DR. BABASAHEB AMBEDKAR MARATHWADA

UNIVERSITY, AURANGABAD

NAAC Reaccredited A Grade

FACULTY OF SCIENCE & TECHNOLOGY

2 Years / 1 Year M.Sc. Artificial Intelligence

(For University Department)
Course Structure

(Effective from 2023-24)

COURSE STRUCTURE AS PER GUIDELINES OF NEP 2020

Illustrative Credit distribution structure for two/ one year M.Sc. Artificial Intelligence Programme with Multiple Entry and Exit options for Discipline Specific Course in Artificial Intelligence

A) Preamble

Welcome to Department of Computer Science and Information Technology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad. The department is one of the most vibrant departments on the university campus and also recognized by Department of Science and Technology (**DST**) **FIST**, University Grants Commission (**UGC**) **SAP** (DRS – PHASE 1, PHASE 2) programs of Government of India.

Department of Computer Science and Information Technology adopted a credit-based system under the Academic Flexibility Program of the University from the academic year 2011-12 and marching ahead with incorporation of guidelines of National Education Policy 2020. The department of computer science and information technology has provided excellent learning environment for the student by providing state of art curriculum offering latest technology trends that designed to meet expectation of industries and research. The courses offer flexible, cafeteria-type learning system with an inbuilt horizontal mobility for students to all desireunits of education in the Department/Departments with provision for even inter Departmental mobility for students.

The Outcome Based Education (OBE) and Choice Based Credit System (CBCS) operating cohesively towards implementation of modular pattern where module / units called "credits", wherein 'credit' defines the quantum of contents / syllabus prepared for a course / paper and determines the minimum number of teachings-learning hours required to utilized towards module.

OBE & CBCS permits students to:

- Learn at their own pace,
- Choose electives from a wide range of elective courses offered by the department,
- Undergo additional/value added courses and acquire more than the required number of credits, depending upon the learner aptitude,
- Adopt an interdisciplinary approach in learning,
- Make best use of the expertise of faculty across the Department, beside the particular department faculty
- Acquire knowledge, skill and attitude of learning outcomes through participatory teaching and learning and continuous evaluation process

This provides the flexibility to make the system more responsive to the changing needs of our students, the professionals and society. The credit-based system also facilitates the transfer of credits.

B) Master's programs offered by the Department

Sr. No	Name of Master Program	Duration	Intake
1	M.Sc. Computer Science	1 Yr.[@] / 2Yr.[$]	32[*]+ 08[#]
2	M.Sc. Information Technology	1 Yr.[@] / 2Yr.[$]	32[#]
3	M.Sc. Artificial Intelligence	1 Yr.[@] / 2Yr.[$]	32[#]

*Grant in Aid, [#]Non-Grant, [@]PG-Diploma (up on exit), [$]Master Degree upon Exit option of NEP

C) Admission to M.Sc. Artificial Intelligence Program

The admission to M.Sc. Artificial Intelligence program is conducted by the university by announcement of admission notification on www.bamu.ac.in and Centralized Admission process have been adopted for filling all seats as per intake capacity. For more information and detail kindly visit university website for all required details. Once the student is admitted to the department for the course, he/she will be promoted to next semester with full carry-on; subject to the registration of student in every consecutive semester. Dropout student will be allowed to register for respective semester as and when the concerned courses are offered by the department, subject to the condition that his/her tenure should not exceed more than twice the duration of course from the date of first registration at parent department. The admission of concern student will be automatically get canceled if he/she fails to complete the course in maximum period (Four years / Eight semesters) and to be observed with time to time amendments.

D) Eligibility for the course:

i) B.Sc. Computer Science (**OR)** B.Sc. Information Technology **(OR)** B. Sc. Computer Application (Science & Technology) **(OR)** B.E/B. Tech. in Computer Science and Engineering/IT. (**OR)** ii) Any Science Graduate with at least one Optional Subject as Computer Science.

If any seat vacant after following above criteria students with B.Voc(IT) ,B.Voc(Automation), and B.E.(Mech.Eng.) can be allotted seats (admission).

E) Course Fees:

Please refer to the course prospectus of university for the course fees. Course Fees for M.Sc. Artificial Intelligence is 26241/- (Non-Grant) per year.

F) Credits and Degrees:

i) A candidate who has successfully completed all the core courses, Elective / Specialized courses and, seminars and project prescribed and or optional service courses approved by the University for the program with prescribed CGPA shall be eligible to receive the degree.

ii) One Credit shall mean one teaching period of one hour per week for one semester (of 15 weeks) for theory courses and two practical / laboratory / field / demonstration hours / week for one semester.

iii) Every student will have to complete at least 88 credits to obtain the master's degree of M. Sc. Artificial Intelligence(Post graduate degree) out of which 88 credits should be from this Department.

iv) The department is committed towards ensuring the provision of the necessary contact hours for course engagement by the faculty. Accordingly, the workload for both the course and faculty will be calculated, taking into account the allocated contact hours for one credit in theory as well as practical components as per following

   a. 1 Credit (THEORY) = 15 Contact Hours / Semester i.e 1 Contact hour per week
   b. 1 Credit (PRACTICAL) = 30 Contact Hours / Semester, i.e 2 Contact hour per week per batch. The batch size for practical will be min 8 student – maximum 10 students

However, the Department has framed the curriculum as per the Model course structure suggested by NEP 2020 guidelines.

G) Courses Inclusions:

(i) **Core Course / Mandatory Courses / Discipline Specific Core Courses (DSC):** - A core course is a course that a student admitted to M. Sc. Artificial Intelligence program must successfully completed to receive the degree. Normally no theory course shall have more than 4 credits.

(ii) **Discipline Specific Elective Course (DSE):** Means Elective course from the basic subject or specialization. The elective course defined for 4 credits and dedicated for choice of specialization that student want to perceive. The horizontal learning path is to be followed by the student for selection of elective course. Department may offer more than one specialization depending availability of resources.

(iii) **Skill Courses (SC):** The service courses will be offered as per the structure of the NEP. This course will be conducted to impart special technology skills to the students. This course is defined for 2 Credits and completely engaged in practical form.

(iv) **On Job Training (OJT)**: The student is required to complete 30 hours on job training in the summer of semester 2 examination.

(iv) Each Course shall include lectures / tutorials / laboratory or field work / Seminar / Practical training / Assignments / midterm and term end examinations/ paper / Report writing or review of literature and any other innovative practice etc., to meet effective teaching and learning needs.

PROGRAM OBJECTIVES (PO) for M.Sc. Artificial Intelligence

Program objectives for an M.Sc. (Master of Science) in Artificial Intelligence course typically aim to provide students with a comprehensive understanding of Artificial Intelligence concepts and practical skills. Following are some broad program objectives earmarked by the department:

1. To equip students with an in-depth understanding of topics in Artificial Intelligence(**Advanced Knowledge**).

2. To foster the ability to critically analyse complex problems in real time and conduct independent research to propose innovative solutions (**Research and Analysis**).

3. To develop strong programming skill enabling students to design and implement software systems and applications (**Programming Proficiency**).

4. To enhance problem-solving and logical thinking skills to tackle real-world challenges in Artificial Intelligence and related interdisciplinary domains (**Problem-Solving Abilities**).

5. To cultivate a sense of ethical responsibility and professionalism among students, emphasizing the importance of adhering to legal and ethical standards in computing (**Ethical and Professional Awareness**).

6. To promote effective teamwork, communication, and leadership skills to work collaboratively in diverse, multidisciplinary projects (**Collaboration and Communication**).

7. To provide opportunities for hands-on experience through case studies, projects, internships, and practical assignments, ensuring students can apply theoretical knowledge to real-world scenarios (**Practical Experience**:).

8. To encourage an entrepreneurial mindset and foster innovation, allowing students to develop novel solutions and potentially start their ventures in the technology industry (**Innovation and Entrepreneurship**).

PROGRAM SPECIFIC OBJECTIVES (PSO) for M.Sc. Artificial Intelligence

Program Specific Objectives (PSOs) are more focused and concrete statements that describe the specific outcomes expected from a Master of Science (M.Sc.) in Artificial Intelligence program. These objectives shouldalign with the broader program objectives mentioned earlier.

PSO1: Ability to contribute to problem identification, analysis, design, and development of systems using principles and concepts of Artificial Intelligence and Machine Learning

PSO2: Apply the knowledge of building efficient and optimized algorithm, the artificial agents, use basic and advanced learning techniques, reasoning and inference mechanisms to the knowledge base, natural language processing tools, and software engineering principles to develop the real time Artificial Intelligence based projects.

PSO3: Ability to critically evaluate the results with proper arguments, selection of tools and techniques when subjected to loosely defined scenarios.

SEMESTER WISE PROGRAM STRUCTURE

Class: M.Sc. Artificial Intelligence First Year : Ist Semester

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./ week)		Credits Assigned		Total Credits
			Theory	Practical	Theory	Practical	
Discipline Specific Courses (Major Mandatory) – DSC	AIT/MJ/500	Concepts in AI	2	-	2	-	**14**
	AIT/MJ/501	Fundamentals of Machine Learning	2	-	2	-	
	AIT/MJ/502	Mathematical Foundation for AI	2	-	2	-	
	AIP/MJ/500	Practical Based on Concepts in AI	-	4	-	2	
	AIP/MJ/501	Practical Based on Fundamentals of Machine Learning	-	4	-	2	
	AIP/MJ/502	Practical Based on Mathematical Foundation for AI	-	4	-	2	
Skill / Advance Course	AIP/MJ/506	Problem- solving using Python	-	4	-	2	
Discipline Specific Electives – DSE	AIT/DSE/520-522	(Elective-1)#	2	-	2	-	04
	AIP/DSE/520-522	Practical based on Elective-1	-	4	-	2	
RM	**AIT/RM/529**	**RM**	4	-	4	-	04
		Total	12	20	12	10	22 credits

Note: AIT means Theory Course and AIP means Practical Course

Class: M.Sc. Artificial Intelligence First Year : IInd Semester

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./ week)		Credits Assigned		Total Credits
			Theory	Practical	Theory	Practical	
Discipline Specific Courses (Major Mandatory) – DSC	AIT/MJ/507	Artificial Neural Networks and Deep learning for AI	2	-	2	-	14
	AIT/MJ/508	Data Mining and Data Warehousing	2	-	2	-	
	AIT/MJ/509	Exploratory Data Analytics	2	-	2	-	
	AIP/MJ/507	Practical based Artificial Neural Networks and Deep learning for AI	-	4	-	2	
	AIP/MJ/508	Practical Based on Data Mining and Data Warehousing	-	4	-	2	
	AIP/MJ/509	Practical Based on Exploratory Data Analytics	-	4	-	2	
Skill/advance technique	AIP/MJ/513	Data Visualization using R & Python	-	4	-	2	
DSE	AIT/DSE/530–532	(Elective-2)#	2	-	2	-	

(Choose any one from pool of courses)	AIP/DSE/530 –532	Practical basedon Elective-2	-	4	-	2	04
OJT/FP	**AIP/OJT/559**	OJT/FP	-	8	-	4	04
		Total	8	28	8	14	22 credits

Note: AIT means Theory Course and AIP means Practical Course

Class: M.Sc. Artificial Intelligence Second Year : III[rd] Semester

Course Type	**Course Code**	**Course Name**	**Teaching Scheme (Hrs./ week)**		**Credits Assigned**		**Total Credits**
			Theory	**Practical**	**Theory**	**Practical**	
Discipline Specific Courses (Major Mandatory) – DSC	AIT/MJ/600	Reinforcement Learning	2	-	2	-	14
	AIT/MJ/601	Big Data Analytics	2	-	2	-	
	AIT/MJ/602	Cyber Security	2	-	2	-	
	AIP/MJ/600	Practical Based On Reinforcement Learning	-	4	-	2	
	AIP/MJ/601	Practical Basedon Big Data Analytics	-	4	-	2	
	AIP/MJ/602	Practical Based on Cyber Security	-	4	-	2	
Skill/advance technique	AIP/MJ/606	Adv. Python		4	-	2	
DSE (Choose any one from pool of courses)	AIT/DSE/620 - 622	(Elective-3)#	2	-	2	-	04
	AIP/DSE/620 - 622	Practical basedon Elective-3	-	4	-	2	
RP	**AIP/RP/649**	Research Project-1		8	-	4	04
		Total	8	28	8	14	22 credits

Note: AIT means Theory Course and AIP means Practical Course

Class: M.Sc. Artificial Intelligence Second Year : IV[th] Semester

Course Type	**Course Code**	**Course Name**	**Teaching Scheme (Hrs./ week)**		**Credits Assigned**		**Total Credits**
			Theory	**Practical**	**Theory**	**Practical**	
Discipline Specific Courses (Major Mandatory) - DSC	AIT/MJ/607	Internet of Things	2	-	2	-	14
	AIT/MJ/608	Evolutionary Computing	2	-	2	-	
	AIT/MJ/609	Generative Adversarial Networks	2	-	2	-	
	AIP/MJ/607	Practical Based on Internet of Things	-	4	-	2	
	AIP/MJ/608	Practical Based On Evolutionary Computing	-	4	-	2	
	AIP/MJ/609	Practical Based On Generative Adversarial Networks	-	4	-	2	
DSE (Choose any	AIT/DSE/630 - 632	(Elective-4)#	-	4	-	2	

one from pool of courses)	AIP/DSE/630 - 632	Practical based on Elective-4	-	4	-	2	04
RP	**AIP/RP2/699**	Research Project-2		12	-	6	06
		Total	8	28	8	14	22 credits

Note: AIT means Theory Course and AIP means Practical Course

Discipline Specific Electives - DSE (Elective Group Basket)

Elective Group	**Elective 1** AIT/DSE/520-522 & AIP/DSE/520-522	**Elective 2** AIT/DSE/530–532 & AIP/DSE/530–532	**Elective 3** AIT/DSE/620- 622 & AIP/DSE/620- 622	**Elective 4** AIT/DSE/630- 632 & AIP/DSE/630- 632
Track-I	Natural Language Processing	Speech and Text Analysis	Social Media Analytics	Affective Computing
Track-II	Digital Image Processing	Computer Vision	Augmented Reality and Virtual Reality	Video Processing
Track-III	Foundation of Remote Sensing	Geographical Information System	Spatial & Temporal Computing	Hyper Spectral Image Processing

Note: # Student is advised to select the any one course from the pool of courses, however horizontal selection of courses to be followed at the time of selection of the course.

Semester I

Course Type(**Mandatory)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/MJ/500	Concepts in Artificial Intelligence	2	**2hrs/per week**
AIP/MJ/500	Practical based on Concepts in Artificial Intelligence	2	**4hrs/per week**

Course Description:

AI is a fast-growing technology with impacts and implications for individuals as well as society. In this course, students will get a basic introduction to basic elements and components of artificial intelligence. Emphasis on concepts on learning Students will also explore how AI is already being used, and evaluate

problem areas of AI.

Prerequisites: Basics of Data structures and Computer programming

Course Objectives (CO):

- To gain a historical perspective of AI and its foundations.
- Introduce and define the meaning of Intelligence and explore various paradigms for knowledge encoding and representation, problem solving, inference and learning. To gain a historical perspective of AI.

Learning Outcomes (LO):

Upon successful completion of the course, students will be able to:

- Understand the basics of the theory and practice of Artificial Intelligence as a discipline and about intelligent agents capable of problem formulation.
- Be exposed to the role of AI in different areas like NLP, Pattern Recognition etc.
- Learn the practical applicability of intelligent systems and able to develop intelligent systems

Course Outline:

Unit 1: Overview of AI:

Introduction, history and foundation of AI, Searching: Why Search?, Graph Searching, A Generic Searching Algorithm, Costs, Finding Paths, Blind Search Strategies, Depth-First Search, Breadth-First Search, Heuristic Search: Best-First Search, Heuristic Depth- First Search, A* Search, Iterative Deepening, Direction of Search, Bidirectional Search,Constraint Satisfaction Problems, Generate-and-Test Algorithms, Backtracking Algorithms, Hill Climbing, Beam Search

Unit 2: Introduction to knowledge representation ,Reasoning , Learning and Agents:

Need for proper representation, The Propositional Calculus, Propositional Logic: Representation, Inference, Reasoning Patterns, Resolution, Forward and Backward Chaining. First order Logic: Representation, Inference, Reasoning Patterns, Resolution, Forward and Backward Chaining. The Predicate Calculus, Weak Slot-and-Filler Structures: semantic nets, frames, Strong slot-and-Filler Structures: Conceptual dependency, Scripts, Object Oriented Programming, Search Spaces, Monotonic and Non-monotonic reasoning, bays net, Demster Shafer Theory, Basics of PROLOG: Representation, Structure, Backtracking. Expert System: Case study of Expert System in PROLOG

What is Learning?, How can we learn? Rote Learning, Learning by Taking Advice Learning by Problem Solving, learning by Parameter Adjustment, Learning by Macro Operators, Learning by Chunking, Inductive Learning, Version Spaces, Decision Trees, Explanation Based Learning, Discovery, Analogy. PEAS Representation for an Agent, Agent Environments, Concept of Rational Agent, Structure of Intelligent agents, Types of Agents.

Unit 3: Fuzzy Sets, Fuzzy Systems and strategies in Games:

Need for Numeric and Linguistic Processing, Fuzzy Uncertainty and the Linguistic Variable, Fuzzy Set, Membership Functions, Geometry of Fuzzy Sets, Simple Operations on Fuzzy Sets, Fuzzy Rules for Approximate Reasoning, Rule Composition and Deffuzification, Fuzzy Engineering.

Optimal Decisions in Games, Optimal strategies, the minimax algorithm, optimal decisions in multiplayer, Games, Alpha-Beta Pruning.

Reference Books:

1. Patterson, D. W., Introduction to Artificial Intelligence and Expert
2. Systems, Prentice-Hall, Englewood Cliffs, NJ, pp. 345-347, 1990.
3. Rich, E. and Knight, K., Artificial Intelligence, McGraw-Hill, New York, 1996.
4. Russel, S. and Norvig, P., Artificial Intelligence: A Modern Approach, Prentice-Hall, Englewood Cliffs, NJ, 1995.
5. Nilson, N. J., Principles of Artificial Intelligence, Morgan Kaufmann, San Mateo, CA, pp. 6-7, 1980.
6. T Ross, Fuzzy logic with Engineering applications. ,
7. G Klir, B Yuan, Fuzzy sets and fuzzy logic : Theory and application, PHI.

E-Resources:

- https://nptel.ac.in/courses/106106126
- http://www.eecs.qmul.ac.uk/~mmh/AINotes/AINotes4.pdf

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Course Type(**Mandatory)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/MJ/501	Fundamentals of Machine Learning	2	**2hrs/per week**
AIP/MJ/501	Practical based on Fundamentals of Machine Learning	2	**4hrs/per week**

Course Description:

The course is concerned introducing machine learning techniques like regression, classification clusteringetc .Use of various techniques for developing real-time application and analyzing its performance

Prerequisites: There are no perquisites required for attending this course.

Course Objectives (CO):

- Apply suitable machine learning techniques for data handling and to gain knowledge from it.
- Design and implement supervised and unsupervised machine learning algorithms for real-world applications, while understanding the strengths and weaknesses.

Learning Outcomes (LO):

Students should be able to:

- Mathematical modeling of real time problem.
- Demonstrate knowledge of learning algorithms through implementation for sustainable solutions of applications
- Analyze research based problems using Machine learning techniques

Course Outline:

Unit 1 : Introduction and learning :

Learning theory, Components of Learning , Learning Models , Geometric Models, Probabilistic Models, Logic Models, Grouping and Grading, Designing a Learning System, Types of Learning, Supervised, Unsupervised, Reinforcement, Perspectives and Issues, Version Spaces, PAC Learning, VC Dimension, Hypothesis and target class, Inductive bias and bias-variance tradeoff, Occam's razor, Limitations of inference machines, Approximation and estimation errors. Supervised and Unsupervised Learning Decision Trees: ID3, Classification and Regression Trees, Regression: Linear Regression, Multiple Linear Regression, Logistic Regression, Neural Networks: Introduction, Perception, Multilayer Perception, Support Vector Machines: Linear and Non-Linear, Kernel Functions, K Nearest Neighbors, Introduction to clustering, K-means clustering, K- Mode Clustering.

Unit 2: Bayesian and Graphical Models:

Bayes Theorem Concept Learning Maximum Likelihood Minimum Description Length Principle Bayes Optimal Classifier Gibbs Algorithm Naïve Bayes Classifier Bayesian Belief Network EM Algorithm Probability Learning Sample Complexity Finite and Infinite Hypothesis Spaces – Mistake Bound Model.

Introduction of Graphical Models :Directed Graphical Model ,Undirected Graphical Model , Generative vs Discriminative ,Markov Chains and Monte Carlo Simulation ,Discrete-Time Markov Chain Canonical Representation ,Definitions and Terminologies , Stationary Distribution , Long Run Behavior and Convergence Rate ,Markov Chain Monte Carlo Simulation , Markov Random Fields, Hidden Markov model.

Unit 3: Genetic Algorithms and Machine Learning Applications:

Genetic Algorithms: Representing Hypotheses, Genetic Operator, Fitness Function and Selection, An Illustrative Example, Hypothesis Space Search, Genetic Programming, Models of Evolution and Learning: Lamarkian Evolution, Baldwin Effect, Parallelizing Genetic Algorithms.

Machine Learning Applications: Recommender System, Sentiment Analysis, Image Captioning, Object detection.

Reference Books:

1. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Prentice Hall of India, 3rd Edition2014.
2. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar" Foundations of Machine Learning", MIT Press, 2012.
3. Tom Mitchell, "Machine Learning", McGraw Hill, 3rdEdition, 1997.
4. Stephen Marsland ,MACHINE LEARNING - An Algorithmic Perspective, Second Edition, , 2015.
5. Yihong Gong and Wei Xu ,Machine Learning for Multimedia Content Analysis, Springer ,2007, ISBN 978-0-387-69938-7
6. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.
7. Michalewicz, Z., Genetic algorithms + Data Structures = Evolution Programs, Springer-Verlag, Berlin, 1992.

E –Resources:

- https://nptel.ac.in/courses/ 106106139/84
- https://www.coursera.org/learn/machine-learning
- https://courses.cs.vt.edu/cs5824/Fall19/
- https://www.cs.ou.edu/~fagg/classes/mlfds_2018/syllabus.html
- https://courses.cs.vt.edu/cs5824/Fall19/

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Course Type(**Mandatory)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/MJ/502	Mathematical Foundation for AI	2	**2hrs/per week**
AIP/MJ/502	Practical based on Mathematical Foundation for AI	2	**4hrs/per week**

Course Description:

This course is designed to introduce the concepts of vector linear algebra & matrix. The course also provides in depth knowledge of the probability & central limit theorem used in development of models

Prerequisites: Basics of Matrices and set theory

Course Objectives (CO):

- To create awareness of required mathematical concepts for AI & ML application development
- To develop the basic skill to mathematically formulate real time problem

Learning Outcomes (LO):

By the end of this course, students will be able to:

- To clearly specify or formulate the problem.
- To use formulation for implementation purpose

Course Outline:

Unit 1: Linear Algebra and Multivariate Calculus:

Scalars, Vector and Matrix Norms, Vectors, Matrices, and Tensors in Python, Special Matrices and Vectors, Eigen values and Eigenvectors, Norms and Eigen decomposition. Derivatives, Integrals, Gradients, Differential Operators, Convex Optimization

Unit 2: Probability Theory, Order Statistics and Convergence:

Elements of Probability, Random Variables, Distributions, Variance and Expectation Special Random Variables, Sum Rule, Product Rule, and Bayes' Theorem,Summary Statistics and Independence. Order Statistics, Convergence and Limit Theorem, Chebychev's Inequality

Unit 3: Central limit theorem: Central limit theorem for independent and identically distributed (i.i.d) random variables- Levy and Lindbergh form, central limit theorem for independent random variables-Lindbergh and Feller condition (Statement only), Liapounov form of central limit theorem. Statements of results on asymptotic variances and covariances, distribution of sample moments, sample quantiles.

Reference Books:

1. Mathematical Foundation for AI and Machine Learning by Eduonix Released July 2018 Publisher(s): Packt Publishing, ISBN: 9781789613209
2. Linear Algebra and Its Application, 3rd Edition, David C. Lay
3. Linear Algebra, Kenneth Hoffman
4. Linear Algebra and Its Applications, Gilbert Strang
5. A First Course in Probability, 9th Edition, Sheldon Ross
6. An Introduction to Probability and Statistics, 2nd Edition, Rohatgi & Saleh f) Probabilistic Graphical Models, Daphne Koller & Nir Friedman

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Course Type(**Mandatory-Skill Enhancement)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIP/MJ/506	Problem-solving using Python	2	**4hrs/per week**

Course Description:

The course is designed in way that a student will be able implement various data structures or optimization methods using python. It provides a critical way to problem understanding and deploying solution as per the problem.

Prerequisites: Having knowledge of any programming language

Course Objectives (CO):

- The course is designed to provide Basic knowledge of Python and aspects of data structure to gain logical understanding for solving problems .
- Students will be able to learn potential of python, to achieve modern computing requirements.

Learning Outcomes (LO):

By the end of the course, students will be able to:

- To clearly specify or formulate the problem.
- To use formulation for implementation purpose
- Perform operations on data structures in python
- Develop functions for given problem

Course Outline:

Unit 1: Planning the Computer Program and Introduction to Python:

Concept of problem solving, Problem definition, Program design, Debugging, Types of errors in programming, Documentation. Techniques of Problem Solving: Flowcharting, decision table, algorithms, Structured programming concepts, Programming methodologies viz. top-down and bottom-up programming.

Structure of a Python Program, Elements of Python, Python Interpreter, Using Python as calculator, Python shell, Indentation. Atoms, Identifiers and keywords, Literals, Strings and Operators.

Unit 2: Conditional Statements , Looping and string Manipulation:

Branching, Looping, Conditional Statement, Exit function, Difference between break, continue and pass. String Manipulation: Understanding string, Accessing Strings, Basic Operations, String slices, Function and Methods.

Lists ,Tuples, Dictionary:

List: Introduction to list, Accessing list, list operations, Working with lists, Function and Methods.
Tuples: Introduction to tuple, Accessing tuples, Operations, Working, Functions and Methods.
Dictionary: Introduction to dictionaries, Accessing values in dictionaries, Working with dictionaries, Properties, Functions.

Unit 3: Functions and Modules, I/O and Error Handling, Object and Classes :

Introduction, Defining user defined Functions ,Parameters, Function Documentation ,Keyword and Optional Parameters , Passing Collections to a Function , Variable Number of Arguments , Scope , Functions , Passing Functions to a Function , Mapping Functions in a Dictionary , Lambda , Modules , Standard Modules – sys , Standard Modules – math , Standard Modules – time, The dir Function

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

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.

Reference Books:

1. Dive into Python, Mike
2. Learning Python, 4th Edition by Mark Lutz
3. Programming Python, 4th Edition by Mark Lutz
4. Mastering Object-Oriented Python: Build powerful applications with reusable code using OOP design patterns and Python 3.7, 2nd Edition, Steven F. Lott (June 14, 2019), ISBN-10:1789531365
5. Kenneth A. Lambert, The Fundamentals of Python: First Programs, 2011, Cengage Learning, ISBN: 978-1111822705.

E-Resources:

• https://onlinecourses.nptel.ac.in/noc18_cs21/ OR https://nptel.ac.in/courses/106106145/
• https://nptel.ac.in/courses/106106182/ OR https://onlinecourses.nptel.ac.in/noc18_cs35
• https://www.python.org/ • https://docs.python.org/3/tutorial

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Course Type(**DSE)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/DSE/520	Natural Language Processing	2	**2hrs/per week**
AIP/DSE/520	Practical based on Natural Language Processing	2	**4hrs/per week**

Course Description:

This course is introduced with a theoretical & methodological introduction to NLP. Various NLP tasks are analyzed through various algorithm with good performance with statistical methods to train text corpora to automatically acquire the knowledge need to performance the task

Prerequisites: There are no perquisites required for attending this course.

Course Objectives (CO):

- To learn Morphological analysis, Lexical analysis, Syntactic and Semantic analysis.
- To Understand feature engineering concepts and rule-based systems for NLP.
- To Use techniques of Machine learning and deep learning for NLP.

Learning Outcomes (LO):

Students are able

- Analyze corpus and corpora of NL.
- Learn the language modeling, formal grammars, statistical parsing, machine translation,
- and dialog processing
- Apply Machine and Deep learning to NLP applications

Course Outline:

Unit 1: Introduction:

Understanding natural language processing, Understanding basic applications, Advantages of togetherness, NLP and Python, Environment setup for NLTK.
Practical Understanding of a Corpus and Dataset: What is a corpus? Why do we need a corpus? Understanding corpus analysis, understanding types of data attributes, exploring different file formats for corpora, Resources for accessing free corpora, Preparing a dataset for NLP applications, Web scraping

Unit 2:Understanding the Structure of a Sentences:

Understanding components of NLP, Natural language understanding, Defining context-free grammar, Morphological analysis, Syntactic analysis, Semantic analysis, Handling ambiguity, Discourse integration, Pragmatic analysis.

Pre-processing: Handling corpus-raw text, Handling corpus-raw sentences, Basic preprocessing, Feature Engineering and NLP Algorithms: Understanding feature engineering, Basic feature of NLP, Basic statistical features for NLP, Advantages of features engineering, Challenges of features engineering.

Unit 3:
Advanced Feature Engineering :Recall word embedding, Understanding the basics of word2vec, Converting the word2vec model from black box to white box, Understanding the components of the word2vec model, Understanding the logic of the word2vec model, Understanding algorithmic techniques and the mathematics behind the word2vec model

Reference Books

1. "Speech and Language Processing", Daniel Jurafskey and James H. Martin, Prentice Hall, 2009.
2. "Foundation of Statistical Natural Language Processing", Christopher D. Manning and Hinrich Schutze, MIT Press, 1999.
3. "Python Natural Language Processing", Jalaj Thanaki, Packt.
4. "Natural Language Processing with Python: Analyzing Text with the Natural Launguage Toolkit", By Steven Bird, Ewan Klein, and Edward Loper, NLTK.
5. "Foundations of Computational Linguistics", Ronald Hausser, Springer,Verleg, 1999.
6. "Natural Language Understanding", James Allen, Benjamin/Cummings Publishing Co. 1995.
7. "Corpus – Based Methods in Language and Speech Processing", Steve Young and Gerrit Bloothooft, Kluwer Academic Publishers, 1997.

E-Resources:
https://people.cs.umass.edu/~mccallum/courses/inlp2007/syllabus.html

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the

assignments published by the teacher on notice board / during practical's etc.

Course Type(**DSE)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/DSE/521	Digital Image Processing	2	**2hrs/per week**
AIP/DSE/521	Practical based on Digital Image Processing	2	**4hrs/per week**

Course Description:

This course provides the understanding of the fundamentals blocks of DIP. It helps to learn various image transforms, image enhancement techniques , restoration techniques and segmentation methods to improve the image analysis and recognition.

Prerequisites: To have deep understanding of linear algebra and good programming skill.

Course Objectives (CO):

- To study the image fundamentals and mathematical transforms necessary for image processing.
- To study the image enhancement techniques, image restoration and image compression procedures

Learning Outcomes (LO):

- Analyze images in the frequency domain using various transforms.
- Evaluate the techniques for image enhancement and image restoration.
- Interpret image segmentation and representation techniques.

Course Outline:

Unit 1: Introduction to Image Processing**:**

Example of fields that uses image processing, Steps of image processing, Components, Applications, Image sensors and Image formats. Visual Preliminaries Brightness adaptation and contrast, Acuity and contour, Texture and pattern discrimination, Shape detection and recognition, perception of color, Computational model of perceptual processing, Image sampling and quantization, Basic relationship between pixels.

Unit 2: Intensity transformations and Colour Image Processing**:**

Introduction, Basic intensity transformation functions, Histogram equalization, Local histogram processing, and Using histogram statistics for image enhancement. Spatial filtering Fundamentals of spatial filtering, Smoothing and sharpening spatial filters, combining spatial enhancement methods,**:** Colour fundamentals, Colour models, Pseudo color image processing, Basic of full, color image processing, colour transformations, Smoothing and sharpening, Image segmentation bases on colour, Noise in colour images,

Unit 3: Morphological Image Processing**:**

Introduction, Erosion and Dilation, Opening and closing, History, Miss transformation, Basic morphological algorithms, Gray scale morphology. Segmentation Fundamentals, Point, Line and Edge detection, Thresholding, Region based segmentation, Segmentation using morphological watersheds, Use of motion in segmentation – Spatial techniques.

References Books:

1. "Digital Image Processing", Gonzalez and Woods, 3rd Edition, Pearson Education.
2. "Digital Image Processing and Analysis", Bhabatosh Chanda, Dwijesh Dutta Majumder, 2nd Edition, PHI.
3. "Fundamentals of Digital Image Processing", Anil K Jain, 1st Edition, PHI.
4. "Hands-on image processing with Python: expert techniques for advanced image analysis and effective interpretation of image data", DEY S, Birmingham, UK : Packt Publishing, 2018.
5. "Digital Image Processing", M.Anji Reddy, Y.Hari Shankar, BS Publications.
6. "Fundamentals of Digital Image Processing", S.Annadurai, R.Shanmugalakshmi,Pearson Education, 2007

E-Resources:

https://www.geo.university/courses/digital-image-processing-with-opencv-in-python

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc..

Course Type(**DSE)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/DSE/522	Foundation of Remote Sensing	2	**2hrs/per week**
AIP/DSE/522	Practical based on Foundation of Remote Sensing	2	**4hrs/per week**

Course Description:

Student should be able understand the basic principles of Remote sensing and its utilization on natural resource managements. Use various techniques of computer for spatial inventory & analysis of natural resources.

Prerequisites: No prerequisites required

Course Objectives (CO):

- To understand and be able to articulate the basics of how electromagnetic energy enables remote sensing
- To be able to explain the concepts of spatial, spectral, radiometric and temporal resolution.

Learning Outcomes (LO):

- Understanding basic components of remote Sensing
- To understand functioning, data acquisition and orbit operations of missions.

Course Outline:

Unit 1:Introduction:

History of Remote Sensing; Physics of Remote Sensing: Electromagnetic Radiation (EMR), Characteristics; Electromagnetic Spectrum (EMS); Interactions Between Matter and Electro-Magnetic Radiation; Energy Interaction in The Atmosphere; Energy Interactions with The Earth's Surface. Radiation Laws. Atmospheric Windows; Types of Remote Sensing with Respect to Wavelength Regions.

Unit 2: Sensor and Platforms.

Sensor Technology; Historical Development; Types of Platforms and Sensors– Airborne Remote Sensing; Space Borne Remote Sensing; Orbital Elements of Satellite; Sensor Types Characteristics: Active and Passive Remote Sensing; Imaging Systems; Non-Imaging Sensors; Across Track and Along Track Scanners; Framing and Scanning Systems; Characteristics of Optical Sensors; Resolution.

Unit 3:Remote Sensing Satellites and Data Products:

Overview of Different Satellite and Sensors for Earth Observations– Coarse; Medium and High-Resolution Missions (Landsat Series); SPOT; Ikonos; Quickbird; ASTER; Sentinel; Aqua and Terra (MODIS); SAR and Future Missions.

References Books:

1. Lillesand, T., Kiefer, R. W., & Chipman, J. (2014). Remote Sensing and Image Interpretation. John Wiley & Sons.
2. Rees, W. G. (2012). Physical Principles of Remote Sensing. Cambridge University Press.
3. Jensen, J. R. (2009). Remote Sensing of The Environment: An Earth Resource Perspective 2/E. Pearson Education India.
4. Sabins, F. F. (2007). Remote Sensing: Principles and Applications. Waveland Press. "Digital Image Processing", Gonzalez and Woods, 3rd Edition, Pearson Education.

E-Resources:

https://www.geo.university/courses/digital-image-processing-with-opencv-in-python

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc..

Course Type(**Mandatory)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/RM/529	Research Methodology (Artificial Intelligence)	4	**4hrs/per week**

Course Description:

This course is designed to provide computer science students with a comprehensive understanding of computational and statistical methods used in research methodology. Students will learn various techniques and tools to analyse, interpret, and present research data in computer science. The course will also include case studies to illustrate the application of these methods in real-world scenarios. Students will gain practical skills indesigning experiments, collecting and analysing data, and drawing meaningful conclusions. Reference books will be provided to supplement the course materials and enhance the students' knowledge.

Prerequisites:

- Basic understanding of computer science concepts
- Familiarity with programming languages (e.g., Python, R, or MATLAB)
- Knowledge of introductory statistics

Course Objectives (CO):

- To introduce students to the fundamental principles of research methodology in computer science.
- To provide students with a comprehensive understanding of computational and statistical methods used in computer science research.
- To equip students with the skills to collect, pre-process, analyse, and interpret data for research purposes.
- To enable students to apply appropriate statistical techniques for hypothesis testing and inference.
- To familiarize students with machine learning algorithms and their applications in computer science research.
- To develop students' ability to design and analyse experiments in the context of computer science research.
- To enhance students' critical thinking and problem-solving skills through case studies and practical assignments.

Learning Outcomes (LO):

By the end of the course, students will be able to:

- Formulate research questions and select appropriate research methodologies.
- Collect, pre-process, and analyse data using computational and statistical techniques.
- Apply hypothesis testing and statistical inference to draw meaningful conclusions from data.
- Build and evaluate regression and machine learning models for predictive analysis.
- Design and analyse controlled experiments to investigate research hypotheses.
- Demonstrate an understanding of real-world applications of computational and statistical methods in computer science research.
- Critically evaluate research studies and identify strengths and limitations in their methodology.

Course Outline:

Unit 1: Introduction to Research Methodology - Overview of research methodology in computer science, Research design and problem formulation, Literature review and identifying research gaps, Ethical considerations in research

Unit 2: Data Collection and Pre-processing - Data collection techniques: surveys, interviews, observations, etc. Data pre-processing and cleaning, Handling missing data and outliers, Exploratory data analysis, Case study:

Visualizing and summarizing real-world datasets

Unit 3: Statistical Analysis - Descriptive statistics: measures of central tendency, dispersion, etc., Hypothesis testing and statistical significance, Parametric and non-parametric tests, Analysis of variance (ANOVA) and regression analysis, Case study: Applying statistical inference techniques to analyse experimental data

Unit 4: Computational Analysis - Introduction to machine learning algorithms, Supervised and unsupervised learning techniques, feature selection and dimensionality reduction, Evaluation metrics for Computational Methods and Techniques, Case study: Building a computational model for classification or clustering

Unit 5: Presenting Research Findings - Effective data visualization techniques, Scientific writing and report preparation, Presenting research findings in conferences and journals, Peer review process and publication ethics.

Assessment Methods:

- Assignments and quizzes to assess understanding of concepts and techniques
- Course project report and presentation evaluation
- Participation in class discussions and group activities

Recommended Reference Books:

"Research Methodology: A Step-by-Step Guide for Beginners" by Ranjit Kumar

"Designing and Conducting Mixed Methods Research" by John W. Creswell and Vicki L. Plano Clark

"Statistical Methods for Computer Science" by Walter D. Wallis

"Pattern Recognition and Machine Learning" by Christopher M. Bishop

"Data Science for Business" by Foster Provost and Tom Fawcett

"The Elements of Statistical Learning: Data Mining, Inference, and Prediction" by Trevor Hastie, Robert Tibshirani, and Jerome Friedman

"Visualization Analysis and Design" by Tamara Munzner

Semester – II

Course Type(**Mandatory)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/MJ/507	Artificial Neural Networks and Deep learning for AI	2	**2hrs/per week**
AIP/MJ/507	Practical based on Artificial Neural Networks and Deep learning for AI	2	**4hrs/per week**

Course Description:

The course gives a complete understanding of architecture and building blocks of artificial neural network and deep learning models. It provides an in depth knowledge of how to choose and implement the model according to requirement of application. The course also provides students with the error estimation and level of fault tolerance to be applied to an application.

Prerequisites: Fundamentals of Mathematics (Linear algebra, Statistics)

Course Objectives (CO):

- To introduce the fundamental techniques and principles of Neural Networks
- To study the different models in ANN and their applications
- To familiarize with deep learning concepts

Learning Outcomes (LO):

Students are able

- To understand and apply ANN according to the problem
- To use different architectures for optimization
- To understand Deep Learning Models and be able to build, train and apply fully connected deep neural

networks

Course Outline:

Unit 1: Introduction To Artificial Neural Networks :

Fundamentals Of Neural Networks – Model of Artificial Neuron – Neural Network Architectures – Learning Methods – Taxonomy Of Neural Network Architectures – Applications

Feed Forward Neural Networks **:** Mc Culloch –Pitts Model**,** Perceptron Models: Discrete, Continuous and Multi-Category –Training Algorithms: Discrete and Continuous Perceptron Networks – Limitations of the Perceptron – Model. Credit Assignment Problem – Generalized Delta Rule, Derivation of Back propagation (BP) Training, and Summary of Back propagation Algorithm –Kolmogorov Theorem

Unit 2 : Other ANN Architectures **:**

Associative Memory – Exponential BAM – Associative Memory For Real Coded Pattern Pairs – Applications Adaptive Resonance Theory – Introduction – ART 1 – ART2 – Applications – Neural Networks Based On Competition – Kohenen Self Organizing Maps – Learning Vector Quantization – Counter Propagation Networks – Industrial Applications

Unit 3: Deep Learning **:**

Deep Feed Forward network, regularizations, training deep models, dropouts, Training Deep Neural Networks using Back Propagation-Setup and initialization issues, vanishing and exploding Gradient problems, Gradient-Descent Strategies .

Convolutional Neural Network **:** Convolutional Neural Network, Basic structure of Convolutional Network, Case studies: Alex net, or VGGNet or GoogLeNet, Applications of CNN– Object Detection, Content based image Retrieval**.**

Reference Books:

1. Charu C. Aggarwal "Neural Networks and Deep learning" Springer InternationalPublishing, 2018
2. Satish Kumar, "Neural Networks, A Classroom Approach", Tata McGraw -Hill, 2007.
3. Simon Haykin, "Neural Networks, A Comprehensive Foundation", 2nd Edition, Addison Wesley Longman, 2001.
4. Bishop, Christopher M. Pattern Recognition and Machine Learning. Springer, 2006
5. Duda, Richard, Peter Hart, and David Stork. Pattern Classification. 2nd ed. New York, NY:Wiley-Interscience, 2000.

E- Resources:

- Michael Nielsen, "Neural Networks and Deep Learning", Determination Press, 2015. http://neuralnetworksanddeeplearning.com/
- https://www.coursera.org/learn/neural-networks-deep-learning

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Course Type(**Mandatory)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/MJ/508	Data Mining and Data Warehousing	2	**2hrs/per week**
AIP/MJ/508	Practical based on Data Mining and Data Warehousing	2	**4hrs/per week**

Course Description:

This course will introduce the concepts of data warehouse and data mining, which gives a complete description about the principles, used, architectures, applications, design and implementation of data mining and data warehousing concepts In this course student shall learn mathematical & algorithmic detail of various data association ,clustering techniques to discover patterns in underlying data.

Prerequisites: Fundamentals of Relational database system

Course Objectives (CO):

- Identify data mining problems
- Implement the data warehouse according to requirement.
- Write association rules for a given data pattern.
- Choose between classification and clustering solution.

Learning Outcomes (LO):

Students are able

- Understand what Is Data Mining, what kinds of data can be mined, what kinds of patterns can be mined, and what kinds of applications are targeted.
- Explain major Issues in data mining and understand architecture in data warehouse.
- To fully understand standard data mining methods and techniques such as association rules, data clustering and classification.

Course Outline:

Unit 1: Data Warehousing modeling and Introduction to Data Mining :

Basic Concepts: Data Warehousing: A multitier Architecture, Data warehouse models: Enterprise warehouse, Data mart and virtual warehouse, Extraction, Transformation and loading, Data Cube: A multidimensional data model, Stars, Snowflakes and Fact constellations: Schemas for multidimensional Data models, Dimensions: The role of concept Hierarchies, Measures: Their Categorization and computation, Typical OLAP Operation What is data mining, Challenges, Data Mining Tasks, Data: Types of Data, Data Quality, Data Preprocessing, Measures of Similarity and Dissimilarity. Data preprocessing: Data cleaning , Data transformation ,Data reduction Discretization and generating concept hierarchies Installing Weka 3 Data Mining System , Experiments with Weka - filters, discretization

Unit 2: Data mining knowledge representation, mining algorithms:

Attribute-oriented analysis, Attribute generalization , Attribute relevance , Class comparison, Statistical measures, Experiments with Weka - using filters and statistics, Data mining algorithms: Association rules, Example: mining weather data , Basic idea: item sets, Generating item sets and rules efficiently, Correlation analysis, Experiments with Weka - mining association rules. Classification Basic learning/mining tasks , Decision trees , Covering rules, Experiments with Weka - decision trees, rules , Prediction Statistical (Bayesian) classification, Bayesian networks, Instance-based methods (nearest neighbor) , Linear models, Experiments with Weka - Prediction

Unit 3: Clustering and Advanced techniques:

Basic issues in clustering, Partitioning methods: k-means, expectation maximization (EM) ,Hierarchical methods: distance-based agglomerative and divisible clustering ,Cobweb ,Advanced techniques, Data Mining software and applications: Text mining: extracting attributes (keywords), structural approaches (parsing, soft parsing).Bayesian approach to classifying text, Web mining: classifying web pages, extracting knowledge from the web Data Mining software and applications

Reference Books:

1. Sam Anahory, Dennis Murray: Data Warehousing in the Real World, Pearson,Tenth Impression,2012.
2. Michael.J.Berry, Gordon.S.Linoff: Mastering Data Mining , Wiley Edition, second edtion,2012.3.Pang-Ning Tan, Michael Steinbach, Vipin Kumar: Introduction to Data Mining, Pearson, First impression,2014.
4. Jiawei Han, Micheline Kamber, Jian Pei: Data Mining -Concepts and Techniques, 3rd Edition, Morgan Kaufmann Publisher, 2012.

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Course Type(**Mandatory)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/MJ/509	Exploratory Data Analytics	2	**2hrs/per week**
AIP/MJ/509	Practical based on Exploratory Data Analytics	2	**4hrs/per week**

Course Description:

Through exploratory data analysis, students will learn how to perform an initial analysis on data, how to ask questions to their data, discover patterns and anomalies. The course will help in data preparation, preparing summary statistics and using data visualization techniques

Prerequisites: There are no perquisites required for attending this course.

Course Objectives (CO):

- This course introduces the methods for data preparation and data understanding.
- It covers essential exploratory techniques for understanding multivariate data by summarizing it through statistical methods and graphical methods.
- Supports to Summarize the insurers use of predictive analytics, data science an Data visualization

Learning Outcomes (LO):

students are able

- To apply mathematics and science in AI applications.
- To have computational thinking i.e. ability to translate vast data in to abstract concepts and to understand database reasoning.
- Able to choose appropriate feature selection ,dimensionality reduction and techniques for handling multi-dimensional data

Course Outline:

Unit 1: Introduction To Exploratory Data Analysis: Module content: Data Analytics lifecycle, Exploratory Data Analysis (EDA)–Definition, Motivation, Steps in data exploration, The basic data types Data Type Portability.
Module content: Introduction to Missing data, Traditional methods for dealing with missing data, Maximum Likelihood Estimation – Basics, Missing data handling, Improving the accuracy of analysis. Introduction to Bayesian Estimation ,Multiple Imputation-Imputation Phase, Analysis and Pooling Phase, Practical Issues in Multiple Imputation, Models for Missing Notation Random Data

Unit 2: Data Summarization & Visualization :
Statistical data elaboration, 1-D Statistical data analysis, 2-D Statistical data Analysis, ND Statistical data analysis, Outlier Analysis : Introduction, Extreme Value Analysis, Clustering based, Distance Based and Density Based outlier analysis, Outlier Detection in Categorical Data.

Unit 3: Feature Subset Selection and Dimensionality Reduction:
Feature selection algorithms: filter methods, wrapper methods and embedded methods, Forward selection backward elimination, Relief, greedy selection, genetic algorithms for features election
Introduction, Principal Component Analysis (PCA), Kernel PCA, Canonical Correlation Analysis, Factor Analysis, Multi-dimensional scaling, Correspondence Analysis , Contemporary issues: Recent Trends.

Reference Books:

1. Charu C. Aggarwal ,"Data Mining The Text book", Springer, 2015.
2. Craig K. Enders, "Applied Missing Data Analysis", The Guilford Press, 2010.
3. Inge Koch, "Analysis of Multivariate and High dimensional data", Cambridge University Press, 2014. Michael Jambu, "Exploratory and multivariate data analysis", Academic Press Inc. , 1990.
4. Charu C. Aggarwal, "Data Classification Algorithms and Applications", CRC press, 2015

E-Resources:

https://www.coursera.org/projects/exploratory-data-analysis-python-pandas

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the

assignments published by the teacher on notice board / during practical's etc..

Course Type(**Mandatory Skill Enhancement)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIP/MJ/513	Data Visualization using R & Python	2	**4hrs/per week**

Course Description:

In this course, you will learn the basics of Graphics, a system for describing and building graphs, and how to use the data visualization package of R for basic bar charts, histograms, pie charts, scatter plots, line plots, and box plots. It also demonstrates practice in working and visualizing datasets in Python

Prerequisites: There are no perquisites required for attending this course.

Course Objectives (CO):

- To get familiar with data and its visualization using R and Python
- To understand information aspects presented by using appropriate data visualization on given information

Learning Outcomes (LO):

- An understanding of the key techniques and theory used in visualization, including data models, graphical perception and techniques for visual encoding and interaction.
- Identify appropriate data visualization techniques given particular requirements imposed by the data.
- Practical experience building and evaluating visualization systems.

Course Outline

Unit 1: Introduction Context of data visualization:

Definition, Methodology, Visualization design objectives. Key Factors: Purpose, visualization function and tone, visualization design options: Data representation, Data Presentation, Seven stages of data visualization, widgets, data visualization tools.Visualizing Data Methods Mapping, Time series, Connections and correlations, Scatterplot maps, Trees, Hierarchies and Recursion, Networks and Graphs, Info graphics Visualizing and Acquiring data, Where to Find Data, Tools for Acquiring Data from the Internet, Locating Files for Use with Processing, Loading Text Data, Dealing with Files and Folders, Listing Files in a Folder, Asynchronous Image Downloads, Advanced Web Techniques, using a Database, Dealing with a Large Number of Files.

Unit 2: Visualization using R:

Basic plotting: Plots and Lines, Built-in Plot Types, Legends and Annotations, Other Built-in Plotting Functionalities, Histograms and Curves, Cleveland's Dot Plot, Axis, Titles, Subtitles and Panel Styles, The Notorious Pie Chart, WORKING WITH GGPLOT2 : Grammar of Graphics System, Mapping Aesthetics, Working with Geometries, Background Image, ENHANCING using GGPLOT2

Unit 3: Data Visualization using Python:

Introduction to Matplotlib, Basic Plotting with Matplotlib, Line Plots, Area Plots, ,Bar Charts, Pie Charts, Box Plots, Scatter Plots, Bubble Plots, Waffle Charts, Word Clouds, Seaborn and Regression Plots ,Panda: Series, DataFrame Basics and Data Manipulation

Reference Books :

1. "Interactive data visualization for the web", Scott Murray, O'Reilly Media, Inc., 2013.
2. . "Visualizing Data", Ben Fry, O'Reilly Media, Inc., 2007.
3. "Security Data Visualization: Graphical Techniques for Network Analysis", Greg Conti, No Starch Press Inc, 2007.
4. Rahlf, T. (2017). Data Visualisation with R: 100 Examples. Germany: Springer International Publishing.
5. Raman, K. (2015). Mastering Python Data Visualization. United Kingdom: Packt Publishing.
6. Ware C and Kaufman M ,Visual thinking for design, Morgan Kaufmann Publishers, 2008.
7. Chakrabarti, S —Mining the web: Discovering knowledge from hypertext data —, Morgan Kaufman Publishers, 2003

E-Resources:

- https://www.coursera.org/learn/jhu-data-visualization-r
- https://www.coursera.org/learn/data-visualization-r
- https://www.coursera.org/learn/python-for-data-visualization
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Course Type(**DSE)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/DSE/530	Speech and Text Analysis	2	**2hrs/per week**
AIP/DSE/530	Practical based on Speech and Text Analysis	2	**4hrs/per week**

Course Description:

The course focuses on the theory and applications of natural language processing and speech processing to retrieve linguistic knowledge in these sources. Students will be able to organize, categorize, analyze and interpret the unstructured and semi-structured text that allow users to seek advice to make a decision.

Prerequisites: Basics for data visualization.

Course Objectives (CO):

- Understand the role of social media data and analytics in helping organizations achieve their goals andunderstand their publics.
- Identify and select key performance indicators to accurately measure the success of social media efforts.

Learning Outcomes (LO):

- Analyze social media data using native analytics.
- Develop social media measurement plans and analytics reports, and communicate findings and recommendations effectively.

Course Outline:

Unit 1: Introduction to Semantic Web:

Limitations of current Web, Development of Semantic Web, Emergence of the Social Web. Social Network analysis: Development of Social Network Analysis -Key concepts and measures in network analysis. Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities - Web-based networks. Knowledge representation on the Semantic web: Ontology and their role in the Semantic Web: Ontology-based knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework - Web Ontology Language.

Unit 2: Modelling and aggregating social network data**:**

State-of-the-art in network data representation - Ontological representation of social individuals - Ontological representation of social relationships - Aggregating and reasoning with social network data. Social-semantic applications: Generic Architecture- Sesame- Elmo – Graph util, Flink-Open academia. Social network extraction: Survey method-electronic data extraction- Data collection Optimization, prediction- Evaluation.

Unit 3: Text Analytics : Data Collection**:**

Survey Sampling, Observational result, Statistical Techniques, Analysis of Unstructured Data, Understanding Text ,Extracting and Presenting Statistics Data Formats, Cleaning Data Sets, Duplicate Detection, Tagging Text, Indexing and Search,, Evaluating Algorithms, topic modeling, Text Classification, Text clustering ,entity resolution ,Information retrieval, Introduction: Integration of text and network analysis, Types of networks extracted from texts across disciplines, Natural Language Processing and (Computational) Linguistics for Information and Relation Extraction, Introduction: Multi-agent models for representing networks.

Reference Books:

- Manning, C. D., Raghavan, P., and Schutze, H. 2008. Introduction to Information Retrieval. Cambridge University Press, 2008. Retrieved from: http://www- nlp.stanford.edu/IRbook/.
- Miner, G., Delen, D., Elder, J., Fast, A., Hill, T., and Nisbet, A. R. (2012).Practical Text Mining and Statistical Analysis for Non-structured Text Data Applications. Elsevier Inc. Available online

http://www.gbv.de/dms/ilmenau/toc/668584769.PDF.

- Przemyslaw Kazienko, Nitesh Chawla, Applications of Social Media and Social Network Analysis, Springer, 2015
- Robert Tibshirani, Trevor Hastie, Jerome Friedman ,The Elements of Data Mining, Statistical Learning, Inference, and Prediction.
- Manning, Christopher D., and Hinrich Schütze. Foundations of statistical natural language processing. MIT press, 1999.

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Course Type(**DSE)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/DSE/531	Computer Vision	2	**2hrs/per week**
AIP/DSE/531	Practical based on Computer Vision	2	**4hrs/per week**

Course Description:

This course aims to convey the nature of some of the fundamental problems in vision, and to explain a variety of techniques used to overcome them. Vision is a rapidly evolving area of computer science, and new and emerging approaches to these problems are discussed along with more "classical" techniques. Various vision problems are considered, including: feature detection in images, e.g. edge detection, and the accumulation of edge data to form lines; recovery of 3D shape from images, recognizing and classifying objects in images. Several assignments will be given to enable the student to gain practical experience in tackling some of these problems.

Prerequisites: Student must have knowledge of Image Processing, Neural Networks and Artificial Intelligence.

Course Objectives (CO):

- To understand master theories and methods in the field of computer vision.
- Design and develop practical real time computer vision application or systems

Learning Outcomes (LO):

Students will be able

- To analyze data and use proper feature extraction and segmentation
- To apply neural network or Machine learning for proper recognition of objects.

Course Outline:

Unit 1: Digital Image Formation and low-level processing:

State-of-the-art, fundamentals of image formation. Transformation: orthogonal, Euclidean, affine, projective. Fourier transform, convolution and filtering, image enhancement, restoration, histogram processing. Depth estimation and multi-camera views: perspective, binocular stereopsis: camera and epipolar geometry, homography, rectification, DLT, RANSAC, 3-D reconstruction framework, auto- calibration, apparel.

Feature extraction: Edges canny, LOG, DOG. Line detectors (Hough Transform), Corners: Harris and Hessian Affine, orientation histogram, SIFT, SURF, HOG, GLOH. Scale-Space Analysis: Image pyramids and Gaussian derivative filters, Gabor filters and DWT.

Unit 2: Image Segmentation:

Region growing, edge based approaches to segmentation, graph-cut, mean-shift, MRFs, texture segmentation, object detection. Clustering: K-Means, K-Medoids, mixture of Gaussians. Classification: Discriminant function, supervised, un-supervised, semi- supervised. Classifiers: Bayes, KNN, ANN models.

Unit 3:

Dimensionality Reduction, Motion Analysis: background subtraction and modeling, optical flow, KLT, spatio-temporal analysis, dynamic stereo, motion parameter estimation. Shape from X: light at surfaces, phong model, reflectance map, Albedo estimation, photometric stereo, use of surface smoothness, constraint, shape from texture, color, motion and edges.

Reference Books:

- Computer Vision: A Modern Approach, Forsyth Ponce , Pearson Education
- Image Processing, Analysis and Machine Vision, Milan Sonka, Thomson Learning .
- Machine Vision, Jain R C Kasturi R, McGrawHill .
- Three Dimensional Computer Vision, Y Shirai, Springer Verlag 3.
- Computer And Robot Vision Vo I and II, Haralick R M And Shapiro L G, Addison Wesley
- Computational Vision, Wechsler, Academic Press .
- Robot Vision, Horn B K P, Cambridge MIT press .
- Digital Image Processing & Computer Vision, Robert J Schalkoff, John Willey Publication

E-Resources:

https://opencv.org/syllabus/cv1-syllabus.pdf https://opencv.org/syllabus/cv2-syllabus.pdf
https://www.coursera.org/learn/introduction-computer-vision-watson-opencv
https://yxw.cs.illinois.edu/course/CS598ACV/S21/schedule.html

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Course Type(**DSE)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/DSE/532	Geographical Information System	2	**2hrs/per week**
AIP/DSE/532	Practical based on Geographical Information System	2	**4hrs/per week**

Course Description:

This course provides an introduction to the fundamental theories and concepts of Geographic Information Systems (GIS). The course content will include data input, storage and editing, spatial data structures, analytical functions of a GIS, data output, management of GIS, and applications of GIS. Laboratory exercises will complement the theory presented in the lectures.

Prerequisites: No prerequisites required

Course Objectives (CO):

- Introduce basic concepts in GIS
- Provide exposure to basic tools and techniques in GIS software

Learning Outcomes (LO):

Students will be able

- Work with basic tools in GIS software •
- Understand and manage spatial information

Course Outline:

Unit 1

Introduction to GIS definition, concept and history of developments in the field of information systems, Computer fundamentals for GIS, Hardware and software requirements for GIS, Coordinate system and projections in GIS – conic, cylindrical and planner. Data structure and formats, Spatial data models – raster and vector, data inputting & GIS, Spatial data quality and uncertainty, Data base design - editing and topology creation in GIS, linkage between spatial and non- spatial data.

Unit 2

Spatial data analysis – significance and type, attribute query, spatial query, Vector based spatial data analysis, Raster based spatial data analysis- local, neighborhood, regional and global operations, Buffer analysis, network analysis, Data quality and sources of errors, Integration of RS and GIS data, Digital elevation model and derivation of parameters, Data analysis and modeling in GIS– types of GIS modelling.

Unit 3

Open sources software, free software and cloud computing, Decision support systems, Overview of image processing & GIS Packages – ARC GIS, ERDAS, MAP INFO, ILWIS, GEOMEDIA, IDRISI, GRASS, SAGA, QGIS, Recent trends in GIS – AM/FM, Virtual 3D GIS, Mobile GIS, OLAP, Internet GIS, Open GIS.

Reference Books:

- Anji Reddy, M. 2004: Geoinformatics for Environmental Management.B.S. Publications
- Chang.T.K. 2002: Geographic Information Systems. Tata McGrawHill
- Heywood.I, Cornelius S, CrverSteve. 2003: An Introduction to Geographical Information Systems. Pearson Education
- Ram Mohan Rao. 2002: Geographical Information Systems. Rawat Publication.
- Skidmore A.2002: Environmental Modeling with GIS and Remote Sensing. Taylor and Francis
- Tar Bernhardsen. Geographical Information Systems. John Wiley.
- Wise S.2002: GIS Basics. Taylor Publications
- ESRI Map book: GIS the Language of Geography by ESRI-USA ESRI-2004
- Satellite Geodesy: Gunter Seeba

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Semester – III

Course Type(**Mandatory)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/MJ/600	Reinforcement Learning	2	**2hrs/per week**
AIP/MJE/600	Practical based on Reinforcement Learning	2	**4hrs/per week**

Course Description:

This course will provide an introduction to, and comprehensive overview of, reinforcement learning (RL) by introducing the basic mathematical foundations of reinforcement learning. It will also help students to apply the models in real time application.

Prerequisites:

- Should have knowledge of basics of deep learning.

Course Objectives (CO):

- To get Implement Reinforcement models
- To get understanding of when and which applications need reinforcement learning

Learning Outcomes (LO):

- Students will be able
- Structure a reinforcement learning problem.
- Understand and apply basic RL algorithms for simple sequential decision making problems in uncertain conditions.
- Evaluate the performance of the solution

Course Outline:

Unit 1: Foundations, Tabular methods and Q-networks: Introduction and Basics of RL, Defining RL Framework

and Markov Decision Process, Polices, Value Functions and Bellman Equations, Exploration vs. Exploitation, Code Standards and Libraries used in RL (Python/Keras/Tensor flow), Tabular methods and Q-networks: Planning through the use of Dynamic Programming and Monte Carlo, Temporal-Difference learning methods (TD(0), SARSA, Q-Learning), Deep Q-networks (DQN, DDQN, Dueling DQN, Prioritized Experience Replay)

Unit 2: Policy optimization: Introduction to policy-based methods, Vanilla Policy Gradient, REINFORCE algorithm and stochastic policy search, Actor-critic methods (A2C, A3C), Advanced policy gradient (PPO, TRPO, DDPG)

Unit 3: Model based RL, Recent Advances and Applications: Model-based RL approach, Meta-learning, Multi-Agent Reinforcement Learning, Partially Observable Markov Decision Process, Ethics in RL, and Applying RL for real-world problems

Reference Books:

1. "Reinforcement Learning: An Introduction", Richard S. Sutton and Andrew G. Barto, 2nd Edition
2. "Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition, Alberto Leon-Garcia
3. "Machine Learning: A Probabilistic Perspective", Kevin P. Murphy

E-Resources:

https://cse.iitkgp.ac.in/~adas/courses/rl_aut2020/syllabus.html

https://www.coursera.org/learn/practical-rl

https://www.coursera.org/learn/fundamentals-of-reinforcement-learning

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Course Type(**Mandatory**)			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/MJ/601	Big Data Analytics	2	**2hrs/per week**
AIP/MJ/601	Practical based on Big Data Analytics	2	**4hrs/per week**

Course Description:

This course gives an overview of Big Data, i.e. storage, retrieval and processing of big data. In addition, it also focuses on the "technologies", i.e., the tools/algorithms that are available for storage, processing of Big Data. It also helps a student to perform a variety of "analytics" using weka and understand the benefits of having parallelization .For parallel and scalable implementation use of hadoop, Hbase, PIG and Hive QL.

Prerequisites:

- There are no perquisites required for attending this course.

Course Objectives (CO):

- To get familiarize with the Big Data Platform and its use cases
- To provide an overview of Apache Hadoop , HDFS Concepts
- To get understanding of Map Reduce analytics using Hadoop and related tools like Pig, Hive

Learning Outcomes (LO):

- To Understand big data collection, integration and storage
- Learn the big data indexing
- Learn the basics of MapReduce paradigms
- Learn various queries over big data
- Learn the core techniques of processing big data
- Understand different real applications and their techniques that involve big data

Course Outline:

Unit 1: Introduction to big data: Introduction to Big Data Platform, Challenges of Conventional Systems - Intelligent data analysis, Nature of Data - Analytic Processes and Tools - Analysis vs Reporting. Introduction To Streams Concepts, Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream Estimating Moments, Counting Oneness in a Window, Decaying Window - Real time Analytics Platform (RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

Unit 2: Components of Hadoop - Analyzing the Data with Hadoop- Scaling Out- Hadoop Streaming- Design of HDFS-Java interfaces to HDFS Basics Developing a Map Reduce Application-Anatomy of a Map Reduce Job, Scheduling-Shuffle and Sort - Task execution. Case Study: IBM Info Sphere Big Insights and Streams

Unit 3: Introduction to HBase, Pig and HiveQl: Filesystems for HBase, Client API - The Basics, Hbase clients – REST, Shell Commands, Map Reduce Integration. Overview Pig, HiveQL: Introduction to Pig, Grunt, pig data model, Pig Latin, Advanced pig latin, developing and testing Pig Latin scripts, Map Reduce Integration Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, HiveQL queries, HiveQL views, HiveQL Indexes, functions.

Reference Books:

1. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley,2013.
2. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of
3. Polyglot Persistence", Addison-Wesley Professional,2012.
4. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley,2012. Analytics for
4. Enterprise Class Hadoop and Streaming Data", McGraw Hill Publishing, 2012.
5. Eric Sammer, "Hadoop Operations", O'Reilley,2012.
6. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley,2012.
7. Lars George, "HBase: The Definitive Guide", O'Reilley,2011.
8. Alan Gates, "Programming Pig", O'Reilley,2011.
9. Chris Eaton, Dirk De Roos, Tom Deutsch, George Lapis, Paul Zikopoulos,"Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGrawHill Publishing, 2012.
5. Anand Rajaraman and Jeffrey D. Ullman,"Mining of Massive Datasets", Cambridge University Press, 2012.
6. ArshdeepBahga, Vijay Madisetti, "Big Data Science & Analytics: A Hands - On Approach",VPT, 2016

E-Resources:

https://www.coursera.org/learn/big-data-introduction

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Course Type(**Mandatory)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/MJ/602	Cyber Security	2	**2hrs/per week**
AIP/MJ/602	Practical based on Cyber Security	2	**4hrs/per week**

Course Description:

The cyber security course syllabus is designed to focus on risk management, network security, security operations, software development, and also on practical applications of cyber security

Prerequisites:

- There are no perquisites required for attending this course.

Course Objectives (CO):

- Identify the malicious activities taking place in the system/network.
- Understand Protection mechanism from the cyber-attacks.
- Understand ethics behind hacking and vulnerability discovery

Learning Outcomes (LO):

- Responding to the Cyber Crime
- Preserving and creating controlled environment for Digital evidence

Course Outline:

Unit 1: Introduction to Cyber Crime: Cyber Crime and Information Security, Classification of Cyber crime- Email Spoofing, Spamming, Internet Time Theft, Salami Attack, Data Hacking, Credit Card Frauds, Identity Theft, Password Sniffing, Software Piracy, Web Jacking, Forgery, Online Frauds. Information Security Concepts :Information Security Overview , Information Security Services ,Goals for Security, E-commerce security, Computer Forensics, Digital Forensics Science, Digital Forensics Life Cycle. Phishing and Identity Theft: Methods of Phishing, Phishing Techniques, Spear phishing, Types of phishing scams, Phishing Toolkits and Spy Phishing, Phishing Countermeasures, Identity Theft, Types and Techniques of identity thefts and its counter measures. Security Threats and Vulnerabilities: Overview of Security threats, Attacks, Hacking Techniques, Insecure Network connections.

Unit 2: Privacy Control Concept: What is Privacy? Methods to control Privacy, Data Collection from Social Networks, Challenges, Opportunities and pitfalls in securities, Credibility and reputation in social system. Privacy policing and preserving. Information Privacy disclosure, revelation and its effect in OSM and networks. Access Control and Intrusion Detection: Overview of Authentication and Authorization, Overview of Intrusion Detection System, IDS Types and Detection Models, IDS Features and Intrusion Prevention Systems

Unit 3: Cybercrimes and Cyber Security: The Legal Perspectives Indian Context, The Indian IT Act –Positive Aspect of the ITA 2000, Weak Areas of ITA 2000.Legal, Ethical and Professional Issues in Information Security: Laws and Ethics in information Security, Relevant (Indian/US) Laws, Ethics and Information Security, Codes of Ethics and Professional Organization. Open source: IPV4, IPV6, IP assigning, MAC, Bridging, Raid protocols, Linux remote connection: (Remote login, transfer file), Remote session (OpenSSh Configuration), Logs introduction, log files (Messages, dmesg, Audit log), cron.

Reference Books:

1. Rhodes-Ousley, Mark. Information Security: The Complete Reference, Second Edition,
2. Information Security Management: Concepts and Practice. New York, McGraw-Hill, 2013.
3. Whitman, Michael E. and Herbert J. Mattord. Roadmap to Information Security for IT and InfoSec Managers. Boston, MA: Course Technology, 2011.
4. Nina Godbole and SunitBelapure ,Cyber Security, by, Wiley Publication
5. Gray Hat Hacking: The Ethical Hackers' Handbook, Shon Harris, Allen Harper, Chris Eagle and Jonathan Ness, TMH Edition.

E-Resources:

https://www.cyberdegrees.org/resources/free-online-courses/

https://www.coursera.org/specializations/intro-cyber-security

https://www.coursera.org/specializations/pythonforcybersecurity

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Course Type(**Mandatory Skill Enhancement)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIP/MJ/606	Advance Python	2	**4hrs/per week**

Course Description:

This course presents advanced topics in Python for professional programming. It contains sections on logging, debugging, profiling, and packaging. The course is designed to develop GUI based projects

Prerequisites:

- Should have knowledge of basic programming using python.

Course Objectives (CO):

- To get fluent in using class, objects and threads.
- To be able to work with databases
- To be able to do networking and GUI designing of applications

Learning Outcomes (LO):

Students will be able

- To develop GUI based application along with databases.
- To create applications based on networking aspects
- Evaluate the performance of the solution

Course Outline:

Unit 1: Classes, Objects and Databases: New Style Classes, Inheritance and Mixins, Properties and Slots, Static and Class Methods, Abstract Base Classes, Method Overriding, Attributes and Functors, Decorators and Factories, Descriptors and Meta Classes, Databases: Shelve and Pickle, SQL Relational Databases, Connection, Cursor, Row Objects, Create, Read, Update, Delete Error Handing, Query Results and Metadata, Create and Aggregate Functions, Exporting and Importing

Unit2: Thread basics and Network Programming: Threads and Concurrency: Creating and Joining Threads, Daemon Threads, Thread Objects, Sockets and Addresses, Establishing Connections, TCP Clients and Servers ,UDP Clients and Servers, UDS Clients and Servers, Network Objects, Socket Servers, Secure Sockets Layer,

Unit 3: GUI in Python: Introduction to GUI building libraries, Widgets: Button, Canvas, Check button, Entry, Frame, Label, List box, Menu button, Menu, Message, Radio button, Scale, Scrollbar. Text, Top level, Spin box, Paned Window, Label Frame

Reference Books:

1. Learning Python Network Programming by Dr. M. O. Faruque Sarker, Sam Washington,June 2015
2. Python GUI Programming with Tkinter: Design and build functional and user-friendly GUIapplications by Alan D. Moore, Oct 2021
3. Python GUI Programming Cookbook by Burkhard A. Meier, Dec 2015

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Course Type(**DSE)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/DSE/620	Social Media Analytics	2	**2hrs/per week**
AIP/DSE/620	Practical based on Social Media Analytics	2	**4hrs/per week**

Course Description:

This course will introduce concepts and approaches to mining social media data. It focuses on obtaining and exploring those data, mining networks, and mining text from social platforms. Students will learn how to apply previously learned data mining concepts to a domain on social media. Students will learn to explore, model, and predict with network and textual data from existing social platforms.

Prerequisites:

- Basic for data visualization

Course Objectives (CO):

- Understand the role of social media data and analytics in helping organizations achieve their goals and understand their publics.
- Identify and select key performance indicators to accurately measure the success of social media efforts

Learning Outcomes (LO):

- Analyze social media data using native analytics.

- Develop social media measurement plans and analytics reports, and communicate findings and recommendations, effectively.

Course Outline:

Unit 1: Introduction to Semantic Web: Limitations of current Web, Development of Semantic Web, Emergence of the Social Web. Social Network analysis: Development of Social Network Analysis -Key concepts and measures in network analysis. Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities - Web-based networks. Knowledge representation on the Semantic web: Ontology and their role in the Semantic Web: Ontology-based knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework - Web Ontology Language.

Unit 2: Modelling and aggregating social network data: State-of-the-art in network data representation - Ontological representation of social individuals - Ontological representation of social relationships - Aggregating and reasoning with social network data. Social-semantic applications: Generic Architecture- Sesame- Elmo – Graph util, Flink-Open academia. Social network extraction: Survey method-electronic data extraction- Data collection Optimization, prediction- Evaluation.

Unit 3: Text Analytics : Data Collection :Survey Sampling, Observational result, Statistical Techniques, Analysis of Unstructured Data, Understanding Text ,Extracting and Presenting Statistics Data Formats, CleaningData Sets, Duplicate Detection, Tagging Text, Indexing and Search,, Evaluating Algorithms, topic modeling, Text Classification, Text clustering ,entity resolution ,Information retrieval, Introduction: Integration of text and network analysis, Types of networks extracted from texts across disciplines, Natural Language Processing and (Computational) Linguistics for Information and Relation Extraction, Introduction: Multi-agent models for representing networks.

Reference Books:

1. Manning, C. D., Raghavan, P., and Schutze, H. 2008. Introduction to Information Retrieval. Cambridge University Press, 2008. Retrieved from: http://www- nlp.stanford.edu/IRbook/.
2. Miner, G., Delen, D., Elder, J., Fast, A., Hill, T., and Nisbet, A. R. (2012).Practical Text Mining and Statistical Analysis for Non-structured Text Data Applications. Elsevier Inc. Available online http://www.gbv.de/dms/ilmenau/toc/668584769.PDF.
3. Przemyslaw Kazienko, Nitesh Chawla, Applications of Social Media and Social Network Analysis, Springer, 2015
4. Robert Tibshirani, Trevor Hastie, Jerome Friedman ,The Elements of Data Mining, Statistical Learning, Inference, and Prediction.
5. Manning, Christopher D., and Hinrich Schütze. Foundations of statistical natural language processing. MIT press, 1999.

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Course Type(**DSE)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/DSE/621	Augmented Reality and Virtual Reality	2	**2hrs/per week**
AIP/DSE/621	Practical based on Augmented Reality and Virtual Reality	2	**4hrs/per week**

Course Description:

Recent advances in technology have allowed AR/VR systems to become extremely sophisticated and realistic. This course introduces students to the technologies that underpin AR/VR systems. After this course the student is able to make new games or applications.

Prerequisites:

- Basic knowledge of Should have knowledge of basic programming

Course Objectives (CO):

- To have the scientific, technical, and engineering aspects of augmented and virtual reality systems.
- To learn the Evaluation of virtual reality from the lens of design.

Learning Outcomes (LO):

Students will be able

- Identify, examine, and develop software that reflects fundamental techniques for the design and deployment of VR and AR experiences.
- Describe how VR and AR systems work.
- Develop, explain, and defend the use of particular designs for AR and VR experiences.

Course Outline:

Unit 1: Introduction : Introduction to Augmented-Virtual and Mixed Reality, Taxonomy, technology and features of augmented reality, difference between AR ,VR and MR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality.

Unit 2: VR systems: VR as a discipline, Basic features of VR systems, Architecture of VR systems, VR hardware: VR input hardware: tracking systems, motion capture systems, datagloves, VR output hardware: visual displays. Challenges in VR software development, Master/slave and Client/server architectures, Cluster rendering, Game Engines and available sdk to develop VR applications for different hardware (HTC VIVE, Oculus, Google VR).

Unit 3: 3D interaction techniques and AR software development: 3D Manipulation tasks, Manipulation Techniques and Input Devices, Interaction Techniques for 3D Manipulation. AR software, Camera parameters and camera calibration, Marker-based augmented reality, AR Toolkit.

Reference Books:

1. George Mather, Foundations of Sensation and Perception:Psychology Press; 2 edition, 2009.
2. The VR Book: Human-Centered Design for Virtual Reality, by Jason Jerald
3. Learning Virtual Reality by Tony Parisi, O' Reilly
4. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition.Wiley-IEEE Press, 2003/2006.
5. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.
6. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.

E-Resources:

http://msl.cs.uiuc.edu/vr/

Others resources suggested by instructor

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Course Type(**DSE)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/DSE/622	Spatial & Temporal Computing	2	**2hrs/per week**
AIP/DSE/622	Practical based on Spatial & Temporal Computing	2	**4hrs/per week**

Course Description:

The course is conceptualized to introduce students to statistical analysis in temporal and spatial domain. It leads students into analysis and interpretation of spatial and temporal data, using different tools. The goal of the course is to familiarize the students with the basic techniques for use in further research. The course would enable the students to analyse environmental data for improved decision-making, enabling efficient resource management.

Prerequisites:

- There are no perquisites required for attending this course

Course Objectives (CO):

- To understand and able to compute basic time series components
- To understand the concept of geostatistical modelling for spatial prediction

Learning Outcomes (LO):

- To analyze a data with time series techniques
- To understand spatio-temporal models

Course Outline:

Unit 1: Introduction: types of data, collection of temporal and spatial data, preparation of data. Time series: classification, components, concept of stationarity, decomposition of time series. Analysis for trend detection and slope estimation: Parametric approach - Linear Regression; Non-Parametric approach – Turning Point test, Man-Kendall Test, Pre Whitened Mann Kendall test, Theil and Sen's Median Slope.

Unit 2: Autocorrelation analysis: Estimation of Autocorrelation coefficient, Correlogram, Moving Average process, Autoregressive Process, Autoregressive Integrated Moving Average Process, Cross correlation analysis. Change point detection and its various frameworks. Spatial continuity, Anisotropy axes, directional tolerance, variogram, relative variogram, correlogram, cross-variogram. Estimation: Weighted linear combinations, Global and local estimation, point and block estimates.

Unit3: Random function models in Geostatistics: Deterministic model, probabilistic models, random variables, parameters for random function. Ordinary kriging and block kriging, cokrigging. Spatio-temporal models and its applications: S- and T- mode Empirical Orthogonal Function, Canonical Correlation Analysis, Singular Spectrum Analysis, Contextual Mann-Kendall, Seasonal Trend Analysis.

Reference Books:

1. Burrough P.A. and McDonnel R.A. (2007) Principles of Geographical Information Systems, 3e, Oxford University Press, New York.
2. Chatfield C. (2003) The Analysis of Time Series: An Introduction, 6e, Chapman and Hall, London.
3. Conover W.J. (2006) Practical Nonparametric Statistics, John Wiley & Sons, 584pp.
4. Daniel W.W. (2000) Applied Nonparametric Statistics, Houghton Miffin Company, USA.
5. Barnett V. (2004) Environmental Statistics, Methods and Applications, John Wiley & Sons.
6. Box G.E.P., Jenkins G.M. and Reinsel G.C. (2007) Time Series Analysis Forecasting and Control, 3e, Pearson Education, Delhi.
7. Isaaks E.H. and Srivastava R.M. (1989) Applied Geostatistics, Oxford University Press, New York.
8. Jolliffe, I. (2002). Principal component analysis. John Wiley & Sons Ltd.

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Semester IV

Course Type(**Mandatory)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/MJ/607	Internet of Things	2	**2hrs/per week**
AIP/MJ/607	Practical based on Internet of Things	2	**4hrs/per week**

Course Description:

This course teaches a deep understanding of IoT technologies from the ground up. Students will learn IoT device programming (Arduino and Raspberry Pi), sensing and actuating technologies, IoT protocol stacks (Zigbee, 5G, NFC, MQTT, etc), networking backhaul design and security enforcement, data science for IoT.

Prerequisites:

- There are no perquisites required for attending this course

Course Objectives (CO):

- The course enables student to understand the basics of internet of things and protocols
- Familiarizes some of the application areas where Internet of Things can be applied

Learning Outcomes (LO): Students will

- Know about the middleware for Internet of Things.
- To understand the concepts of Web of Things

- Apply their logic for new system building

Course Outline:

Unit 1: IOT : What is the IoT and why is it important? Elements of an IoT ecosystem, Technology drivers, Business drivers, Trends and implications, Overview of Governance, Privacy and Security Issues. Protocols :Protocol Standardization for IoT , Efforts, M2M and WSN Protocols: SCADA and RFID Protocols , Issues with IoT Standardization, Unified Data Standards :Protocols – IEEE802.15.4–BACNet Protocol– Modbus – KNX – Zigbee– Network layer – APS layer– Security

Unit 2: IOT ARCHITECTURE and WEB OF THINGS: IoT Open source architecture (OIC)- OIC Architecture & Design principles- IoT Devices and deployment models- IoTivity : An Open source IoT stack - Overview- IoTivity stack architecture- Resource model and Abstraction.

Unit 3: IOT APPLICATIONS: IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms /middleware, IoT- A, Hydra etc.

Reference books:

1. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press,2012.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
3. David Easley and Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning About a Highly Connected World", Cambridge University Press, 2010.
4. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applicationsand Protocols", Wiley, 2012.
5. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014 Francis da Costa, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013
6. CunoPfister, Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN: 978-1- 4493-9357-1

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc..

Course Type(**Mandatory)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/MJ/608	Evolutionary Computing	2	**2hrs/per week**
AIP/MJ/608	Practical based on Evolutionary Computing	2	**4hrs/per week**

Course Description:

This course introduces to students the field of Evolutionary Computation and exposes them to the nuances of applying and designing EAs for problems encountered in a wide range of application domains. After this course the student may design new parametric functions for evolutionary algorithms.

Prerequisites:

- Should have knowledge of Machine learning.

Course Objectives (CO):

- To understand and be able to apply evolutionary approaches for problem solving.
- To understand solution approaches and algorithms for determining feasible and optimal solutions

Learning Outcomes (LO):

Students will be able

- To develop the understanding of evolutionary algorithms and evolutionary optimization algorithms
- Design new evolutionary operators, representations and fitness functions for specific practical and scientific applications.
- Determine the appropriate parameter settings to make different evolutionary algorithms

Course Outline

Unit1 : Introduction to Evolutionary Computation and search operators – Evolutionary Algorithms :Genetic Algorithms, Genetic Programming, Differential Evolution, Evolution Strategies, Covariance Matrix Adaptation , Different Components of Evolutionary Algorithms. 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.

Unit 2: 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 ,Selection Schemes, Fitness proportional selection and fitness scaling

Unit 3: Fitness Landscapes and introduction to swarm: Adaptive Parameter Control and Tuning – Constraint Handling ,Niching and Fitness Sharing ,Memetic Algorithms , Ensemble Evolutionary Algorithms, Hybridization with other techniques – Multi-Objective Optimization – Hyper-Heuristics,– Special Forms of Evolution :Co-evolution and Speciation Swarm Intelligence, Swarm Optimization and Ant Colony Optimization

References

1. E. Eiben and J. E. Smith, "An Introduction to Evolutionary Computing", Natural Computing Series, Springer, 2 nd Edition, 2015.
2. Eyal Wirsansky, "Hands-On Genetic Algorithms with Python: Applying Genetic Algorithms to Solve Real-World Deep Learning and Artificial Intelligence Problems", Packt Publishing, 2020.
3. Iaroslav Omelianenko, "Hands-on Neuroevolution with Python: Build HighPerforming Artificial Neural Network Architectures using Neuroevolution-based Algorithm", Packt Publishing, 2019.
4. Slim Bechikh, Rituparna Datta and Abhishek Gupta (Eds.), "Recent Advances in Evolutionary Multi-objective Optimization", Adaptation, Learning, and Optimization Book – 20, Springer, 2017.
5. Nelishia Pillay and Rong Qu, "Hyper-Heuristics: Theory and Applications", Springer, 2018.
6. Hitoshi Iba, "Evolutionary Approach to Machine Learning and Deep Neural Networks: Neuro-Evolution and Gene Regulatory Networks", Springer, 2018.

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc..

Course Type(**Mandatory)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/MJ/609	Generative Adversarial Networks	2	**2hrs/per week**
AIP/MJ/609	Practical based on Generative Adversarial Networks	2	**4hrs/per week**

Course Overview:

In this course, it gives brief auto encoder understanding Boltzmann machines, GAN model for optimization solution of GANS. The students will be able to understand and use the models as per the application requirement

Prerequisites:

- Should have knowledge of artificial neural networks.

Course Objectives (CO):

- To understand Regularization for Deep Learning
- To Develop Applications of Auto encoders
- To understand the components of Deep Generative Models according to application.

Learning Outcomes (LO):

Students will be able

- Implement Generative adversarial networks(GANs)
- To use GANs for optimization purpose

Course Outline:

Unit 1: Introduction to Adversarial Machine Learning and Autoencoders: need of Adversarial Machine Learning, components of Autoencoders, Regularized Autoencoders, Representational Power, Layer Size and Depth

Stochastic Encoders and Decoders ,Denoising Autoencoders , Learning Manifolds with Autoencoders, Contractive Autoencoders ,Predictive Sparse Decomposition , Applications of Autoencoders, Generative adversarial networks

Unit 2: Deep Generative Models: Boltzmann Machines, Restricted Boltzmann Machines, Deep Belief Networks ,Deep Boltzmann Machines , Boltzmann Machines for Real-Valued Data ,Convolutional Boltzmann ,Boltzmann Machines for Structured or Sequential Outputs

Unit 3: Deep Generative Models: , Generative Adversarial Network (GAN), Deep Convolutional GAN, Variants and Applications of GANs, Wasserstein GANs with Gradient Penalty

Reference Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press,2016.
2. Josh Patterson and Adam Gibson, "Deep learning: A practitioner's approach", O'Reilly Media, First Edition, 2017.
3. Fundamentals of Deep Learning, Designing next-generation machine intelligence algorithms, Nikhil Buduma, O'Reilly, Shroff Publishers, 2019.
4. Deep learning Cook Book, Practical recipes to get started Quickly, Douwe Osinga, O'Reilly, Shroff Publishers, 2019.

E-Resources:

https://www.classcentral.com/course/build-basic-generative-adversarial-networks-gans-21788

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc.

Course Type(**DSE)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/DSE/630	Affective Computing	2	**2hrs/per week**
AIP/DSE/630	Practical based on Affective Computing	2	**4hrs/per week**

Course Description:

This course is designed to learn emotional recognition techniques. This course is used to gain a knowledge & understanding of the various affective computing models & learns about various machine developed using human emotions.

Prerequisite:

- There are no perquisites required for attending this course

Course Objectives (CO):

- To understand the various affective computing models.
- To learn emotional recognition techniques.

Learning Outcome (LO):

- To understand the role of emotion and machine interaction.
- To get the understanding of the aesthetic aspect of machine design.
- To develop systems to reduce the emotional gap between humans and machines.

Course Outline:

Unit 1: Introduction: Affective Computing and the Challenge of mood measurement and forecasting. Affective phenomena: emotion, mood, attitude/sentiment, personality. Computers, robots, smartphones with emotional intelligence.

Unit 2: Emotion Theory: Dual-process theories of emotion, Constructivist theories, Appraisal theories. Affective Technology Interaction and Empathy: Computational Appraisal Theory, reinforcement learning based approaches, recognizing emotional context, facial affect recognition, Emotion and Decision-making Ethical issues related to emotion and AI, Emotionally Intelligent Human Computer Interaction, Emotion and Perception, Decision-making, and Creativity, Emotion and Learning, Physiology of Emotion,

Unit 3: Experiment design and modeling: Behavioral game theory, Neurological Mechanisms involved in Emotion, Affect Recognition by Wearable's and other Machines, Communicating Frustration/Stress in Autism and in Customer Experience, Responding to User Emotion to Reduce User Frustration, Inducing Emotion, Robots/Agents that "have" Emotion, Expression of Emotion by Machines/Agents/Synthetic characters, Philosophical, Social Ethical Challenges Implications of Affective Computing, Machine/Mobile Empathy and Emotional Support, Lie Detection and Stress Detection.

Reference Books:

1. Affective Computing and Interaction: Psychological, Cognitive and Neuroscientific Perspectives by Didem Gökçay and Gülsen Yildirim, IGI Global.
2. The Encyclopedia of Human-Computer Interaction by Jonas Lowgren, John M. Carroll, Marc Hassenzahl, and Thomas Erickson, Interaction Design Foundation.
3. Affective Computing by R.W. Picard, MIT Press.
4. The Oxford Handbook of Affective Computing by R.A. Calvo, S.K. D'Mello, J. Gratch, and
5. Kappas, Oxford University Press.

LAB WORK: Students are required to complete minimum 5 practical's on each unit in addition to the assignments published by the teacher on notice board / during practical's etc..

Course Type(**DSE)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/DSE/631	Video Processing	2	**2hrs/per week**
AIP/DSE/631	Practical based on Video Processing	2	**4hrs/per week**

Course Description:

After completion of this course the students will analyze the video & process it by using different optimization algorithms. In this the student gain knowledge about different image processing, segmentation, classification, identification & recognition of an object

Prerequisite:

- Should have knowledge of Image processing.

Course Objectives (CO):

- Understand and describe the fundamental principles video processing
- To be able to do video analysis and have an idea of their application.

Learning Outcomes (LO):

Students will be able

- To analyze video and process on it.
- To use optimization algorithms for better performance analysis of video.
- To develop better techniques for segmentation, classification, identification and recognition of objects.

Course Outline:

Unit 1: Fundamentals of video processing: video fundamentals and formats, 2-D and 3-D sampling and aliasing, 2-D/ 3-D filtering, image decimation/interpolation, video sampling and interpolation, Histogram, Point processing, filtering, image restoration, algorithms for 2-D motion estimation, change detection, motion-compensated filtering, frame rate conversion, de-interlacing, video resolution enhancement, Image and Video restoration

Unit 2: Segmentation: Discontinuity based segmentation- Line detection, edge detection, thresholding, Region based segmentation, Scene Change Detection, Spatiotemporal Change Detection, Motion Segmentation, Simultaneous Motion Estimation and Segmentation Semantic Video Object Segmentation,,

Unit 3: Video detection: Video indexing, summarization, and retrieval. Video-based object classification, Audio and video semantic analysis, Object detection and tracking, Video processing in the compressed domain, Multi-

camera systems and multi-camera data fusion and processing, Objective video quality evaluation.

Reference Books:

1. Rafael C. Gonzalez and Richard E. Woods," Digital Image Processing", 3rd Edition, Prentice Hall, 2008.
2. J. W. Woods, "Multidimensional Signal, Image and Video Processing and Coding", 2nd Edition, Academic Press, 2011.
3. Ed. Al Bovik, "Handbook of Image and Video Processing", 2nd Edition, Academic Press, 2000.
4. A. M. Tekalp, "Digital Video Processing", 2nd Edition, Prentice Hall, 2015.
5. S. Shridhar, "Digital Image Processing", 2nd Edition, Oxford University Press, 2016Ian Good fellow,
6. Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016.

E-Resources:

https://www.coursera.org/learn/digital/

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Course Type(**DSE)**			
Course Code	**Course Title**	**Credits**	**Contact Hours**
AIT/DSE/632	Hyper Spectral Image Processing	2	**2hrs/per week**
AIP/DSE/632	Practical based on Hyper Spectral Image Processing	2	**4hrs/per week**

Course Description:

The course is designed to gain the knowledge of hyper spectral imaging & its different tools. To developed skills for processing of multi spectral & hyper spectral images.

Prerequisite:

- Linear Algebra, and Calculus and statistics should be known.

Course Objectives (CO):

- To study the spectral tool for processing Hyperspectral images.
- To study the concept of Hyperspectral remote sensing.
- To know the basics, importance, and methods of Spectral remote sensing.
- To study machine learning technology for processing hyperspectral images.

Learning Outcome (LO):

- To understand the structure of spectral data including band associations, shape and size of a hyperspectral images.
- To develop software skills in programs used for map production in the modern cartographic workflow.
- To develop skills for deploy machine learning technology for processing multispectral and hyperspectral images.

Course Outline:

Unit-1: Reflectance spectroscopy, dimensionality reduction, feature selection, subspace modelling, endmember extraction, Hyperspectral Concepts and System Trade offs: Signal-to-Noise ratio (SNR) – spectral resolution– sampling – range.

Unit –2: Hyperspectral band ratios and vegetation indices, hyperspectral classification methods, target detection, data collection systems – current HIS systems: Ground – airborne – space borne – calibration techniques – HSI Data Processing Software – HSI Data Processing Techniques: Image Space – spectral space – feature space, spectral angle mapping – N-dimensional scatterplots – projection pursuit – spectral mixture analysis – Principal Component Analysis (PCA).

Unit-3: Spectral unmixing, spectral libraries, applications of hyperspectral remote sensing, Spectral mapping – Pixel Purity Index (PPI) – Minimum Noise Fraction (MNF) – Mixture Tuned Matched Filtering (MTMF) – Classification Techniques: Supervised – Unsupervised – Hybrid – Detection, Classification, and Quantification in Hyperspectral Images Using Classical Least Squares Models.

References

1. Hyperspectral Remote Sensing by Michael T Eismann, SPIE, 2012
2. Hyperspectral Data Exploitation: Theory and Applications by Chein-I Chang,Wiley& Sons Ltd. 2007
3. Techniques and Applications of Hyperspectral Image Analysis by Hans F. Grahn and Paul Geladi, Wiley & Sons Ltd.
4. Chein-I-Chang, "Hyperspectral Techniques for Spectral Detection and Classification Graphics and General-Purpose Computation," Kluwer Academic Publishers, 2003.

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