SANJEEV AGRAWAL GLOBAL EDUCATIONAL (SAGE) UNIVERSITY, BHOPAL

Scheme & Syllabus

for

Master of Technology (Artificial Intelligence)

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 Artificial Intelligence (AI) for higher studies, research, employability, product development and handle the realistic problems.

PEO-2: To understand industry careers involving innovation and programming solving using AI and Machine Learning technologies.

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 have the ability to apply the gained knowledge to improve the society ensuring ethical and moral values.

PEO-5: Promote Design, Research, and implementation of products and services in the field of Artificial Intelligence 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
AI20M102	Artificial Intelligence and Machine Learning	2	1	2	4	3	30	05	05	10	50	100	20	30	50	150
AI20M103	Essentials of Data Science	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 Experts

Second Semester																	
Course Code	**Course Title**	**Contact Hours per Week**			**Credits**	**ESE Duration (Hours)**	**Theory**						**Practical**			**G T**
		L	**T**	**P**			**MSE**	**ASG**	**TA**	**ATTD**	**ESE**	**Tot**	**CE**	**ESE**	**Tot**	
AI20M201	Evolutionary Computing	3	1	-	4	3	30	05	05	10	50	100	-	-	-	100
AI20M202	Deep Learning	2	1	2	4	3	30	05	05	10	50	100	20	30	50	150
AI20M203	Big Data Analytics	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	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 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
AI20M303	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

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**	
AI20M401	Dissertation Phase-II	-	-	32	16						-	-	200	200	400	400
		Total			**16**											**400**

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

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
	AI20M107	Knowledge Engineering and Expert System
	AI20M108	Computability Algorithms and Complexity
SN	**Course Code**	**DSE-II**
2.	AI20M109	Data Mining and Warehousing
	AI20M110	Computational Vision
	AI20M111	AI for Robotics
SN	**Course Code**	**DSE-III**
1.	DS20M201	Natural Language Processing
	AI20M208	Embedded System
	AI20M209	Pattern Recognition
SN	**Course Code**	**DSE-IV**
2.	AI20M210	Simulation and Modeling of Digital System
	AI20M211	Speech and Biometric Processing
	AI20M212	Semantic Web

SANJEEV AGRAWAL GLOBAL EDUCATIONAL (SAGE) UNIVERSITY, BHOPAL

Syllabus

for

Master of Technology (Artificial Intelligence)

I Semester

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 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	**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**, New Delhi :Sultan Chand & Sons,. • Jimmie Gilbert (2010): **Linear Algebra And Matrix Theory**, India: Elsevier. • 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., and Saleh, A.K.Md. Ehsanes (2009): **An introduction to probability and statistics- Second Edition**, India: Wiley. • Trefethen L. N. and Bau David (1997): **Numerical Linear Algebra**, Philadelphia: SIAM.

COURSE CODE	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	Total Lecture : 60 Theory : 45 Practical : 15
AI20M102		(LTP= 3 – 0 – 2 = 4)

Course Objectives:

- Learning basic concepts of various machine learning methods is primary objective of this course.
- To be able to formulate machine learning problems corresponding to different applications.
- To understand a range of machine learning algorithms along with their strengths and weaknesses.
- To be able to apply machine learning algorithms to solve problems of moderate complexity.
- Make student able to learn mathematical concepts, and algorithms used in machine learning techniques for solving real world problems

UNIT	CONTENTS	HOURS
I.	Introduction: Artificial Intelligence, AI Problems, AI Techniques, The Level of the Model, Criteria For Success. Defining the Problem as a State Space Search, Problem Characteristics, Production Systems, Search: Issues in The Design of Search Programs, Un-Informed Search, BFS, DFS; Heuristic Search Techniques: Generate-And- Test, Hill Climbing, Best-First Search, A*Algorithm, Problem Reduction, AO*Algorithm, Constraint Satisfaction, Means-Ends Analysis.	6
II.	Introduction to Machine Learning: Applications of ML, Difference between Data Mining and Predictive Analysis, Tools and Techniques of Machine Learning. What is Machine Learning, Basic Terminologies of Machine Learning	6
III.	Types of Machine Learning: Reinforcement Learning, Machine Learning Lifecycle, Supervised Learning, Unsupervised Learning, Introduction to ANN and deep neural networks, Principle component analysis.	6
IV.	Supervised Learning: Classification and Regression: Non-Linear Regression, Classification: K-Nearest Neighbour, Decision Trees, Linear Regression, Logistic Regression, Naïve Bayes, Regression: Model Representation, Support Vector Machines.	6

V.	Unsupervised and Reinforcement Learning: Genetic Algorithm, Clustering: K-Means Clustering, Density-Based Clustering, Hierarchical clustering	6

Course Outcomes as per Bloom's Taxonomy

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

CO 1	**Demonstrate**[2] fundamental understanding of the history of artificial intelligence (AI) and its foundations.
CO 2	**Apply**[3] basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
CO 3	**Demonstrate**[2] awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
CO 4	**Understand**[2] about various learning and their types.
CO 5	**Demonstrate**[2] an ability to share in discussions of AI, its current scope and limitations, and societal implications.
Text Books	• Luger F George: **Artificial Intelligence**, Singapore Pearson Education Publications • Rich Elaine and Knight: ***Artificial Intelligence,*** Mcgraw-Hill Publications.
Reference Books	• Patterson: ***Introduction To Artificial Intelligence & Expert Systems***,PHI • G. Weiss: ***Multi Agent systems- a modern approach to Distributed Artificial intelligence,*** MIT Press. • Russell and Norvig: ***Artificial Intelligence : A modern Approach***, Prentice Hall

COURSE CODE	ESSENTIALS OF DATA SCIENCE	Total Lecture : 60 Theory : 45 Practical : 15
AI20M103		(LTP= 3 – 0 – 2 = 4)

Course Objectives:

- To provide an understanding of the data science.
- To understand exploratory data analysis, and various machine learning methods
- To learn and understand analysis of data and pattern.
- To understand data Visualization techniques.
- To understand Feature Generation & Feature Selection methods.

UNIT	CONTENTS	HOURS
I.	Introduction: What is Data Science? - Big Data and Data Science hype – and getting past the hype – Datafication - Current landscape of perspectives - Skill sets needed, Statistical Inference - Populations and samples - Statistical modeling, probability distributions, fitting a model - Intro to R.	10
II.	Exploratory Data Analysis and the Data Science Process - Basic tools (plots, graphs and summary statistics) of EDA - Philosophy of EDA - The Data Science Process - Case Study: RealDirect (online real estate firm), Data Cleaning, Web Scraping. Linear Regression, Logistic Regression, k-Nearest Neighbors (k-NN), k-means, Clustering, Usage in Applications - Filtering Spam - Why Linear Regression and k-NN are poor choices for Filtering Spam - Naive Bayes and why it works for Filtering Spam - Data Wrangling: APIs and other tools for scrapping the Web	10
III.	Feature Generation and Feature Selection (Extracting Meaning From Data) - Motivating application: user (customer) retention - Feature Generation (brainstorming, role of domain expertise, and place for imagination) - Feature Selection algorithms – Filters; Wrappers; Decision Trees; Random Forests.	10
IV.	Recommendation Systems: Building a User-Facing Data Product - Algorithmic ingredients of a Recommendation Engine - Dimensionality Reduction - Singular Value Decomposition - Principal Component Analysis - Exercise: build your	8

	own recommendation system.	
V.	Mining Social-Network Graphs - Social networks as graphs - Clustering of graphs - Direct discovery of communities in graphs - Partitioning of graphs - Neighborhood properties in graphs, Data Visualization - Basic principles, ideas and tools for data visualization.	7

List of Experiments:

1. Use R to carry out basic statistical modeling and analysis.
2. Apply basic tools (plots, graphs, summary statistics) to carry out EDA.
3. Use APIs and other tools to scrap the Web and collect data.
4. Apply EDA and the Data Science process in a case study.
5. Apply basic machine learning algorithms (Linear Regression, k-Nearest Neighbors (k-NN), k-means, Naive Bayes) for predictive modeling. Explain why Linear Regression and k-NN are poor choices for Filtering Spam.
6. Explain why Naive Bayes is a better alternative.
7. Identify basic Feature Selection algorithms (Filters, Wrappers, Decision Trees, Random Forests) and use in applications.
8. Identify and explain fundamental mathematical and algorithmic ingredients that constitute a Recommendation Engine (dimensionality reduction, singular value decomposition, principal component analysis). Build own recommendation system using existing components.
9. Create effective visualization of given data (to communicate or persuade).

Course Outcomes as per Bloom's Taxonomy

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

CO 1	**Understand**[2] what Data Science is and the skill sets needed to be a data scientist.
CO 2	**Understand**[2] how to perform evaluation of learning algorithms and model selection.
CO 3	**Apply**[3] and use APIs and other tools to scrap the Web and collect data.
CO 4	**Experiment**[5] with Feature Generation algorithms (Filters, Wrappers, Decision Trees, Random Forests) and use in applications.
CO 5	**Create**[6] effective visualization of given data (to communicate or persuade).

Text Books	• Mitchell M Tom (2017): ***Machine Learning***, Ist Edition, India :Tata McGraw Hill • O'Neil Cathy and Schutt Rachel, (2013): ***Doing Data Science, Straight Talk From The Frontline***, Ist Edition, O′Reilly Publishers.
Reference Books	• VanderPlas Jake (2016***): Python Data Science Handbook,*** O'Reilly Media, Inc. • Leskovek Jure, Rajaraman Anand and Ullman Jeffrey (2014): ***Mining of Massive Datasets,*** v2.1, Cambridge University Press. • Murphy P Kevin (2012): ***Machine Learning: A Probabilistic Perspective***, Illustrated edition, MIT Press. • Provost Foster and Fawcett Tom (2013): ***Data Science for Business:What You Need to Know about Data Mining and Data-analytic Thinking***, 1st Edition, O′Reilly Publishers. • Hastie Trevor, Tibshirani Robert and Friedman Jerome (2009): ***Elements of Statistical Learning,*** IInd Edition, Springer Series. • Blum Avrim, Hopcroft John and Kannan Ravindran (2018): ***Foundations of Data Science***. • Zaki J Mohammed and Miera Wagner (2014): ***Data Mining and Analysis: Fundamental Concepts and Algorithms***, Cambridge University Press. • Han Jiawei, Kamber Micheline and Pei Jian (2011): ***Data Mining: Concepts and Techniques***, Third Edition.

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 Practical's

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	To **Identify**[1] how IoT differs from traditional data collection systems
Text Books	• Holler Jan, Tsiatsis Vlasios, Mulligan Catherine, Avesand Stefan, Karnouskos Stamatis, Boyle David (2014): ***From Machine-to-Machine to the Internet of Things:Introduction to a New Age of Intelligence***, 1st Edition, Academic Press. • Scholz-Reiter Bernd, Michahelles Florian: ***Architecting the Internet of***

	Things, Springer • Madisetti Vijay and Bahga Arshdeep (2014): ***Internet of Things (A Hands-on Approach)***, 1 st Edition, VPT. • http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html
Reference Books	• Minoli Daniel: ***Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications***, Willy Publications • Waher Peter: ***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.
Text Books	• Gonzalez A.J. and Dankel D. D. (1993): ***The Engineering of Knowledge-based Systems***, Prentice Hall. • Gonzalez J. Avelino, Dankel D Douglas (2000): ***Engineering of Knowledge-Based Systems***, Prentice Hall. • . Giarratano C Joseph, D. Rilez Gary (2004): ***Expert Systems: Principles and Programming***, Fourth Edition.
Reference Books	• Martin James , Oxman Steven (1988): ***Building Expert Systems,*** Prentice-Hall. • Hasan M.K., (2019): ***Fuzzy Sets and Fuzzy Logic with Applications Imprecision , Uncertainty and Vagueness,*** Illustrated edition, Scholars' Press. • Dennis Merritt: ***Building Expert Systems in Prolog***.

COURSE CODE	DSE-I COMPUTABILITY ALGORITHMS AND COMPLEXITY	Total Lecture : 60 Theory : 45 Practical : 15
AI20M108		(LTP= 3 – 0 – 2 = 4)

Course Objectives:

- To Identify and implement an appropriate algorithm for solving a novel problem;
- To Analyze an algorithm's asymptotic running time and memory consumption;
- To Evaluate a set of proposed algorithmic solutions to a problem according to given constraints
- To demonstrate the correctness of an algorithm.
- To develop an appreciation and understanding of the theoretical framework for computer science and some of the consequences of this theory.

UNIT	CONTENTS	HOURS
I.	Computability- algorithm, Turing machines, Turing machines importance's , Church's thesis, Turing machines and examples , Input and output of a Turing machine, Representing Turing , Examples of Turing machines , Variants of Turing machines, Computational power , Two-way-tape Turing machines , Multi-tape Turing machines , Codes for standard Turing machines, The universal Turing machine.	10
II.	Unsolvable problems – Introduction, The halting problem, Reduction , Godel's incompleteness theorem , Part I in a nutshell.	10
III.	Algorithms - Use of algorithms, Run time function of an algorithm, Choice of algorithm, Implementation.	10
IV.	Graph algorithms - Graphs: the basics, Representing graphs, Algorithm for searching a graph , Paths and connectedness , Trees, spanning trees , Complete graphs, Hamiltonian circuit problem (HCP), Weighted graphs, Minimal spanning trees , Prim's algorithm to find a MST, Shortest path , Travelling salesman problem (TSP),polynomial time , NP-completeness.	8

V.	Complexity - Basic complexity theory, Yes/no problems, Polynomial time Turing machines, Tractable problems, the class P, Intractable problems?, Exhaustive search in algorithms, deterministic Turing machines, Definition of non-deterministic TM, examples of NDTMs ,speed of NDTMs ,The class NP. NP-completeness - Introduction, Proving NP-completeness by reduction, Cook's theorem.	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] and implement an appropriate algorithm for solving novel problem;
CO 2	Learn and **Analyze**[2] an algorithm's asymptotic running time and memory consumption.
CO 3	**Evaluate**[5] a set of proposed algorithmic solutions to a problem according to given constraints.
CO 4	Can **demonstrate**[2] the correctness of an algorithm.
CO 5	To **develop**[6] an appreciation and understanding of the theoretical framework for computer science and some of the consequences of this theory.
Text Books	• Sipser (2014): ***Introduction to the Theory of Computation***, IIIrd edition, Cengage. • Papadimitriou (1994): ***Computational Complexity*** Addison-Wesley Pub Co.
Reference Books	• Kleinberg & Tardos. (2009): ***Algorithm Design***, Pearson.

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, kMedoids; Prediction: Numerical Prediction, Linear, Non-Linear	8

	Regression; Outlier Analysis: Applications, Techniques.	
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, Wiley John. (2002): ***The Data Warehouse Lifecycle Toolkit***, ISBN 9971-51-415-X. • Han Jiawei and Kamber Micheline, Kaufman Morgan: ***Data Mining: Concepts and Techniques***, 2nd Edition, ISBN 978-81-312-0535-8.

Reference Books	• Mallach G Efrem (2009): ***Decision Support and Data Warehouse Systems***, Tata McGraw Hill. • Berry M and . Linoff G, Wiley John (2008): ***Mastering Data Mining: The art and science of customer relationship management***, Ist Edition, Wiley India Pvt. Ltd.

COURSE CODE	DSE-II COMPUTATIONAL VISION	Total Lecture : 60 Theory : 45 Tutorial : 15
AI20M110		(LTP= 3 – 1 – 0 = 4)

Course Objectives:

- To review image processing techniques for computer vision.
- To understand shape and region analysis.
- To understand Hough Transform and its applications to detect lines, circles, ellipses.
- To understand three-dimensional image analysis and motion analysis techniques.
- To study some applications of computer vision algorithms

UNIT	CONTENTS	HOURS
I.	Image Processing Foundations: Review of image processing techniques - classical filtering operations – thresholding techniques - edge detection techniques - corner and interest point detection - mathematical morphology – texture.	10
II.	Shapes And Regions: Binary shape analysis - connectedness - object labeling and counting - size filtering - distance functions - skeletons and thinning - deformable shape analysis - boundary tracking procedures - active contours - shape models and shape recognition - centroidal profiles - handling occlusion - boundary length measures - boundary descriptors - chain codes - Fourier descriptors – region descriptors – moments.	10
III.	Hough Transform: Line detection - Hough Transform (HT) for line detection – foot-of-normal method – line localization - line fitting - RANSAC for straight line detection - HT based circular object detection - accurate center location - speed problem - ellipse detection - Case study: Human Iris location - hole detection - generalized Hough Transform - spatial matched filtering - GHT for ellipse detection -object location - GHT for feature collation.	10
IV.	3D Vision And Motion: Methods for 3D vision – projection schemes – shape from shading - photometric stereo – shape from texture – shape from focus - active range finding - surface representations - point-based representation – volumetric representations – 3D object recognition – 3D reconstruction - introduction to motion – triangulation - bundle adjustment - translational alignment - parametric motion - spline based motion - optical flow - layered motion.	8
V.	Application: Photo album - Face detection - Face recognition - Eigen faces - Active appearance and 3D shape models of faces Application: Surveillance -	7

	foreground-background separation – particle filters - Chamfer matching, tracking, and occlusion - combining views from multiple cameras – human gait analysis Application: In-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians **List of experiments ML** To implement various image processing techniques.	

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	Comprehend the **knowledge**[1] of image processing techniques required for computer vision.
CO 2	**Implement**[6] boundary tracking techniques and apply chain codes and other region descriptors
CO 3	**Apply**[6] Hough Transform for line, circle, and ellipse detections
CO 4	**Implement**[6] motion related techniques.
CO 5	**Develop**[6] applications using computer vision techniques.
Text Books	• Davies R.E (2012): ***Computer & Machine Vision***, Fourth Edition, Academic Press. • Szeliski R. (2011): ***Computer Vision: Algorithms and Applications***, Springer. • Prince J. D Simon. (2012): ***Computer Vision: Models, Learning, and Inference***, Cambridge University Press. • Nixon Mark and Aquado S. Alberto (2012): ***Feature Extraction & Image Processing for Computer Vision***, Third Edition, Academic Press.
Reference Books	• et al. Baggio D. L. (2012): ***Mastering Open CV with Practical Computer Vision Projects***, Packet Publishing. • Solem Erik Jan. (2012): ***Programming Computer Vision with Python: Tools andalgorithms for analyzing images***, O'Reilly Media.

COURSE CODE	DSE-II ARTIFICIAL INTELLIGENCE FOR ROBOTICS	Total Lecture : 60 Theory : 45 Tutorial : 15
AI20M111		(LTP= 3 – 1– 0 = 4)

Course Objectives:

- Leverage fundamentals of Al and robotics.
- Work through use cases to implement various machine learning algorithms.
- Explore Natural Language Processing (NLP) concepts for efficient decision making in robots.
- To understand robot speech recognition technique.
- To understand the working of robot.

UNIT	CONTENTS	HOURS
I.	Introduction to Robotics, types of Robots, Robot anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robotics-Simple problems Specifications of Robot, Robot classifications Architecture of robotic systems.	10
II.	Foundation for Advanced Robotics and AI, Basic principles of robotics and AI, Setting Up Your Robot-technical requirements, Software Setup, Hardware, , A Concept for a Practical Robot Design Process, Object Recognition Using Neural Networks and Supervised Learning.	10
III.	Picking up the Toys, Technical Requirement, Teaching the robot arm, Pick up objects using genetic algorithms.	10
IV.	Robot to Listen-Technical specifications, Robot speech recognition, Avoiding the Stairs- Technical specifications, Task Analysis	8
V.	Putting Things Away, Giving the Robot an Artificial Personality **List of experiments ML** To design and assemble the robot for basic operations.	7

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	**Understand**[2] path planning, decision trees, and search algorithms in order to enhance your robot, apply simulation techniques to give your robot an artificial personality.
CO 2	**Understand**[2] object recognition using neural networks and supervised learning techniques.
CO 3	**Illustrate**[4] objects using genetic algorithms for manipulation.
CO 4	**Create**[6] your robot to listen using NLP via an expert system.
CO 5	**Design**[6] using machine learning and computer vision to teach your robot how to avoid obstacles.
Text Books	• Govers X Francis. (2018): ***Artificial Intelligence for Robotics: Build intelligent robots that perform human tasks using AI techniques***, Ist Edition, Packt. • Corke Peter (2017): ***Robotics, Vision and Control: Fundamental Algorithms In MATLAB***, Second Edition (Springer Tracts in Advanced Robotics), Springer.

Code	SOFTWARE LAB-I PYTHON PROGRAMMING	Practical: 30
AI20M104		0– 0–4 = 2

Course Objectives:

- This course introduces core programming basics—including data types, control structures, algorithm development, and program design with functions—via the Python programming language.
- The course discusses the fundamental principles of Object-Oriented Programming
- Learn about data and information processing techniques.
- Students will solve problems and explore real-world software development challenges
- Learn to create practical and contemporary applications.

Unit	Contents	Hours
I.	Introduction to Python Programming Language. : Introduction to Python Language, Strengths and Weaknesses, IDLE, Dynamic Types, Naming Conventions, String Values, String Operations, String Slices, String Operators, Numeric Data Types, Conversions, Built In Functions	5
II.	Data Collections and Language Component: Introduction, Control Flow and Syntax, Indenting, The if Statement, Relational Operators, Logical, Operators, True or False, Bit Wise Operators, The while Loop, break and continue, The for Loop, Lists, Tuples, Sets, Dictionaries, Sorting Dictionaries, Copying Collections.	10
III.	Object and Classes : Classes in Python, Principles of Object Orientation, Creating Classes, Instance Methods, File Organization, Special Methods, Class Variables, Inheritance, Polymorphism, Type Identification, Custom Exception Classes	10
IV.	Functions and Modules : Introduction, Defining Your Own Functions, Parameters , Function Documentation, Keyword and Optional Parameters, Passing Collections to a Function, Variable Number of Arguments, Scope, Functions - "First Class Citizens", Passing Functions to a Function, Mapping Functions in a Dictionary, Lambda, Modules, Standard Modules – sys, Standard Modules – math, Standard Modules – time, The dir Function	10
V.	I/O and Error Handling In Python : Introduction, Data Streams, Creating Your Own Data Streams, Access Modes, Writing Data to a File, Reading Data From a File, Additional File Methods, Using Pipes as Data Streams, Handling IO	10

	Exceptions, Working with Directories, Metadata, Errors, Run Time Errors, The Exception Model, Exception Hierarchy, Handling Multiple Exceptions	

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	**Apply** the principles python programming
CO 2	**Write** clear and effective python code
CO 3	**Create** applications using python programming
CO 4	**Access** database using python programming
CO 5	**Develop** web applications using python programming
Text Books	• Dive into Python, Mike • Learning Python, 4th Edition by Mark Lutz • Programming Python, 4th Edition by Mark Lutz • Kenneth A. Lambert, The Fundamentals of Python: First Programs, 2011, Cengage Learning, ISBN: 978-1111822705.
Reference Books	• Starting Out with Python (2009) Pearson , Tonny Gaddis • Beginning Pyhton Wrox Publication Peter Norton, Alex Samuel • Python Algorithms Apress, Magnus Liet Hetland • Python Object Oriented Programming PACKT Press, Dusty Phillips • Python for Unix and Linux System Administration O'Relly, Noad Gift

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 systematic approach like problem identification, formulation and solution. • **Collaborate**[6] with professionals and the community at large in written 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

Syllabus

for

Master of Technology (Artificial Intelligence)

II Semester

School of Advanced Computing

COURSE CODE	EVOLUTIONARY COMPUTING	Total Lecture : 60 Theory : 45 Tutorial : 15
AI20M201		(LTP= 3 – 1 – 0 = 4)

Course Objectives:

- To develop coherent understanding of various areas of Advanced Mathematics.
- Understand 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.
- Understand the implementation issues of evolutionary algorithms.
- To understand Evolutionary algorithms.
- To understand Constraint techniques.

UNIT	CONTENTS	HOURS
I.	Introduction to Evolutionary Computation: Biological and artificial evolution, Evolutionary computation and AI, Different historical branches of EC, e.g., GAs, EP, ES, GP, etc. A simple evolutionary algorithm	10
II.	Search Operators: Recombination/Crossover for strings (e.g., binary strings), e.g., one-point, multi-point, and uniform crossover operators, Mutation for strings, e.g., bit-flipping, Recombination/Crossover and mutation rates, Recombination for real-valued representations, e.g., discrete and intermediate recombination, Mutation for real-valued representations, e.g., Gaussian and Cauchy mutations, self-adaptive mutations, etc. Why and how a recombination or mutation operator works, Mixing different search operators.An anomaly of self-adaptive mutations The importance of representation, e.g., binary vs. Gray coding, Adaptive representations.	10
III.	Selection Schemes: Fitness proportional selection and fitness scaling. Ranking, including linear, power, exponential and other ranking methods, Tournament selection Selection pressure and its impact on evolutionary search, Evolutionary Combinatorial Optimization, Evolutionary algorithms for TSPs, Evolutionary	10

	algorithms for lecture room assignment, Hybrid evolutionary and local search algorithms, Coévolution Coopérative coévolution, Niching and Speciation, Fitness sharing (explicit and implicit) Crowding and mating restriction.	
IV.	Constraint Handling: Common techniques, e.g., penalty methods, repair methods, etc. Analysis, Some examples, Genetic Programming, Trees as individuals Major steps of genetic programming, e.g., functional and terminal sets, initialization, crossover, mutation, fitness evaluation, etc. Search operators on trees, Automatically defined functions, Issues in genetic programming, e.g., bloat, scalability, etc. Examples Multi-objective Evolutionary Optimization Pareto optimality, Multiobjective evolutionary algorithms	8
V.	Learning Classifier Systems: Basic ideas and motivations, Main components and the main cycle, Credit assignment and two approaches. Theoretical Analysis of Evolutionary Algorithms, Schema theorems, Convergence of EAs, Computational time complexity of EAs, No free lunch theorem.	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 implementation issues of evolutionary algorithms.
CO 3	**Determine**[1] the appropriate parameter settings to make different evolutionary algorithms work well.
CO 4	**Design**[6] new evolutionary operators, representations and fitness functions for specific practical and scientific applications.
CO 5	**Understand**[2] genetic programming & techniques.

Text Books	• Fogel D. B. Baeck, and Michalewicz Z (eds.), (1997): ***Handbook on Evolutionary Computation*** ,TIOP Press. • Yao X. (ed.), (1999): ***Evolutionary Computation: Theory and Applications***, World Scientific Publ. Co., Singapore.
Reference Books	• Michalewicz Z, (1996)*:* ***Genetic Algorithms + Data Structures = Evolution Programs***, IIIrd Edition, Berlin: Springer-Verlag.

COURSE CODE	DEEP LEARNING	Total Lecture:60 Theory: 45 Practical:15
AI20M2020		(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	To develop a basic **understanding**[2] of the building blocks of AI as presented in terms of intelligent agents.

CO 2	To **choose**[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	To **develop/demonstrate**[2]**/** build simple intelligent systems
CO 5	To **develop/demonstrate**[2]**/** build various classical to y 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	BIG DATA ANALYTICS	Total Lecture : 60 Theory : 45 Practical : 15
AI20M203		(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	To gain **knowledge**[1] about working of Hadoop File System. .
CO 2	Ability to **analyze**[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	Ability to **analyze**[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	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	Probabilistic model of **defining**[1] language and techniques.
CO 3	**Applying**[3] Hidden Markov model and Speech Recognition.
CO 4	**Understand**[2] application of context free grammar and language parsing.
CO 5	Student should be able to make use of NLP concepts to **solve**[3] Information retrieval problems.
Text Books	• Jurafsky Daniel and Martin H. James (2008): ***Speech and Language Processing***, IInd Edition, Prentice Hall. • Aggarwal C. Charu (2018): ***Machine Learning for Text***, Ist Edition Springer. • D.Manning Christopher and Schuetze Hinrich (1999): ***Foundations of Statistical Natural Language Processing***, MIT press. • Bird Steven, Klein Ewan and Loper Edward (2009): ***Natural Language Processing with Python***, Ist Edition, O'Reilly Media.
Reference Books	• R.Hausser Roland (2011): ***Foundations of Computational Linguistics:Human-Computer Communication in Natural Language***, Paperback, MIT press.

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, John Wiley.
Reference Books	• Kamal Raj (2017): ***Embedded Systems***, IIIrd Edition, McGraw Hill, TMH. • K.V. Shibu (2017): ***Introduction to Embedded Systems,*** IInd Edition, McGraw Hill. • Lyla .(2013*): **Embedded Systems : An Integrated Approach***, Pearson. • E. Simon David: ***An Embedded Software Primer***, Pearson.

COURSE CODE	DSE-III PATTERN RECOGNITION	Total Lecture : 60 Theory : 45 Tutorial : 15
AI20M209		(LTP= 3 – 1– 0 = 4)

Course Objectives:

- To equip students with basic mathematical and statistical techniques commonly used in pattern recognition.
- To introduce students to a variety of pattern recognition algorithms.
- Enable students to apply machine learning concepts in real life problems
- To understand parameter estimation methods.
- To understand pattern recognition techniques to real-world problems such as document analysis and recognition.

UNIT	CONTENTS	HOURS
I.	Basics of Probability, Random Processes and Linear Algebra (recap): Probability: independence of events, conditional and joint probability, Bayes theorem Random Processes: Stationary and non-stationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra. Linear Algebra: Inner product, outer product, inverses, eigen values, eigen vectors, singular values, singular vectors.	10
II.	Bayes Decision Theory : Minimum-error-rate classification. Classifiers, Discriminant functions, Decision surfaces. Normal density and discriminant functions. Discrete features.	10
III.	Parameter Estimation Methods : Maximum-Likelihood estimation :Gaussian case. Maximum a Posteriori estimation. Bayesian estimation: Gaussian case. Unsupervised learning and clustering - Criterion functions for clustering. Algorithms for clustering: K-Means, Hierarchical and other methods. Cluster validation. Gaussian mixture models, Expectation-Maximization method for parameter estimation. Maximum entropy estimation. Sequential Pattern Recognition. Hidden Markov Models (HMMs). Discrete HMMs. Continuous HMMs. Nonparametric techniques for density estimation. Parzen-window method. K-Nearest Neighbour method.	10
IV.	Dimensionality reduction: Principal component analysis - it relationship to eigen analysis. Fisher discriminant analysis - Generalised eigen analysis. Eigen vectors/Singular vectors as dictionaries. Factor Analysis, Total variability space - a dictionary learning methods. Non negative matrix factorisation - a dictionary learning method.	8

V.	Linear discriminant functions : Gradient descent procedures, Perceptron, Support vector machines - a brief introduction.	7

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	**Understand**[2] machine learning concepts and range of problems that can be handled by machine learning.
CO 2	**Compare**[2] and parameterize different learning algorithms
CO 3	**Apply**[3] the machine learning concepts in real life problems.
CO 4	**Apply**[3] performance evaluation methods for pattern recognition, and critique comparisons of techniques made in the research literature
CO 5	**Summarize**[2]**, analyze**[4], and relate research in the pattern recognition area verbally and in writing.
Text Books	• Duda R.O., Hart P.E. and Stork D.G. (2001): ***Pattern Classification***, John Wiley. • Theodoridis S. and Koutroumbas K. (2009): ***Pattern Recognition***, IVth Edition , Academic Press, • Bishop C.M. (2006): ***Pattern Recognition and Machine Learning***, Springer.

COURSE CODE	DSE-IV SIMULATION AND MODELING OF DIGITAL SYSTEM	Total Lecture : 60 Theory : 45 Tutorial : 15
AI20M210		(LTP= 3 – 1– 0 = 4)

Course Objectives

- Understand the introduction of simulation.
- To understand the Basic concept of modeling.
- To understand different types of simulation technique.
- Understand the Knowledge of simulation language.
- Understand different simulators.

UNIT	CONTENTS	HOURS
I.	System definition and components, stochastic activities, continuous8and discrete systems, System modeling, Types of models, static and dynamic physical models, static and dynamic mathematical models, full corporate model, types of system study.	10
II.	System simulation, Need of simulation, Basic nature of simulation,8techniques of simulation, comparison of simulation and analytical methods, types of system Simulation, real time simulation, hybrid simulation, simulation of pursuit problem, single-server queuing system and an inventory problem, Monte-Carlo simulation, Distributed Lag model, Cobweb model.	10
III.	Simulation of continuous Systems, analog vs digital simulation, simulation of water reservoir system, simulation of a servo system, simulation of an auto-pilot. Discrete system simulation, fixed time-step vs event-to-event model, generation of random numbers, test of randomness, Monte-Carlo computation vs stochastic simulation.	10
IV.	System dynamics, exponential growth models, exponentialdecay8models, logistic curves, system dynamics diagrams, world model.	8

V.	V Simulation of PERT networks, critical path computation, uncertainties in activity duration, resource allocation and consideration, Simulation languages, object oriented simulation.	7

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	**Demonstrate**[4] Modeling of system.
CO 2	**Apply**[3] techniques of simulation.
CO 3	**Demonstrate**[4] types of simulation.
CO 4	**Demonstrate**[4] exponential growth models.
CO 5	**Understand**[2] the concept of PERT network.
Text Books	• Gordon Geoftrey: ***System Simulation***, PHI • Deo Narsingh: ***System Simulation with digital computer***, PHI. • M. Law Averill, David Kelton W: ***Simulation Modelling and Analysis***,TMH.
Reference Books	• M Law Averill, David Kelton W: ***Simulation Modeling & Analysis***, McGraw Hill. • International Editions – Industrial Engineering series, ISBN – 0-07-100803-9.

COURSE CODE	DSE-IV SPEECH AND BIOMETRIC PROCESSING	Total Lecture : 60 Theory : 45 Tutorial : 15
AI20M211		(LTP= 3 – 1– 0 = 4)

Course Objectives:

- Understanding of the fundamentals of the speech processing.
- Explore the various speech models. Gives knowledge about the phonetics and pronunciation processing. Perform wavelet analysis of speech.
- Understanding of Speech Pronunciation And Signal Processing
- To develop an appreciation and understanding of the theoretical framework for computer science and some of the consequences of this theory.
- Understand and apply different models for speech recognition.

UNIT	CONTENTS	HOURS
I.	Introduction: Knowledge in speech and language processing – ambiguity – models and algorithms – language – thought – understanding – regular expression and automata – words & transducers – N grams.	10
II.	Speech Modelling: Word classes and part of speech tagging – hidden markov model – computing likelihood: the forward algorithm – training hidden markov model – maximum entropy model – transformation-based tagging – evaluation and error analysis – issues in part of speech tagging – noisy channel model for spelling.	10
III.	Speech Pronunciation And Signal Processing: Phonetics – speech sounds and phonetic transcription – articulatory phonetics – phonological categories and pronunciation variation – acoustic phonetics and signals – phonetic resources – articulatory and gestural phonology.	10
IV.	Speech Identification: Speech synthesis – text normalization – phonetic analysis – prosodic analysis – diphone waveform synthesis – unit selection waveform synthesis – evaluation.	8
V.	Speech Recognition: Automatic speech recognition – architecture – applying hidden markov model – feature extraction: mfcc vectors – computing acoustic likelihoods – search and decoding – embedded training – multipass decoding: n-best lists and lattices- a* (_stack‘) decoding – context-dependent acoustic	7

	models: triphones – discriminative training – speech recognition by humans.	

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	**Create**[6] new algorithms with speech processing.
CO 2	**Derive**[4] new speech models.
CO 3	Perform various language phonetic **analysis**[4]**.**
CO 4	**Create**[6] a new speech identification system.
CO 5	**Generate**[6] a new speech recognition system.
Text Books	• Daniel Jurafsky and James H. Martin. (2013*)," Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition"*, Person education.
Reference Books	• Lee Kai-Fu (1999): ***Automatic Speech Recognition***, The Springer International Series in Engineering and Computer Science. • Chaurasiya Himanshu (2010): ***Soft Computing Implementation of Automatic Speech Recognition***, LAP Lambert Academic Publishing. • Becchetti Claudio, Prina Ricotti Klucio. (2008): ***Speech Recognition: Theory and C++ implementation***, Wiley publications. • Eldirawy Ikrami , Ashour Wesam. (2011): ***Visual Speech Recognition***, Wiley publications.

COURSE CODE	DSE-IV SEMANTIC WEB	Total Lecture : 60 Theory : 45 Tutorial : 15
AI20M212		(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	**Understand**[2] logic semantics and inference with OWL.
CO 4	**Applying**[3] ontology engineering approaches in semantic applications
CO 5	**Experimenting**[3] Web graph processing for various applications.
Text Books	• Lee Berners, Godel and 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: ***Semantic Web Technologies, Trends and Research in Ontology Based Systems***, John Wiley & Sons. • Lu. Liyang (2017): ***Semantic Web and Semantic Web Services***, Chapman & Hall/CRC Publishers (Taylor & Francis Group). • Stucken schmidt Heiner, Van Harmelen Frank: **Information sharing on the semantic Web**, Springer Publications. • Segaran T, Evans C, Taylor J: ***Programming the Semantic Web***, O'Reilly, SPD.

Code	SOFTWARE LAB-II R PROGRAMMING	Practical: 30
AI0M204		0– 0–4 = 2

Course Objective

- To learn how to program in R
- To learn how to use R for effective data analysis.
- You will learn how to install and configure software necessary for a statistical programming environment.
- The course covers practical issues in statistical computing which includes programming in R, reading data into R, accessing R packages, writing R functions, debugging, and organizing and commenting R code.

Unit	Contents	Hours
I.	Introduction: Introducing to R, R Data Structures, Help functions in R, Vectors, Scalars, Declarations, recycling, Common Vector operations, Using all and any, Vectorized operations, NA and NULL values, Filtering, Vectorized if-then else, Vector Equality, Vector Element names	5
II.	Matrices, Arrays And Lists: Creating matrices, Matrix operations, Applying Functions to Matrix Rows and Columns, Adding and deleting rows and columns, Vector/Matrix Distinction, Avoiding Dimension Reduction, Higher Dimensional arrays, lists, Creating lists, General list operations, Accessing list components and values, applying functions to lists, recursive lists	10
III.	Data Frames: Creating Data Frames, Matrix-like operations in frames, Merging Data Frames, Applying functions to Data frames, Factors and Tables, factors and levels, Common functions used with factors, Working with tables, Other factors and table related functions, Control statements, Arithmetic and Boolean operators and values, Default values for arguments, Returning Boolean values, functions are objects, Environment and Scope issues, Writing Upstairs, Recursion, Replacement functions, Tools for composing function code, Math and Simulations in R	10
IV.	OOP: S3 Classes, S4 Classes, Managing your objects, Input/Output, accessing keyboard and monitor, reading and writing files, accessing the internet, String Manipulation, Graphics, Creating Graphs, Customizing Graphs, Saving graphs to files, Creating three-dimensional plots	10
V.	Interfacing: Interfacing R to other languages, Parallel R, Basic Statistics, Linear Model, Generalized Linear models, Non-linear models, Time Series and Auto-correlation, Clustering	10

Course Outcomes as per Bloom's Taxonomy	
At the end of the course the students should be able to:	
CO 1	**Understand** the basics in R programming in terms of constructs, control statements, string functions
CO 2	**Understand** the use of R for Big Data analytics
CO 3	**Create** applications using R programming
CO 4	**Learn** to apply R programming for Text processing
CO 5	**Apply** the R programming from a statistical perspective
Text Books	• Norman Matloff , "The Art of R Programming: A Tour of Statistical Software Design", No Starch Press, 2011 • Jared P. Lander, "R for Everyone: Advanced Analytics and Graphics", Addison-Wesley Data & Analytics Series, 2013.
Reference Books	• Mark Gardener, " Beginning R – The Statistical Programming Language", Wiley, 2013 • Robert Knell, "Introductory R: A Beginner's Guide to Data Visualisation, Statistical Analysis and Programming in R", Amazon Digital South Asia Services Inc, 2013.

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 systematic approach like problem identification, formulation and solution. • **Collaborate**[6] with professionals and the community at large in written 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

Syllabus

for

Master of Technology (Artificial Intelligence)

III & IV Semester

School of Advanced Computing

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.