books	

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-IV	Total Lecture:60 Theory:45 Tutorial:15
IO21M208	**MACHINE LEARNING**	**(LTP=3–1– 0=4)**

Course Objectives:

- Identify problems that are amenable to solution by AI methods, and which AI methods may be suited to solving a given problem.
- Formalize a given problem in the language/framework of different AI methods (e.g., as a search problem, as a constraint satisfaction problem, as a planning problem, as a Markov decision process, etc).
- Implement basic AI algorithms (e.g., standard search algorithms or dynamic programming).
- Design and carry out an empirical evaluation of different algorithms on problem formalization, and state the conclusions that the evaluation supports.

UNIT	CONTENTS	HOURS
I	Introduction-Towards Intelligent Machines, Well posed Problems, Example of Applications in diverse fields, Data Representation, Domain Knowledge for Productive use of Machine Learning, Diversity of Data: Structured Unstructured, Forms of Learning, Machine Learning and Data Mining, Basic Linear Algebra in Machine Learning Techniques.	**9**
II	Supervised Learning- Rationale and Basics: Learning from Observations, Bias and Why Learning Works: Computational Learning Theory, Occam's Razor Principle and Over fitting Avoidance Heuristic Search in inductive Learning, Estimating Generalization Errors, Metrics for assessing regression, Metris for assessing classification.	**9**
III	Statistical Learning- Machine Learning and Inferential Statistical Analysis, Descriptive Statistics in learning techniques, Bayesian Reasoning a probabilistic approach to inference, K-Nearest Neighbor Classifier. Discriminant functions and regression functions, Linear Regression with Least Square Error Criterion, Logistic Regression for Classification Tasks, Fisher's Linear Discriminant and Thresholding for Classification, Minimum Description Length Principle.	**9**
IV	Support Vector Machines (SVM)- Introduction, Linear Discriminant Functions for Binary Classification, Perceptron Algorithm, Large Margin Classifier for linearly separable data, Linear Soft Margin Classifier for Overlapping Classes, Kernel Induced Feature Spaces, Nonlinear Classifier, Regression by Support vector Machines. Learning with Neural Networks: Towards Cognitive Machine, Neuron Models, Network Architectures, Perceptrons, Linear neuron and the Widrow-Hoff Learning Rule, The error correction delta rule.	**9**
V	Decision Tree Learning: Introduction, Example of classification decision tree, measures of impurity for evaluating splits in decision trees, ID3, C4.5, and CART decision trees, pruning the tree, strengths and weakness of decision tree approach.	**9**

Course Outcomes as per Bloom's Taxonomy

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

CO1	**Understand**[2] the usage of 'the internet of things' in different contexts
CO2	**Analyze**[4] on various key wireless technologies used in IoT systems, such as WiFi, 6LoWPAN, Bluetooth and ZigBee.
CO3	**Implement**[3] a simple IoT system made up of sensors, wireless network connection, data

	analytics and display/actuators, and writes the necessary control software.
CO4	**Demonstrate**[4] on various network protocols used in IoT.
CO5	**Illustrate**[3] on the role of big data, cloud computing and data analytics in IoT system.
Text Books	• Gopal, M. (2019), **Applied machine learning**, McGraw-Hill Education. • Mitchell, T. M., & Learning, M. (1997). Mcgraw-hill science. Engineering/Math,
Reference Books	• Müller, A. C., & Guido, S. (2016), **Introduction to machine learning with Python: a guide for data scientists,** " O'Reilly Media, Inc.". • Flach, P. (2012), **Machine learning: the art and science of algorithms that make sense of data**, Cambridge University Press.

COURSE CODE	DISCIPLINE SPECIFIC ELECTIVE-IV	Total Lecture:60 Theory:45 Tutorial:15
IO21M209	PRIVACY AND SECURITY IN IOT	(LTP=3–1–0 =4)

Course Objectives:

- To know the state-of-the-art methodologies in Cyber Physical system.
- To impart knowledge on Model threats and countermeasures.
- To explore the Privacy Preservation and Trust Models in Internet of Things (IoT).
- To apply the concept of Internet of Things Security in the real world scenarios.

UNIT	CONTENTS	HOURS
I	**Introduction to IoT –Cyber Physical Systems:**IoT and cyber-physical systems, IoT security (vulnerabilities, attacks, and countermeasures), security engineering for IoT development, IoT security lifecycle.	9
II	**IoT as Interconnection of Threats :**Network Robustness of Internet of Things- Sybil Attack Detection in Vehicular Networks- Malware Propagation and Control in Internet of Things- Solution-Based Analysis of Attack Vectors on Smart Home Systems	9
III	**Crypto Foundations :** Block ciphers, message integrity, authenticated encryption, hash functions, Merkle trees, elliptic curves, public-key crypto(PKI), signature algorithms	9
IV	**Block Chains :** Crypto-currencies, Bitcoin P2P network, distributed consensus, incentives and proof-of-work, mining, script and smart contracts, wallets: hot and cold storage, anonymity, altcoins.	9
V	**Privacy Preservation for IoT :** Privacy Preservation Data Dissemination- Privacy Preservation Data Dissemination- Social Features for Location Privacy Enhancement in Internet of Vehicles- Lightweight and Robust Schemes for Privacy Protection in Key Personal IoT Applications: Mobile WBSN and Participatory Sensing.	9

Course Outcomes as per Bloom's Taxonomy

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

CO1	**Understand**[2] the cryptographic fundamentals for IoT
CO2	**Demonstrate**[2] the Security requirements in IoT.
CO3	**Apply**[3] the authentication credentials and access control
CO4	**Relate**[3] the Block Chains for IoT.
CO5	**Analyze**[4] the security principles and methodologies for Internet of Things
Text Books	• Hu Fei. (2016) ; **Security and privacy in Internet of things (IoTs): Models, Algorithms, and Implementations**, 1st edition, CRC Press. • Russell, Brian, Van Duren Drew (2016) : **Practical Internet of Things Security**, 1st edition, Packt Publishing Ltd.
Reference Books	• Whitehouse O. (2014): **Security of things: An implementers' guide to cyber-security for internet of things devices and beyond**, 1st edition, NCC Group. • DaCosta, Francis, Henderson Byron (2013): **Rethinking the Internet of Things: a scalable approach to connecting everything**, 1st edition, Springer Nature.

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 Outcomes		
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 a presentation 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 ispermissible. 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.