VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY

(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)

Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)

SYLLABUS

For

Master of Engineering Programmes

(M.TECH-AI & ML)

(For admission in 2022-23 and onwards)

M.Tech Evaluation Scheme

Computer Science and Engineering

(Artificial Intelligence & Machine Learning)

Semester I

Sr. No.	Course Type/Code	Course Name	Teaching Scheme			Credits	Internal Marks	External Marks	Total Marks
			L	T	P				
1	AHT-301	Advanced Mathematics	3	1	0	4	50	100	150
2	AIT - 301	Principle of AI and ML	3	1	0	4	50	100	150
3	AIT - 302	Machine Learning for Big Data	3	1	0	4	50	100	150
4	AIT – 3XX	Program Elective - I	3	0	0	3	50	100	150
5	AIT – 3XX	Program Elective - II	3	0	0	3	50	100	150
6	AHT - 302	Research Methodology and IPR	2	0	0	2	50	50	100
7	AHT-303	Audit-I	2	0	0	0	50	0	0
8	AIP- 301	Principle of AI and MLLab	0	0	2	1	25	25	50
9	AIP - 302	Machine Learning for Big DataLab	0	0	2	1	25	25	50
Total			**22**	**3**	**8**	**22**	**400**	**600**	**950**

Program Elective-I

1. **AIT-303** Computer Vision: Foundation and Applications
2. **AIT-304** Artificial Intelligence in Cyber Security
3. **AIT-305** Introduction to Intelligent System
4. **AIT-306** Pattern Recognition

Program Elective-II

1. **AIT-307** Data Science
2. **AIT-308** Health Care Data Analytics
3. **AIT-309** GPU Computing
4. **AIT-310** Natural Language Processing

Semester II									
Sr. No.	**Course Type/Code**	**Course Name**	**Teaching Scheme**			**Credits**	**Internal Marks**	**External Marks**	**Total Marks**
			L	**T**	**P**				
1	AIT – 311	Deep Learning and Artificial Neural Networks	3	1	0	4	50	100	150
2	AIT – 312	Optimization Techniques	3	1	0	4	50	100	150
3	AIT – 3XX	Program Elective - III	3	1	0	4	50	100	150
4	AIT – 3XX	Program Elective - IV	3	0	0	3	50	100	150
5	AIT – 3XX	Open Elective-I	3	0	0	3	50	100	150
6	AIP - 303	Deep Learning and Artificial Neural NetworksLab	0	0	2	1	25	25	50
7	AIP - 304	Optimization TechniquesLab	0	0	2	1	25	25	50
Total			**15**	**3**	**6**	**20**	**300**	**550**	**950**

Program Elective-III

1. **AIT-313** Robotics and Automation
2. **AIT-314** Reinforcement Learning
3. **AIT-315** Data Driven Optimization
4. **AIT-316** Knowledge Based System

Program Elective-IV

1. **AIT-317** Bioinformatics
2. **AIT-318** Web Intelligence
3. **AIT-319** Human Machine Interaction
4. **AIT-320** Data Acquisition and Productization

Open Elective-I

1. **AIT-321** Human Computer Interaction
2. **AIT-322** Software Engineering
3. **AIT-323** Python Programming

Semester III									
Sr. No.	**Course Type/Code**	**Course Name**	**Teaching Scheme**			**Credits**	**Internal Marks**	**External Marks**	**Total Marks**
			L	T	P				
1	AIT-3XX	Open Elective - II	3	0	0	3	50	100	150
2	AIP- 305	Seminar	0	0	4	2	100		100
3	AIP- 306	Project	0	0	10	5	100	150	250
4	AIP- 307	Dissertation	0	0	12	6	300		300
Total			**3**	**0**	**22**	**16**	**550**	**250**	**800**

Open Elective-II

1. **AIT-324** Fuzzy Logic
2. **AIT-325** Software Testing
3. **AIT-326** Neural Networks
4. **AIT-327** Web Technologies
5. **AIT-328** Cyber Laws and Ethics
6. **AIT-329** Mobile Application and Services

Semester IV									
Sr. No.	**Course Type/Code**	**Course Name**	**Teaching Scheme**			**Credits**	**Internal Marks**	**External Marks**	**Total marks**
			L	T	P				
1	AIP- 308	Dissertation	0	0	28	14	250	450	700
Total			**0**	**0**	**28**	**14**	**250**	**450**	**700**

Syllabus
Advanced Mathematics (AHT-301)

L:T:P:: 3:1:0 **Credits-4**

Course objectives:

42-Hours

From this course, students will be able to:

1. Learn distinct methods of solving simultaneous equations.
2. Well-versed with partial differential equations and their solutions and applications.
3. Acquire the knowledge of transformation to ease the complex problems.
4. Acquaintance with basics of random variables and their distribution for dealing with events by chance.
5. Study different mathematical domains to deal with real-time engineering problems.

Learning outcomes:

1. Comprehend with engineering problems in different mathematical realm.
2. Learn analytical and numerical methods to deal with mathematical problems.
3. Understand how to model the engineering problems and their solutions.
4. Implement the solutions to real-time complex engineering problems.
5. Apprehend with mathematical methodology.

Course content:

Unit I:Solution of linear simultaneous equations: (8 hours)

Consistency, Iterative method, Convergence, Cholesky's (Crout's) method, Gauss-Jordan method, Gauss-Seidel iteration and relaxation methods, Solution of Eigenvalue problems, Smallest, largest, and intermediate Eigen values

Computer based algorithm and programme for these methods (non-evaluative)

Unit II:Partial differential equation and its applications: (10 hours)

Introduction and classification of partial differential equation, Four standard forms of non-linear partial differential equations and their solutions, linear equations with constant coefficients. Applications of partial differential equationsone and two-dimensional wave equation, one and two-dimensional heat equation, Two-dimensional Laplace's equation.

Syllabus
Advanced Mathematics (AHT-301)

L:T:P:: 3:1:0 **Credits-4**

Unit III: Transform calculus-I: **(8 hours)**

Laplace transform, Properties of Laplace transform, Inverse Laplace transform,Applications of Laplace transform, Fourier integral theorem, Fourier transforms, Application of Fourier transform

Unit IV: Transform calculus-II: **(8 hours)**

Z-transform, Properties of Z-transform, Shifting theorems, Initial and final value theorem, Convolution theorems, Inverse Z-transform, Application of Z-transform

Unit V: Basic probability theory: **(8 hours)**

Concept and laws of probability,Discrete and continuous random variable and their distributions; Some special distributions such as Binomial, Poisson, Negative Binomial, Geometric, Continuous uniform, Normal, Exponential, Weibull,Moments,Moment generating functions, Expectation and variance

Practical demo with statistical software like R, SPSS, SAS, etc. (non-evaluative)

Text Books / References:

1. B.S. Grewal, Engineering Mathematics, Khanna Publications, 44th edition.
2. F.B. Hilderbrand, Method of Applied Mathematics, PHI Publications, 2nd edition.
3. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand Publication, 20th edition.
4. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathmematical Statistics, S. Chand Publication, 4th edition.
5. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10th edition.
6. S. Ross, a First Course in Probability, Pearson Education, 8th edition.

Syllabus

Deep Learning and Artificial Neural Networks(AIT – 311)

L: T: P: C: 3:1:0:4 **Credits-4**

Course Objective: **40-Hours**

- Themainobjectiveofthiscourseistoprovidethestudentwiththebasicunderstandingofneural networks fundamentals,
- ProgramtherelatedalgorithmsandDesigntherequiredandrelatedsystems

CourseOutcomes:

- DemonstrateANNstructureandactivationFunctions
- Definefoundationsand learningmechanismsandstate-spaceconcepts
- Identifystructure andlearningofperceptions
- ExplainFeedforward,multi-layerfeedforwardnetworksandBackpropagationalgorithms
- Analyze Radial Basis Function Networks ,Theor Regularization andRBFnetworks

UNIT-I: **8Hrs.**

Introduction and ANN Structure, Biological neurons and artificial neurons. Model of anANN.Activation functions usedin ANNs.Typical classes of network architectures.

UNIT-II: **8Hrs.**

Mathematical Foundations and Learning mechanisms.Re-visiting vector and matrixalgebra, State-space concepts, Concepts of optimization, Error-correction learning. Memory-basedlearning,Hebbian learning. Competitivelearning.

UNIT-III: **8Hrs.**

Single layer perceptrons, Structure and learning of perceptrons, Pattern classifier,introduction and Bayes' classifiers, Perceptron as a pattern classifier, Perceptron convergence.Limitationsof aperceptrons.

UNIT-IV: **8Hrs.**

FeedforwardANN,StructuresofMulti-layerfeedforwardnetworks.Backpropagation algorithm, Back propagation - training and convergence, Functional approximationwithback propagation.Practicalanddesign issuesof backpropagation learning.

UNIT-V: **8Hrs.**

Radial Basis Function Networks, Pattern separability and interpolation, RegularizationTheorRegularizationandRBFnetworks.RBFnetworkdesignandtraining .ApproximationpropertiesofRBF.

TextBooks:

1. SimonHaykin,"NeuralNetworks:Acomprehensivefoundation",SecondEdition,Pea

Syllabus

Deep Learning and Artificial Neural Networks (AIT – 311)

L: T: P: C: 3:1:0:4 **Credits-4**

RsonEducationAsia.
2. Satish Kumar, “Neural Networks: Aclassroomapproach”, TataMcGrawHill,2004.

ReferenceBooks:

1. RobertJ.Schalkoff,"ArtificialNeuralNetworks",McGraw-HillInternationalEditions,1997.

Syllabus

Optimization Techniques (AIT – 312)

L: T: P: C: 3:1:0:4 **Credits-4**

Course Objective:

The students will try to learn: **40-Hours**

- Operation research models using optimization techniques based upon the fundamentals of engineering mathematics (minimization and Maximization of objective function).

COURSE OUTCOMES (COs):

- Recall the theoretical foundations of various issues related to linear programmingmodeling to formulate real-world problems as a L P model
- Explain the theoretical workings of the graphical, simplex and analytical methods for making effective decision on variables so as to optimize the objective function.
- Identify appropriate optimization method to solve complex problems involved in various industries.
- Demonstrate the optimized material distribution schedule using transportation model to minimize total distribution cost.
- Find the appropriate algorithm for allocation of resources to optimize the process of assignment.

Unit I: **8Hrs.**

Introduction to Optimization: Historical Development, Engineering applications of Optimization, Design 04 vector and constraints, Constraint surface, Objective function, Classification of Optimization Problems

Unit II: **8Hrs.**

Classical Optimization Techniques Single variable optimization, Constrained and unconstrained multi-variable 06 optimization, Direct substitution method, Lagrange's method of multipliers, Karush-Kuhn-Tucker conditions

Unit III: **8Hrs.**

Linear Programming Statement of an LP problem, Graphical Solution of an LP problem, Simplex 05 method, Dual simplex method

Unit IV: **8Hrs.**

Non-linear Programming: One-dimensional minimization method Unimodal function, Unrestricted search, Exhaustive search, Dichotomous search, 06 Interval halving method, Fibonacci method, Golden section method, Direct root methods

Unit V: **8Hrs.**

Evolutionary Algorithms An overview of evolutionary algorithms, simulated annealing algorithm, Genetic 06 algorithm, Particle swarm optimization

Optimization Techniques (AIT – 312)

L: T: P: C: 3:1:0:4 **Credits-4**

Reference Books:

1. Engineering Optimization Theory and Practice, S.S.Rao, New Age International (P) Ltd, Publishers

2. Kalyanmoy Deb Multi-objective optimization using evolutionary algorithms John Wiley Publications

3. Jasbir S. Arora Introduction to Optimum Design McGraw Hill Publication

Text Books:

1. J. K. Sharma, “Operations Research”, Macmillan, 5th Edition, 2012.

2. R. Pannerselvan, “Operations Research”, 2nd Edition, PHI Publications, 2006.

3. A. M. Natarajan, P. Balasubramani, A. Tamilarasi, “Operations Research”, Pearson Education, 2013

Optimization Techniques Lab(AIT – 304)

L: T: P: C: 0:0:2:2 **Credits-1**

List of Experiments:

Computer programmer (using Mat lab/ Scilab) for optimization techniques mentioned in syllabus like...

1. UnrestrictedSearchmethods
2. GoldenSectionMethod
3. FibonacciMethod
4. Bacteria Foraging Optimization
5. Particle Swarm Optimization
6. Univariatemethods
7. Ant colony optimization

MajorEquipment:

1.ComputationalfacilityandMatlab/ Scilab/ Casnode

List of Open Source Software/learning website:

Scilab Software, Python

(AIT – 303) Deep Learning and Artificial Neural Networks Lab

L: T: P: C: 0:0:2:2 **Credits-1**

CourseObjectives:

- This course will serve as a comprehensive introduction to various topics in machinelearning.At the end of thecourse
- The students should be able to design and implement machine learning solutions toclassification, regression, and clustering problems; and be able to evaluate and interprettheresults of thealgorithms.

CourseOutcomes:

- Createacustomfeed-forwardnetwork.
- DesignConstructingLayers
- SettingTransferFunctions,Eachlayerhasitsowntransfer function
- Define which is set through the net. Layers{i}.trans fer Fcnproperty
- Discriminative Learningmodels: Logistic Regression, Perceptron's ,Artificial Neural Networks, Support Vector Machines.

Note:Theexperimentsneed tobe implementedusing MATLAB.

ListofExperiments

Sample Problem Statement: Create a custom feed-forward network .It consists of thefollowingsections:

1. NetworkLayers
   - ConstructingLayers
   - ConnectingLayers
   - SettingTransfer Functions
2. WeightsandBiases
3. TrainingFunctions &Parameters
   - Thedifferencebetween trainand adapt
   - PerformanceFunctions
   - TrainParameters
4. Conclusion

Syllabus

Principles of Artificial Intelligence and Machine Learning Lab (AIP-301)

L: T: P: C: 0:0:2:1 **Credits-1**

Course Objectives:

1. To provide a strong foundation of fundamental concepts in Artificial Intelligence.
2. To provide a basic exposition of the goals and methods of Artificial Intelligence.
3. To apply the techniques in applications that involve perception, reasoning, and learning.

Course Outcomes:

1. Apply the basic principles of AI in problem-solving using LISP/PROLOG
2. Implement different algorithms using LISP/PROLOG
3. Develop an Expert System using JESS/PROLOG.
4. Demonstrate the various machine learning algorithm for searching problems.
5. Demonstrate the working of the decision tree classifier, Random Forest classifier, and Logistic Regression classifier.

List of Programs:

List of Experiments (Artificial Intelligence)

1. Implementation of DFS for water jug problem using LISP/PROLOG.
2. Implementation of BFS for tic-tac-toe problem using LISP/PROLOG/Java.
3. Implementation of TSP using a heuristic approach using Java/LISP/ROLOG.
4. Implementation of Simulated Annealing Algorithm using LISP/PROLOG.
5. Implementation of Hill-climbing to solve 8- Puzzle Problem.
6. Implementation of Monkey Banana Problem using LISP/PROLOG

List of Experiments (Machine Learning)

Python Libraries required: Sklearn

Note: Standard datasets can be downloaded from UCI Machine Learning Repository

(https://archive.ics.uci.edu/ml/datasets.php)

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .csv file.

Syllabus

AIP-301: Principles of Artificial Intelligence and Machine Learning Lab

M. Tech. I Year I Sem.

L: T: P: C: 0:0:2:1 **Credits-1**

2. For a given set of training data examples stored in a .csv file, implement and demonstrate the candidate elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
3. Write a program to demonstrate the working of the decision tree classifier. Use the appropriate dataset for building the decision tree and apply this knowledge to classify a new sample.
4. Write a program to demonstrate the working of a Decision tree regressor. Use appropriate dataset for decision tree regressor.
5. Write a program to demonstrate the working of the Random Forest classifier. Use appropriate dataset for Random Forest Classifier.
6. Write a program to demonstrate the working of the Logistic Regression classifier. Use appropriate dataset for Logistic Regression.

Syllabus

Machine Learning for Big Data Lab (AIP-302)

L: T: P: C: 0:0:2:1 **Credits-1**

Course Objectives:

1. To implement Map-Reduce programs for processing big data
2. To realize storage of big data using H base, Mongo DB
3. To analyze big data using linear models
4. To analyze big data using machine learning techniques such as SVM / Decision tree classification and clustering.

Course Outcomes

1. Analyze the unstructured data and apply R programming concepts on it.
2. Uncover key insights and create data-driven solute analyzed business challenges.
3. Implement Machine Learning concepts and data visualization techniques on data.
4. Process big data using the Hadoop framework and PySpark.
5. Perform data analysis with machine learning methods. And perform graphical data analysis.

List of Programs: (Based on Hadoop, YARN, R Package, Hbase, MongoDB)

1. Setting Up the Required Environment for Apache Hadoop Installation.
2. Installing the Single-Node Hadoop Configuration on the System.
3. Install, configure, and run Hadoop and HDFS
4. Implement word coconut/frequency grams using MapReduce
5. Implement an MR program that processes a weather dataset
6. Implement Linear and logistic Regression
7. Implement SVM / Decision tree classification techniques
8. Implement clustering techniques
9. Visualize data using any plotting framework
10. Implement an application that stores big data in HBase / MongoDB / Pig using Hadoop / R.
11. Implementing Clara Algorithm in R.
12. Implementing K-Means Algorithm in R.
13. Implementing KNN Algorithm in R Language.
14. Implementing MapReduce Program for Word Count.

(Based on Spark SQL)

15. Program involving Resilient Distributed Datasets.
16. Program involving Transformations and Actions.
17. Program involving Key-Value Resilient Distributed Datasets.
18. Program involving Local Variables, Broadcast Variables and Accumulators.

Syllabus

Machine Learning for Big Data Lab (AIP-302)

L: T: P: C: 0:0:2:1 **Credits-1**

19. Program involving Filter, Join, GroupBy, Agg operations.
20. Viewing and Querying Temporary Tables.
21. Transferring, Summarizing and Analysing Twitter data.
22. Program involving Flume, Kafka and Kinesis.
23. Program involving DStreams and Dstream RDDs.
24. Linear Regression.
25. Decision Tree Classification.
26. Principal Component Analysis.
27. Random Forest Classification.
28. Text Pre-processing with TF-IDF.
29. Naïve Bayes Classification.
30. K-Means Clustering

References:

1. Alan Gates and Daniel Dai, "Programming Pig – Dataflow Scripting with Hadoop", O'Reilley, 2nd Edition, 2016.
2. Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, ―An Introduction to Statistical Learning with Applications in R, Springer Publications, 2015(Corrected 6th Printing).
3. Hadley Wickham, ggplot2 – Elegant Graphics for Data Analysis, Springer Publications,2nd Edition, 2016.
4. Kristina Chodorow, "MongoDB: The Definitive Guide – Powerful and Scalable Data Storage", O'Reilley, 2nd Edition, 2013.
5. Lars George, "HBase: The Definitive Guide", O'Reilley, 2015.
6. Tom White, ―Hadoop: The Definitive Guide – Storage and Analysis at Internet Scale, O'Reilley, 4th Edition, 2015.
7. Tomasz Drabos, “Learning PySpark”, PACKT, 2017.
8. Padma Priya Chitturi, “Apache Spark for Data Science”, PACKT, 2017.
9. Holden Karau, “Learning Spark”. PACKT, 2016.
10. Sandy Riza, “Advanced Analytics with Spark”, O’ Reilly, 2016.
11. Romeo Kienzler, “Mastering Apache Spark”, PACKT, 2017.

Syllabus

Computer Vision: Foundation and Applications (AIT-303)

L: T: P: C: 3:0:0:3 **Credits-3**

Course Objectives: **40-Hours**

1. To review image processing techniques for computer vision.
2. To understand shape and region analysis.
3. To understand Hough, Transform and its applications to detect lines, circles, ellipses.
4. To understand three-dimensional image analysis techniques.
5. To understand motion analysis.
6. To implement computer vision algorithms for real-world problems.

Course Outcomes:

1. Understand and apply fundamental image processing techniques required for computer vision.
2. Analyze shapes and regions.
3. Apply Hough Transform for line, circle, and ellipse detections.
4. Understand and analyze 3D vision techniques.
5. Understand motion analysis and develop applications using computer vision techniques.

UNIT - I **8 Hour**

Image Processing Foundations: Review of image processing techniques; classical filtering operations; thresholding techniques; edge detection techniques; corner and interest point detection; mathematical morphology; texture.

UNIT - II **8 Hour**

Shapes And Regions: Binary shape analysis; connectedness; object labelling and counting; size filtering; distance functions; skeletons and thinning; deformable shape analysis; boundary tracking procedures; active contours; shape models and shape recognition; centroidal profiles; handling occlusion; boundary length measures; boundary descriptors; chain codes; Fourier descriptors; region descriptors; moments.

UNIT - III **8 Hour**

Hough Transform: Line detection; Hough Transform (HT) for line detection; foot-of-normal method; line localization; line fitting; RANSAC for straight line detection; HT based circular object detection; accurate center location; speed problem; ellipse detection; Case study: Human Iris location; hole detection; generalized Hough Transform (GHT); spatial matched filtering; GHT for ellipse detection; object location; GHT for feature collation.

Syllabus

Computer Vision: Foundation and Applications (AIT-303)

L: T: P: C: 3:0:0:3 **Credits-3**

UNIT - IV **8 Hour**

3D Vision: Methods for 3D vision; projection schemes; shape from shading; photometric stereo; shape from texture; shape from focus; active range finding; surface representations; point-based representation; volumetric representations; 3D object recognition; 3D reconstruction.

Introduction To Motion: Triangulation; bundle adjustment; translational alignment; parametric motion; spline-based motion; optical flow; layered motion.

UNIT - V **8 Hour**

Applications and Case Studies: Implementation of application like face detection, face recognition, eigen faces, surveillance, foreground-background separation, particle filters, Chamfer matching, tracking, and occlusion; combining views from multiple cameras; human gait analysis; locating roadway; road markings; identifying road signs; locating pedestrians, etc.; Case Studies and recent research in Computer Vision.

TEXTBOOKS:

1. D. Forsyth, J. Ponce, Computer Vision: A Modern Approach, Pearson Education.
2. J. Solem, Programming Computer Vision with Python: Tools and Algorithms for Analyzing Images, O'Reilly.

REFERENCE BOOKS:

1. M. Nixon and A. Aquado, Feature Extraction & Image Processing for Computer Vision, 3rd Edition, Academic Press.
2. R. Jain, R. Kasturi, B. Schunck, Machine Vision, Indo American Books.
3. R. Szeliski, Computer Vision: Algorithms and Applications, Springer.
4. S. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press

Syllabus

Artificial Intelligence in Cyber Security AIT-304

L: T: P: C: 3:0:0:3 **Credits-3**

Course Objectives: **40-Hours**

1. To learn the need of AI for Cyber Security.
2. To learn the detection of DDOS using AI techniques.
3. To learn the intrusion detection using Neural Networks.
4. To learn the various applications of AI to detect cyber-attacks.

Course Outcomes

1. Understand the cyber threats, attacks and vulnerabilities and its defensive mechanism.
2. Understand and implement various AI techniques to detect cyber-attacks.
3. Identify recent challenges in AI related to cyber security.
4. Ability to apply AI and machine learning models in cyber security issues.
5. Able to develop new security solutions to the real time applications.

UNIT - I **8 Hour**

Fundamentals of AI: Introduction – Problems that AI Solves – Why AI in Cyber security – Current Cyber Security Solutions - Structured data, Unstructured data – Supervised learning – Unsupervised learning – Reinforcement learning – classification problem - clustering problems – SVM – ANNs.

AI and DDoS: Time series – Types of Time series – Time Series analysis in Cyber Security – Detecting DDOS with Time Series – Predicting DDOS attacks – Ensemble Techniques for Cyber security – Types of Ensembles – Types of Ensemble Algorithms – Bagging, Boosting, Stacking, Bayesian Model Ensemble Method to detect Cyber-attack.

UNIT - II **8 Hour**

Detection of malicious web pages, URLs: URL Blacklisting – Drive by download URL-Command and Control URLs – Phishing URLs – Using Heuristics to detect Malicious Pages – Data for the analysis – Feature Extraction – Lexical Features Web Content based Features – Host based features – site Popularity features.

CAPTCHA and Scan Detection: Using AI to crack CAPTCHA – Types of CAPTCHAS – ReCAPTCHA – Breaking a CAPTCHA – Solving CAPTCHA with neural network - Machine Learning in Scan Detection - Machine-Learning Applications in Scan Detection

Syllabus

Artificial Intelligence in Cyber Security (AIT-304)

L: T: P: C: 3:0:0:3 **Credits-3**

UNIT - III **8 Hour**

Context based Malicious event detection: Context based Malicious event detection – Adware – Bots –Bugs – Ransomware – Rootkit – Spyware – Trojan horses – Viruses – Worms – Malicious Injections in Wireless networks.

UNIT - IV **8 Hour**

AI and IDS: Architecture of IDS based on Neural networks – Intelligent flow based IDS - Multi-Agent IDS – AI based Ensemble IDS – Machine Learning in Hybrid Intrusion Detection Systems - Machine Learning Applications in Hybrid Intrusion Detection: Anomaly - Misuse Sequence Detection System - Parallel Detection System.

UNIT - V **8 Hour**

AI and Mail Server: Types of Mail Server – Data Collection from mail server – Naive Bayes theorem to detect spam – Laplace smoothing – Featurization Techniques to covert text based emails to numeric values, Logistic regression to spam filters - Anomaly detection techniques for SMTP and HTTP, Contemporary issues.

TEXTBOOKS:

1. Hands-On Machine Learning for Cyber Security: Safeguard your system by making your machine intelligence using the python ecosystem, Soma Harder, Sinan Ozdemir, Packt Publishing Ltd, 2018.
2. The state of the Art in Intrusion Detection System, AI-Sakib Khan Pathan, CRC Press, Taylor & Francis Group, 2014.
3. Data Mining and Machine Learning in Cyber Security, Sumeet Dua and Xian Du, CRC Press, 2011.

REFERENCE BOOKS:

1. Cybersecurity for Dummies, Brian Underdahl, Wiley, 2011.
2. Cryptography and Network security, Behrouz A. Forouzan , Debdeep Mukhopadhyay, Mcgraw Hill Education, 2nd Edition, 2011.

Syllabus

Introduction to Intelligent System (AIT-305)

L: T: P: C: 3:0:0:3 **Credits-3**

Course Objectives: **40-Hours**

1. Different issues involved in trying to define and simulate intelligence.
2. Specific, well known Artificial Intelligence methods, algorithms, and knowledge representation schemes.
3. Different techniques which will help them build simple intelligent systems based on AI/IA concepts.

Course Outcomes

1. Develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents.
2. Choose an appropriate problem-solving method and knowledge-representation scheme.
3. Analyze and formalize the problem (as a state space, graph, etc.) and select the appropriate search method.
4. Build simple intelligent systems or classical toy problems using different AI techniques.
5. Demonstrate, in the form of a major project work, the ability to design and develop an intelligent system for a selected application.

UNIT - I **8 Hour**

Evolution of Modern Computational Intelligence: Introduction, Roots of Artificial Intelligence, Modern Artificial Intelligence, Meta-modern AI

Problem Solving by Search: Tree Based Search, Terminology, Graph Search, Search Methods Classification, Uninformed Search Methods, Breadth First Search, Depth First Search, Backtracking Search, Depth Bounded, Depth First Search, Iterative Deepening Depth FirstSearch, Branch and Bound, Bidirectional Search.

UNIT - II **8 Hour**

Informed (Heuristic) Search: Introduction, Heuristics, Best First Search, Greedy Search, A*Search, Comparisons and Remarks, A* Variants, Iterative Deepening A*(IDA*), Simplified Memory Bounded A*(SMA*), Recursive Best-First Search (RBFS), D*Algorithm

Iterative Search: Introduction, Hill Climbing, Simulated Annealing

Adversarial Search: Introduction, MIN-MAX Algorithm, Designing the Utility Function, Alpha- beta Pruning.

UNIT - III **8 Hour**

Knowledge Representation and Reasoning: Propositional Logic, First Order Predicate Logic (FOPL), Predicate Calculus, FOPL Alphabet, Resolution in Propositional Logic and FOPL, Resolution in Propositional Logic, Resolution in FOPL.

Rule-Based Expert Systems: Introduction, Elements of a Rule-Based System, Rules, Types of Rule-Based Expert Systems, Types of Expert Systems.

Syllabus

Introduction to Intelligent System (AIT-305)

L: T: P: C: 3:0:0:3 **Credits-3**

Managing Uncertainty in Rule Based Expert Systems: Bayesian Theory, Classical Probability Theory, Bayes' Rules, Bayesian Reasoning, Bayesian Networks.

UNIT - IV

Fuzzy Expert Systems: Introduction, Fuzzy Sets, Representing Fuzzy Sets, Operations with Fuzzy Sets, Proprieties of Fuzzy Sets, De-Morgan's Laws, Defuzzification, Mamdani Fuzzy Model, Sugeno Fuzzy Model, Tsukamoto Fuzzy Model**.**

Machine Learning: Introduction, Terminology, Learning Steps, Learning Systems Classification

Artificial Neural Networks: Neural Network Types, the Perceptron, Multi-layer Perceptron Advanced Artificial Neural Networks: Jordan Network, Elman Network, Hopfield Network, Self-Organizing Networks**.**

UNIT - V **8 Hour**

Evolutionary Algorithms: How to Build an Evolutionary Algorithm? Genetic Algorithms**.**

Swarm Intelligence: Particle Swarm Optimization, Parameters of PSO, Ant Colonies Optimization, Ant System.

Hybrid Intelligent Systems: Models of Hybrid Computational Intelligence Architectures, Neuro-fuzzy Systems, Evolutionary Neural Networks (EANN), Hybrid Evolutionary Algorithms.

TEXTBOOKS:

1. Crina Grosan and Ajith Abraham, ―Intelligent Systems: A Modern Approach‖, Springer, 2011.
2. Stuart Russell and Peter Norvig, ―Artificial Intelligence: A Modern Approach‖, Third Edition, Pearson Education, India, 2015.

REFERENCE BOOKS:

1. Elaine Rich, Kevin Knight, Shiv shankar B Nair, ―Artificial Intelligence‖, Third Edition, Tata McGraw Hill Education Pvt Ltd., 2008.
2. Deepak Khemani, ―A First Course in Artificial Intelligence‖, McGraw Hill Publication, 2008.

Web References

1. https://dblp.org/db/series/isrl/index

Syllabus

Pattern Recognition (AIT-306)

L: T: P: C: 3:0:0:3 **Credits-3**

Course Objectives: **40-Hours**

1. To understand the concept of a pattern and the basic approach to the development of pattern recognition and machine intelligence algorithms.
2. To apply the knowledge of feature extraction methods, feature evaluation, and data mining on real life.
3. To apply both supervised and unsupervised classification methods to detect and characterize patterns in real-world data.

Course Outcomes

1. Understand the need and significance of mathematical fundamentals in pattern recognition to solve real-time problems.
2. Explore on supervised learning algorithms and to apply them for solving problems.
3. Apply unsupervised techniques for clustering data without prior knowledge.
4. Design pattern recognition models to extract interesting patterns from structured data like graph, syntactic description etc.
5. Understand the impact of dimensionality reduction on the design of intelligent models and to apply the dimensionality reduction techniques on data.
6. Apply various machine learning techniques like artificial neural networks, Support Vector machines, Fuzzy inference engines etc.to solve real-world problems.
7. Develop prototype pattern recognition algorithms that can be used to study algorithm behavior and performance against real-world multivariate data.

UNIT - I **8 Hour**

Classification: Overview of pattern recognition-Discriminant Functions-Supervised learning-Parametric estimation- Maximum likelihood estimation.

Pattern Classifier: Bayesian parameter estimation-perceptron algorithm-LMSE algorithm-problems with Bayes Approach-Pattern classification by distance functions-Minimum distance pattern classifier.

Syllabus

Pattern Recognition (AIT-306)

L: T: P: C: 3:0:0:3 **Credits-3**

UNIT - II **8 Hour**

Unsupervised Classification: Clustering for unsupervised learning and classification-Clustering concept-C-means algorithm-Hierarchical clustering procedures-Graph theoretic approach to pattern clustering- Validity of clustering solutions..

UNIT - III **8 Hour**

Structural Pattern Recognition: Elements off or mal grammars-String generation as pattern Syntactic Description-Parsing-Stochastic grammars structural representation.

Feature Extraction and Selection: Entropy minimization-Karhunen-Loevetransformation-Feature selection through Functions Approximation-Binary feature selection.

UNIT - IV **8 Hour**

Neural Networks and Kernel Machines: Neural network structures for pattern recognition-Neural network based pattern associators– Self organizing networks-Support vector machines (SVM)-Kernel machines, Maximum margin classification, and generalizability and VC(Vapnik–Chervonenkis) dimension.

UNIT - V **8 Hour**

Neuro Fuzzy and Genetic Algorithm classification: Fuzzy Logic-Fuzzy pattern classifiers-Neuro-Fuzzy Systems-Pattern classification and optimization Using Genetic Algorithms**,** Recent Trends in pattern recognitions.

TEXTBOOKS:

1. Duda R.O., and Hart.P.E.,Pattern Classification and Scene Analysis, second edition, Wiley, 2001.
2. Robert J.Schalkoff, Pattern Recognition: Statistical, Structural and Neural Approaches, JohnWiley& Sons Inc., New York, 2007.
3. Trevor H, Robert T,Jerome Friedman, The Elements of Statistical Learning, Springer Series,2017.
4. Christopher M Bishop, Pattern Recognition and Machine Learning. Springer. 2011.

REFERENCE BOOKS:

1. Tou and Gonzales, Pattern Recognition Principles, Wesley Publication Company, London, 1974.

Syllabus

Pattern Recognition (AIT-306)

L: T: P: C: 3:0:0:3 **Credits-3**

2. Morton Nadier and Eric Smith P., Pattern Recognition Engineering, John Wiley & Sons, NewYork, 1993.

Syllabus

Bioinformatics (AIT-317)

L: T: P: C: 3:0:0:3 **Credits-3**

Course Objectives: **40Hrs**

1. To understand Bio informatics from computing perspective.
2. To Apply data mining techniques to provide better health care services.
3. To explore and extract hidden information from bio informatics databases.
4. To understand the applications of Bio informatics.

Course Outcomes:

After the completion of course the students will able to:

1. Understand the concepts of molecular biology, DNA analysis with respect to data processing.
2. Analyze biological sequences and score matrices with respect to data processing.
3. Implement data mining algorithms on microarray, gene expression, feature selection for proteomic and genomic data.
4. Apply AI in medical field for development of contributive solutions.
5. Investigate state-of-the-art research and developments in bioinformatics.

UNIT – I **8hrs**

Introduction: Introduction to Bioinformatics and Data Mining; Molecular Biology background: Analyzing DNA; Bioinformatics perspective of how individuals of a species differ and how different species differ; Bioinformatics challenges and opportunities.

UNIT – II **8hrs**

Biological Sequence Analysis: DNA sequence analysis; DNA databases; Protein structure and function; Protein sequence databases; Sequence alignment; Sequence comparison, Sequence similarity search; Longest common subsequence problem; Scoring matrices for similarity search PAM, BLOSUM, etc.

UNIT – III **8hrs**

Mining Biological Data: Protein structural classification; Protein structural prediction; Modeling text retrieval in biomedicine; Mining from microarray and gene expressions; Feature selection for proteomic and genomic data mining.

Syllabus

Bioinformatics (AIT-317)

L: T: P: C: 3:0:0:3 **Credits-3**

UNIT – IV **8hrs**

Ethics in Bioinformatics: Ethical and social challenges of electronic health information; Public access to anatomic images; Evidence based medicine; Outcome measures and practice guidelines for using data mining in medicine; Computer assisted medical and patient education.

UNIT – V **8hrs**

AI in Medical Informatics: Infectious disease informatics and outbreak detection; Identification of biological Relationships from text documents; Medical expert systems; Telemedicine and tele surgery; Internet grateful med (IGM).

Case Studies: Case Studies and recent research in application of artificial intelligence in bioinformatics.

TEXTBOOKS:

1. S. Rastogi, N. Mendiratta and P. Rastogi, Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery, PHI.
2. Z. Ghosh, B. Mallick, Bioinformatics: Principles and Applications, Oxford University Press.

REFERENCE BOOKS:

1. J. Chen and S. Lonardi, Biological Data Mining, Chapman and Hall/CRC.
2. V. Buffalo, Bioinformatics Data Skills, O′Reilly Publishing.
3. H. Zengyou, Data Mining for Bioinformatics Applications, Woodhead Publishing.
4. L. Low, Bioinformatics: A Practical Handbook of Next Generation Sequencing and its Applications, World Scientific Publishing.
5. M. Model, Bioinformatics Programming Using Python, O′Reilly Publishing.

Syllabus

Web Intelligence (AIT-318)

L: T: P: C: 3:0:0:3 **Credits-3**

Course Objectives: **40hrs**

1. To know the importance of qualitative data, get insights and techniques.
2. To develop customer-centric approach in dealing with data.
3. To know the principles, tools, and methods of web intelligence.
4. To apply analytics for business situations.

Course Outcomes:

After the completion of course the students will able to:

1. Know the concepts and terminologies related to web analytics.
2. Explore various parameters used for web analytics and their impact.
3. Explore the use of tools and techniques of web analytics.
4. Get experience on websites, web data insights and conversions.
5. Develop efficient web analytical support systems for business.

UNIT – I **8hrs**

Web Analytics: Basics, Traditional Ways, Expectations, Data Collection, Clickstream Data, Weblogs, Beacons, JavaScript Tags, Packet Sniffing, Outcomes data, Competitive data, Search Engine Data.

UNIT – II **8hrs**

Qualitative Analysis: Customer Centricity, Site Visits, Surveys, Questionnaires, Website Surveys, Post visits, Creating and Running, Benefits of surveys, Critical components of successful strategy.

UNIT – III **8hrs**

Web Analytic concepts:URLS, Cookies, Time on site, Page views, Understand standard reports, Website content quality, Navigation reports (top pages, top destinations, site overlay).

Search Analytics: Internal search, SEO and PPC, Measuring Email and Multichannel Marketing, Competitive intelligence and Web 2.0 Analytics, Segmentation, Connectable reports.

Syllabus

Web Intelligence (AIT-318)

L: T: P: C: 3:0:0:3 **Credits-3**

UNIT – IV **8hrs**

Google Analytics: Analytics, Cookies, Accounts vs Property, Tracking Code, Tracking Unique Visitors, Demographics, Page Views & Bounce Rate Acquisitions, Custom Reporting.

UNIT – V **8hrs**

Goals & Funnels: Filters, Ecommerce Tracking, Real Time Reports, Customer Data Alert, AdWords Linking, AdSense Linking, Attribution Modeling, Segmentation, Campaign Tracking, Multi-Channel Attribution.

TEXTBOOKS:

1. Avinash Kaushik, "Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity ", 1st edition, Sybex, 2009.
2. Michael Beasley, "Practical Web Analytics for User Experience: How Analytics can help you Understand your Users", Morgan Kaufmann, 2013.

REFERENCE BOOKS:

1. Magy Seif El-Nasr, Anders Drachen, Alessandro Canossa, eds., "Game Analytics: Maximizing the Value of Player Data", Springer, 2013.
2. Bing Liu, "Web Data Mining: Exploring Hyperlinks, Content, and Usage Data", 2nd Edition, Springer, 2011.
3. Justin Cutroni, "Google Analytics", O'Reilly, 2010.
4. Eric Fettman, Shiraz Asif, Feras Alhlou, "Google Analytics Breakthrough", John Wiley & sons, 2016.

Human Machine Interaction (AIT-319)

L: T: P: C: 3:0:0:3 **Credits-3**

Course Objectives: **40hrs**

1. Learn the foundation of human machine interaction.
2. Understand the importance of human psychology in designing good interfaces.
3. Be aware of mobile interaction design and its usage in day – to – day activities.
4. Understand various design technologies to meet user requirements.
5. Encourage to indulge into research in Machine Interaction Design.

Course Outcomes:

After the completion of course the students will able to:

1. Identify User Interface (UI) design principles.
2. Analysis of effective user friendly interfaces.
3. Apply Interactive Design process in real world applications.
4. Evaluate UI design and justify.
5. Create application for social and technical task.

UNIT - I **8hrs**

FOUNDATIONS OF HMI: The Human: History of User Interface Designing, I/O channels, Hardware, Software and Operating environments, The Psychopathology of everyday Things, Psychology of everyday actions, Reasoning and problem solving. The computer: Devices, Memory, processing, and networks. Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, Paradigms.

UNIT – II **8hrs**

DESIGN & SOFTWARE PROCESS: Mistakes performed while designing a computer system, Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds. Interactive Design basics, process, scenarios, navigation, Iteration, and prototyping. HMI in software process: software life cycle, usability engineering, Prototyping in practice, design rationale. Design rules: principles, standards, guidelines, rules. Recognize the goals, Goal directed design process. Evaluation Techniques: Universal Design.

Human Machine Interaction (AIT-319)

L: T: P: C: 3:0:0:3 **Credits-3**

UNIT – III **8hrs**

GRAPHICAL USER INTERFACE: The graphical User Interface: Popularity of graphics, the concept of direct manipulation, graphical systems, Characteristics. Web user Interface: Interface popularity, characteristics. The merging of graphical Business systems and the Web. Principles of user interface design.

UNIT – IV **8hrs**

SCREEN DESIGNING: Design goals, Screen planning and purpose, organizing screen elements, ordering of screen data and content, screen navigation and flow, visually pleasing composition, amount of information, focus and emphasis, presentation information simply and meaningfully, information retrieval on web, statistical graphics, Technological consideration in interface design.

UNIT – V **8hrs**

INTERFACE DESIGN FOR MOBILE DEVICES: Mobile Ecosystem: Platforms, Application frameworks: Types of Mobile Applications: Widgets, Applications, Games, Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.

INTERACTION STYLES AND COMMUNICATION: Windows: Characteristics, Components, Presentation styles, Types of Windows, Management, operations. Text messages: Words, Sentences, messages and text words, Text for web pages. Icons, Multimedia, and colors

TEXTBOOKS:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, ―Human Computer Interaction, 3rdEdition, Pearson Education, 2004.
2. Wilbert O. Galitz, ―The Essential Guide to User Interface Design, Wiley publication.
3. Alan Cooper, Robert Reimann, David Cronin, ―About Face3: Essentials of Interaction design, Wiley publication.
4. Jeff Johnson, ―Designing with the mind in mind, Morgan Kaufmann Publication.
5. Donald A. Normann, ― Design of everyday things,Basic Books; Reprint edition 2002.

6. Brian Fling, ―Mobile Design and Development‖, First Edition, O'Reilly Media Inc., 2009.

AIT-319 Human Machine Interaction

L: T: P: C: 3:0:0:3 **Credits-3**

REFERENCE BOOKS:

1. Rogers Sharp Peerce,Interaction Design: Beyond Human Computer Interaction, Wiley.
2. Guy A. Boy ―The Handbook of Human Machine Interaction, Ashgate publishing Ltd.
3. Kalbande,Kanade,Iyer,Galitz's Human Machine Interaction, Wiley Publications.

AIT-320: Data Acquisition and Productization

L: T: P: C: 3:0:0:3 **Credits-3**

Course Objectives: **40hrs**

1. To explore the fundamental concepts of data pre-processing, extraction, cleaning, annotation, integration.
2. To understand the various information visualization techniques.
3. To understand data productization using Internet of things.

Course Outcomes:

After the completion of course the students will able to:

1. Identity a data acquisition system and their processes.
2. Apply of data pre-processing, extraction, cleaning, annotation, integration on data.
3. Apply the suitable visualization techniques to output analytical results.
4. Identify the requirements of intelligent application and Security and Privacy in IoT
5. Explore on applications using Internet of things.

UNIT - I **8hrs**

Introduction to Data Warehouse: OLTP and OLAP concepts, Introduction to Data Mining, Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Exploratory Data analysis, Measuring Data Similarity and Dissimilarity, Graphical representation of data.

UNIT - II **8hrs**

Introduction to Data Acquisition: Applications, Process, Data Extraction, Data Cleaning and Annotation, Data Integration, Data Reduction, Data Transformation, Data Discretization and Concept Hierarchy Generation.

UNIT - III **8hrs**

Visualization: Introduction, Terminology, Basic Charts and Plots, Multivariate Data Visualization, Data Visualization Techniques, Pixel-Oriented Visualization Techniques, Geometric Projection Visualization Techniques, Icon-Based Visualization Techniques, Hierarchical Visualization Techniques, Visualizing Complex Data and Relations, Data Visualization Tools, Rank Analysis Tools, Trend Analysis Tools, Multivariate Analysis Tools, Distribution Analysis Tools, Correlation Analysis Tools, Geographical Analysis Tools**.**

AIT-320: Data Acquisition and Productization

L: T: P: C: 3:0:0:3 **Credits-3**

UNIT - IV **8hrs**

IoT Overview: IoT Design methodology, Semantic Web Infrastructure, Intelligence Applications, Programming Framework for IoT, Distributed Data Analysis for IoT, Security and Privacy in IoT, Applied IoT, Cloud Based Smart Facilities Management**.**

UNIT – V **8hrs**

Virtualization on Embedded Boards IoT: Stream Processing in IoT, Internet of Vehicles and Applications, Case study on Data Acquisition using Dashboards, Android, and iOS apps.

TEXTBOOKS:

1. Han, Jiawei, Jian Pei, and Micheline Kamber, “Data mining: concepts and techniques”, 3rd Edition, Elsevier, 2011.
2. Margaret H. Dunham, "Data Mining: Introductory and Advanced Topics", Pearson Education, 2012.
3. Arshdeep Bahga, Vijay Madisetti, “Internet of Things -A hands-on approach”, Universities Press, 2015.

REFERENCE BOOKS:

1. Manoel Carlos Ramon, “Intel Galileo and Intel Galileo Gen 2: API Features and Arduino Projects for Linux Programmers”, Apress, 2014.
2. Karl Pover, “Learning Qlikview Data Visualization”, Packt, 2013.
3. Rajkumar Buyya, Amir Vahid Dastjerdi, “Internet of Things: Principles and Paradigms”, Elsevier, 2016.

Syllabus

AIT-307 Data Science

L: T: P: C: 3:0:0:3 **Credits-3**

Course Objectives: **40hrs**

1. Generalizable extraction of knowledge from data.
2. Engineering effective solutions.
3. Basic machine learning algorithms.
4. Building recommendation systems.
5. Considerate concepts on Graphs.

Course Outcomes:

1. Describe what Data Science is and the skill sets needed to be a data scientist, the Data Science Process and how its components interact.
2. Explain in basic terms what Statistical Inference means.
3. Identify probability distributions commonly used as foundations for statistical modeling. Fit a model to data.
4. Use R to carry out basic statistical modeling and analysis and APIs and other tools to scrap the web and collect data.
5. Apply basic tools (plots, graphs, summary statistics) to carry out EDA and apply EDA and the Data Science process in a case study.

UNIT - I **8hrs**

Introduction: What is Data Science? Big Data and Data Science hype, getting past the hype now? Data fication current landscape of perspectives, Skill sets needed, Statistical Inference, Populations and samples, Statistical modeling, probability, distributions, fitting a model, Introduction to R.

UNIT - II **8hrs**

Exploratory Data Analysis and the Data Science Process, Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA, The Data Science Process, **Case Study:** Real Direct (online real estate firm).

Three Basic Machine Learning Algorithms: Linear Regression, k-Nearest Neighbors (k-NN) K-means.

UNIT - III **8hrs**

Spam Filters, Naive Bayes, and Wrangling, Thought Experiment: Learning by Example, Naive Bayes, **Fancy It Up:** Laplace Smoothing, Comparing Naive Bayes to k-NN, Sample Code in bash, **Scraping the Web:** APIs and Other Tools, Jake‘s Exercise: Naive Bayes for Article Classification.

Syllabus

AIT-307 Data Science

L: T: P: C: 3:0:0:3 **Credits-3**

Logistic Regression: Thought Experiments, Classifiers, M6D Logistic Regression Case Study, Media 6 Degrees Exercise.

UNIT - IV **8hrs**

Recommendation Systems: Building a User-Facing Data Product, Algorithmic ingredients of a Recommendation Engine, Dimensionality Reduction, Singular Value Decomposition, Principal Component Analysis, Exercise: build your own recommendation system.

UNIT - V **8hrs**

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

Data Science and Ethical Issues: Discussions on privacy, security, ethics, A look back at Data Science.

TEXTBOOKS:

1. Cathy O'Neil and Rachel Schutt. ―Doing Data Science, Straight Talk from the Frontline‖, O'Reilly Media, 2013.
2. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman, ―Mining of Massive Datasets‖, Second Edition, Dreamtech Press. 2016.

REFERENCE BOOKS:

1. Kevin P. Murphy, ―Machine Learning: A Probabilistic Perspective (Adaptive Computation and Machine Learning Series‖, MIT Press, 2012.
2. Foster Provost and Tom Fawcet,―Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking‖, O'Reilly Media, 2013.

Syllabus

Health Care Data Analytics (AIT-308)

L: T: P: C: 3:0:0:3 **Credits-3**

Course Objectives: **40hrs**

1. To explore the various forms of electronic health care information.
2. To learn the techniques adopted to analyses health care data.
3. To understand the predictive models for clinical data.
4. Understand the role of clinical integration in improving quality, safety and outcomes.

Course Outcomes

1. Analyze health care data using appropriate analytical techniques.
2. Apply analytics for decision making in healthcare services.
3. Apply data mining to integrate health data from multiple sources.
4. Describe the tools and techniques used for data analytics in health care organizations.
5. Develop efficient clinical decision support systems.

UNIT - I **8hrs**

Introduction: Introduction to Healthcare Data Analytics- Electronic Health Records– Components of EHR- Coding Systems- Benefits of EHR- Barrier to Adopting EHR- Challenges- Phenotyping Algorithms.

UNIT - II **8hrs**

Analysis: Biomedical Image Analysis- Mining of Sensor Data in Healthcare- Biomedical Signal Analysis- Genomic Data Analysis for Personalized Medicine.

UNIT - III **8hrs**

Analytics: Natural Language Processing and Data Mining for Clinical Text- Mining the Biomedical- Social Media Analytics for Healthcare**.**

UNIT – IV **8hrs**

Syllabus

Health Care Data Analytics (AIT-308)

L: T: P: C: 3:0:0:3 **Credits-3**

Advanced Data Analytics: Advanced Data Analytics for Healthcare– Review of Clinical Prediction Models- Temporal Data Mining for Healthcare Data- Visual Analytics for Healthcare- Predictive Models for Integrating Clinical and Genomic Data- Information Retrieval for Healthcare- Privacy-Preserving Data Publishing Methods in Healthcare.

UNIT - V **8hrs**

Applications: Applications and Practical Systems for Healthcare– Data Analytics for Pervasive Health- Fraud Detection in Healthcare- Data Analytics for Pharmaceutical Discoveries- Clinical Decision Support Systems- Computer-Assisted Medical Image Analysis Systems- Mobile Imaging and Analytics for Biomedical Data**.**

TEXTBOOKS:

1. Chandan K. Reddy and Charu C Aggarwal, "Healthcare data analytics", Taylor & Francis, 2015
2. Hui Yang and Eva K. Lee, "Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley, 2016.

REFERENCE BOOKS:

1. Trevor L. Strome (2013). Healthcare Analytics for Quality and Performance Improvement. John Wiley & Sons, Inc.
2. Healthcare Data Analytics: Primary Methods and Related Insights. Bob Kelley. September 23, 2019, | ISBN-10: 1694588742 | ISBN-13: 978-1694588746

Syllabus

GPU Computing (AIT-309)

L: T: P: C: 3:0:0:3 **Credits-3**

Objectives: **40hrs**

1. To study all modern multi-core processors, and in order to make effective use of them.
2. To organize the computations of the threads so that they work together and performs the required computations efficiently.
3. To make good use of the available hardware resources.
4. To understand of usage of GPUs for general purpose computing, rather than for graphics.

Course Outcomes:

1. Define terminology commonly used in parallel computing, such as efficiency and speedup.
2. Describe common GPU architectures and programming models.
3. Implement efficient algorithms for common application kernels, such as matrix multiplication.
4. Given a problem, develop an efficient parallel algorithm to solve it.
5. Given a problem, implement an efficient and correct code to solve it, analyze its performance, and give convincing written and oral presentations explaining the achievements.

UNIT - I **8hrs**

Introduction: History, GPU Architecture, Clock speeds, CPU / GPU comparisons, Heterogeneity, Accelerators, Parallel Programming, CUDA OpenCL / OpenACC, Kernels Launch parameters, Thread hierarchy, Warps/Wavefronts, Threadblocks/Workgroups, Streaming multiprocessors, 1D/2D/3D thread mapping, Device properties, Simple Programs**.**

UNIT - II **8hrs**

Memory: Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories.

UNIT - III **8hrs**

Synchronization: Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Worklists, Linked lists. Synchronization across CPU and GPU.

Functions: Device functions, Host functions, Kernels functions, using libraries (such as Thrust), and developing libraries.

Syllabus

GPU Computing (AIT-309)

L: T: P: C: 3:0:0:3 **Credits-3**

UNIT - IV **8hrs**

Support: Debugging GPU Programs. Profiling, Profile tools, Performance aspects.

Streams: Asynchronous processing, tasks, Task-dependence, overlapped data transfers, Default Stream, Synchronization with streams. Events, Event-based- Synchronization - Overlapping data transfer and kernel execution, pitfalls.

UNIT - V **8hrs**

Advanced Topics: Dynamic parallelism, Unified Virtual Memory, Multi-GPU, processing, Peer access, Heterogeneous processing.

Case Studies: Image Processing, Graph algorithms, Simulations, Deep Learning.

TEXTBOOKS:

1. Programming Massively Parallel Processors: A Hands-on Approach; David Kirk, Wen-mei Hwu; Morgan Kaufman.
2. CUDA Programming: A Developer's Guide to Parallel Computing with GPUs; Shane Cook; Morgan Kaufman.
3. GPU Computing and Applications: Yiyu Cai, Simon See; Springer;

REFERENCE BOOKS:

1. Hands-On GPU Programming with Python and CUDA: Explore high-performance parallel computing with CUDA, Brian Tuomanen, Packt Publishing.
2. Gerassimos Barlas, Multicore and GPU Programming: An Integrated Approach, Morgan Kaufmann; 2nd edition (June 16, 2022)

Syllabus

Natural Language Processing (AIT-310)

L: T: P: C: 3:0:0:3 **Credits-3**

Course Objectives: **40hrs**

1. To understand natural language processing and to learn how to apply basic algorithms in this field.
2. To get acquainted with the basic concepts and algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics.
3. To design and implement applications based on natural language processing.
4. To implement various language Models.
5. To design systems that uses NLP techniques.

Course Outcomes:

1. Have a broad understanding of the capabilities and limitations of current natural language technologies.
2. Able to model linguistic phenomena with formal grammars.
3. Be able to Design, implement and test algorithms for NLP problems.
4. Understand the mathematical and linguistic foundations underlying approaches to the various areas in NLP.
5. Able to apply NLP techniques to design real world NLP applications such as machine translation, text categorization, text summarization, information extraction...etc.

UNIT - I **8hrs**

Introduction: History of NLP, Generic NLP system, levels of NLP, Knowledge in language processing, Ambiguity in Natural language, stages in NLP, challenges of NLP, Applications of NLP**.**

UNIT - II **8hrs**

Word Level Analysis: Morphology analysis –survey of English Morphology, Inflectional morphology & Derivational morphology, Lemmatization, Regular expression, finite automata, finite state transducers (FST), Morphological parsing with FST, Lexicon free FST Porter stemmer. N –Grams- N-gram language model, N-gram for spelling correction.

Syllabus

Natural Language Processing (AIT-310)

L: T: P: C: 3:0:0:3 **Credits-3**

UNIT - III **8hrs**

Syntax Analysis: Part-Of-Speech tagging (POS)- Tag set for English (Penn Treebank) , Rule based POS tagging, Stochastic POS tagging, Issues –Multiple tags & words, Unknown words. Introduction to CFG, Sequence labeling: Hidden Markov Model (HMM), Maximum Entropy, and Conditional Random Field (CRF).

UNIT - IV

Semantic Analysis: Lexical Semantics, Attachment for fragment of English- sentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their senses – Homonymy, Polysemy, Synonymy, Hyponymy, WordNet, Robust Word Sense Disambiguation (WSD), Dictionary based approach**.**

Pragmatics: Discourse reference resolution, reference phenomenon, syntactic & semantic constraints on co reference

UNIT – V **8hrs**

Applications (preferably for Indian regional languages): Machine translation, Information retrieval, Question answers system, categorization, summarization, sentiment analysis, Named Entity Recognition.

TEXTBOOKS:

1. Daniel Jurafsky, James H. Martin ―Speech and Language Processing‖ Second Edition, Prentice Hall, 2008.
2. Christopher D.Manning and Hinrich Schutze, ― Foundations of Statistical Natural Language Processing ―, MIT Press, 1999.

REFERENCE BOOKS:

1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
2. Daniel M Bikel and Imed Zitouni ― Multilingual natural language processing applications Pearson, 2013.
3. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) ― The Handbook of Computational Linguistics and Natural Language Processing ― ISBN: 978-1-118-.

4. Syllabus

Natural Language Processing (AIT-310)

L: T: P: C: 3:0:0:3 **Credits-3**

5. Steven Bird, Ewan Klein, Natural Language Processing with Python, O 'Reilly.
6. Brian Neil Levine, An Introduction to R Programming.
7. Niel J le Roux, Sugnet Lubbe, A step by step tutorial: An introduction into R application and programming

AIT-301: Principles of Artificial Intelligence & Machine Learning

L: T: P:: 3:1:0 **Credits-4**

Course Objectives: **40hrs**

1. To provide a strong foundation of fundamental concepts in Artificial Intelligence.
2. To acquire knowledge about agents and their types.
3. To solve problems by searching.
4. To define the ANN, why we need the ANN, and the architecture of ANN
5. To transform the training set of data using a kernel function.
6. To provide a basic exposition of the goals and methods of Artificial Intelligence.
7. To provide fundamentals of machine learning.

Course Outcomes:

1. Enumerate the impact of the various fields in Artificial Intelligence.
2. Apply the basic principles of AI in problem-solving and the need for the ANN and the architecture of ANN.
3. Choose the appropriate representation of Knowledge.
4. Enumerate the Perspectives and Issues in Machine Learning.
5. Identify the optimal hyperplane in the training phase with a classifier.

UNIT – I **8 Hour**

Introduction: Artificial Intelligence, Application of AI, AI Problems, Problem Formulation, Intelligent Agents, Types of Agents, Agent Environments, PEAS representation for an Agent, Architecture of Intelligent agents. Reasoning and Logic, Prepositional logic, first-order logic, Using First-order logic, Inference in First-order logic, forward and Backward Chaining.

UNIT - II **8 Hour**

Problem Solving: Solving problems by searching, Search- Issues in The Design of Search Programs, Un-Informed Search- BFS, DFS; Heuristic Search Techniques: Generate-And Test, Hill Climbing, Best-First Search, A* Algorithm, Alpha-beta search algorithm, Problem Reduction, AO*Algorithm, Constraint Satisfaction, Means-Ends Analysis**.**

UNIT - III **8 Hour**

Knowledge Representation: Knowledge-Based Agents, Logic, Propositional Logic: A Very Simple Logic, Ontological Engineering, Categories and Objects, Events, Mental Events, and Mental Objects, Reasoning Systems for Categories, The Internet Shopping World.

Artificial Neural Networks: Introduction, Activation Function, Optimization algorithm Gradient decent, Networks Perceptron's, Adaline, Multilayer Perceptron's, Backpropagation Algorithms Training Procedures, Tuning the Network Size

AIT-301: Principles of Artificial Intelligence & Machine Learning

L: T: P:: 3:1:0 **Credits-4**

UNIT – IV **8 Hour**

Introduction to Machine Learning: Machine Learning basics, Applications of ML, Data Mining Vs Machine Learning vs Big Data Analytics. Supervised Learning Naïve Base Classifier, Classifying with k-Nearest Neighbour classifier, Decision Tree classifier, Naive Bayes classifier. Unsupervised Learning - Grouping unlabelled items using k-means clustering, Association analysis with the Apriori algorithm Introduction to reinforcement learning

Forecasting and Learning Theory: Non-linear regression, Logistic regression, Random Forest, Bayesian Belief networks, Bias/variance trade-off, Tuning Model Complexity, Model Selection Dilemma

Clustering: Expectation-Maximization Algorithm, Hierarchical Clustering, Supervised Learning after Clustering, Choosing the number of clusters, Learning using ANN.

UNIT - V **8 Hour**

Kernel Machines & Ensemble Methods: Introduction, Optimal Separating Hyperplane, separating data with maximum margin, Support Vector Machine (SVM), Finding the maximum margin, The Non-Separable Case: Soft Margin Hyperplane, Kernel Trick, Defining Kernels.

Ensemble Methods: Mixture Models, Classifier using multiple samples of the data set, improving classifier by focusing on error, a weak learner with a decision stump, Bagging, Stacking, Boosting, Implementing the AdaBoost algorithm, Classifying with AdaBoost Bootstrapping and cross-validation.

TEXTBOOKS:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, 3rd Edition, Pearson
2. Tom M. Mitchell, *Machine Learning,* McGraw Hill Edition, 2013.

REFERENCE BOOKS:

1. Saroj Kaushik, “Artificial Intelligence”, Cengage Learning India, 2011
2. Elaine Rich and Kevin Knight, “Artificial Intelligence”, Tata McGraw Hill
3. David Poole and Alan Mackworth, “Artificial Intelligence: Foundations for Computational Agents”, Cambridge University Press 2010.
4. Trivedi, M.C., “A Classical Approach to Artificial Intelligence,” Khanna Publishing House, Delhi.

Principles of Artificial Intelligence & Machine Learning (AIT-301)

L: T: P:: 3:1:0 **Credits-4**

5. Christopher Bishop, Pattern Recognition and Machine Learning (PRML), Springer, 2007.
6. ShaiShalev-Shwartz and Shai Ben-David, Understanding Machine Learning: From Theory to Algorithms (UML) , Cambridge University Press, 2014..

Machine Learning for Big Data (AIT-302)

1. **L: T: P:C: 3:1:0 :4** **Credits-4**

Course Objectives: **40hrs**

1. To understand various scalable machine learning algorithms to solve big data problems.
2. To understand the SPARK architecture.
3. To implement Machine Learning algorithms using PySpark.
4. To introduce Classification Techniques– Supervised Machine learning and Unsupervised Machine Learning.

Course Outcomes

1. Understand how Machine learning algorithm is made scalable to solve big data problems.
2. Implement scalable Machine Learning algorithms using PySpark.
3. Apply and compare different strategies for big data analytics using various machine learning algorithms
4. Understand Streaming algorithms and Coreset concept to analyze voluminous and high-dimensional data
5. Understanding the Pre-processing concepts in Machine Learning.

UNIT - I **8 Hour**

Introduction to Big Data - Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Infosphere Big Insights and Big Sheets.

UNIT - II **8 Hour**

HDFS (Hadoop Distributed File System): The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro, and File-Based Data structures.

Map Reduce: Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle, and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.\

UNIT – III **8 Hour**

Machine Learning for Big Data (AIT-302)

1. **L: T: P:C: 3:1:0 :4** **Credits-4**

Introduction to Spark: Spark Architecture, Spark Jobs, and APIs. Resilient Distributed Datasets Creating RDDs, Transformation, Actions. Data frames- Python to RDD communications, Creating Data frames, Data frame queries. MLlib -Loading and Transforming

The data. Implementation of Machine Learning algorithms such as Classification and Clustering using MLlib.

UNIT - IV **8 Hour**

Approaches to Modelling: Importance of Words in Documents - Hash Functions- Indexes - Secondary Storage -The Base of Natural Logarithms - Power Laws - Map Reduce. Finding similar items: Shingling – LSH - Distance Measures. Mining Data Streams: Stream data model - Sampling data - Filtering streams. Link Analysis: Page Rank, Link Spam.

UNIT – V **8 Hour**

Frequent Item Sets: Market Basket Analysis, A-Priori Algorithm - PCY Algorithm, Big data Clustering: Clustering in Non-Euclidean Spaces, BFR, CURE**.**

Structured Streaming: Spark Streaming, Application dataflow. Coresets: Coresets for K-means, K-median clustering.

TEXTBOOKS:

1. Anand Raja Raman, Jure Leskovec and J.D. Ullman, “Mining of Massive Data sets”, e-book, Publisher, 2014.
2. Kevin P. Murphey, “Machine Learning, a Probabilistic Perspective”, The MIT Press Cambridge, Massachusetts, 2012.
3. Tomasz Drabas, Denny Lee,” Learning Pyspark”, Packt, February 2017.
4. Jeff M. Phillips,” Coresets and Sketches”, arXiv:1601.00617,2016.

REFERENCE BOOKS:

1. Jared Dean, ―Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners‖, Wiley India Private Limited, 2014.
2. Lior Rokach and Oded Maimon, ―Data Mining and Knowledge Discovery Handbook‖, Springer, 2nd edition, 2010.
3. Ronen Feldman and James Sanger, ―The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data‖, Cambridge University Press, 2006.

Syllabus

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

Syllabus

Reinforcement Learning (AIT-314)

L: T: P: C: 3:0:0:3 **Credits-4**

40hrs

Course Objectives:

1. Formalize problems as Markov Decision Processes
2. Understand basic exploration methods and the exploration / exploitation tradeoff
3. Understand value functions, as a general-purpose tool for optimal decision-making
4. Know how to implement dynamic programming as an efficient solution approach to an industrial control problem

Course Outcomes:

1. Formalize problems as Markov Decision Processes
2. Understand basic exploration methods and the exploration/exploitation trade-off
3. Understand value functions, as a general-purpose tool for optimal decision-making
4. Know how to implement dynamic programming as an efficient solution approach to an industrial control problem

UNIT – I **8hrs**

Introduction
Course logistics and overview. Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning.

Probability Primer
Brush up of Probability concepts - Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.

UNIT – II **8hrs**

Markov Decision Process
Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.

Syllabus

Reinforcement Learning (AIT-314)

L: T: P: C: 3:0:0:3 **Credits-4**

UNIT – III 8hrs

Prediction and Control by Dynamic Programing
Overview of dynamic programing for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evaluation and value iteration algorithms, DP extensions.

Monte Carlo Methods for Model Free Prediction and Control
Overview of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling.

UNIT – IV 8hrs

TD Methods
Incremental Monte Carlo Methods for Model Free Prediction, Overview TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.

Function Approximation Methods
Getting started with the function approximation methods, Revisiting risk minimization, gradient descent from Machine Learning, Gradient MC and Semi-gradient TD(0) algorithms, Eligibility trace for function approximation, Afterstates, Control with function approximation, Least squares, Experience replay in deep Q-Networks.

UNIT – V 8hrs

Policy Gradients
Getting started with policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.

Syllabus

Textbooks:

1. "Reinforcement Learning: An Introduction", Richard S. Sutton and Andrew G. Barto, 2nd Edition

Reinforcement Learning (AIT-314)

L: T: P: C: 3:0:0:3 **Credits-4**

2. Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition, Alberto Leon-Garcia

REFERENCE BOOKS:

3. "Machine Learning: A Probabilistic Perspective", Kevin P. Murphy
4. “Reinforcement Learning: An Introduction”, 2nd Edition, MIT Press, 2018, R.S. Sutton and A.G. Barto

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Syllabus

Robotics and Planning (AIT-313)

L: T: P: C: 3:0:0:3 **Credits-4**

40hrs

Course Objectives:

1. The motivation behind robotics will be discussed.
2. Applications of robots in different areas like in manufacturing units, medical science, space, and others.
3. Various methods of robot teaching.
4. The working principles of various sensors used in robots.
5. The principles of motion planning algorithms.

Course Outcomes:

- The fundamentals of image filtering and tracking, and how to apply those principles to face detection, mosaicking and stabilization
- How to use geometric transformations to determine 3D poses from 2D images for augmented reality tasks and visual odometry for robot localization
- How to recognize objects and the basics of visual learning and neural networks for the purpose of classification

UNIT – I **8hrs**

Introduction to Robotics: Types and Classification of robots; Science and Technology of Robots. **Rigid Body Transformation:** Overview of Rigid Body Kinematics; Homogeneous Transformation; Link Transformation Matrices

UNIT – II **8hrs**

Robotic vision sensors and their interfacing. Fundamentals of Computer Vision: Image accusation and representation, image transformation, filtering, restoration, morphing, Camera Models, Calibration, Single view geometry, Multiple view geometry, Epipolar geometry, RANSAC

Syllabus

Robotics and Planning (AIT-313)

L: T: P: C: 3:0:0:3 **Credits-4**

UNIT – III **8hrs**

Position and Orientation: Feature based alignment; Pose estimation; Time varying pose and trajectories, Structure from motion, dense Motion Estimation, Visual Odometry (Semi-direct VO, direct sparse odometry), Bundle Assignment.

UNIT – IV **8hrs**

Localization and Mapping: Initialization, Tracking, Mapping, geometric SLAM formulations (indirect vs. direct error formulation, geometry parameterization, sparse vs. dense model, optimization approach), Relocalization and map Optimization, Visual SLAM, Examples: Indirect (Feature based) methods (MonoSLAM, PTAM, ORB-SLAM), Direct methods (DTAM, LSD-SLAM), Sensor combinations (IMU, mono vs. Stereo, RGB-Depth), Analysis and parameter studies.

UNIT – V **8hrs**

Recognition and Interpretations: Concepts of machine learning and deep learning, sequence modeling, Learning for robotic vision: Active learning, incremental and class incremental learning identify unknowns, uncertainty estimation, Embodiment for robotic vision: active vision, spatial and temporal embodiment, reasoning for object, scene and scene semantics.

Textbooks

1. Fu. K.S., Gonzalez R.C. and Lee C.S.G., Robotics: Control, Sensing, Vision and Intelligence, Tata McGraw Hill, 2008.
2. H. R. Everett, Sensors for Mobile Robots: Theory and Application, A K Peters/CRC Press, 1995.
3. Dahiya, Ravinder S., Valle, Maurizio, Robotic Tactile Sensing, Springer, 2013.
4. S. R. Deb, Sankha Deb, Robotics Technology and Flexible Automation, 2nd edition, McGraw Hill Education, 2017.
5. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis and Machine Vision, Cengage, Third Edition (2013)

Syllabus

Robotics and Planning (AIT-313)

L: T: P: C: 3:0:0:3 **Credits-4**

References Books:

1. Spong M.W., Hutchinson S. and Vidyasagar M., Robot Modeling and Control, John Wiley Sons & Inc., 2005.
2. Saha. S.K., Introduction to Robotics, McGraw Hill Education (India) Private Limited, 2014.
3. Buduma N., Fundamentals of Deep Learning, Designing Next-Generation Artificial Intelligence Algorithms , O'Reilly Media, June 2015
4. D. A. Forsyth and J. Ponce, Computer Vision, A Modern Approach, Pearson Education, 2003

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Syllabus

Data Driven Optimization (AIT-315)

L: T: P: C: 3:0:0:3 **Credits-4**

40hrs

Course Objectives:

Most problems arising in modern Machine Learning and Data Science are formulated as optimization programs. The most efficiently tractable subclass of these problems is the family of convex programs. The course will consist of two parts:
1) Convex Optimization (CO),
2) Application of the CO machinery in Data Science.

Course Outcomes:

Upon successful completion of the course the students will
1) Understand the theory and methodology of CO,
2) Be familiar with the most efficient and commonly used optimization techniques and advantages of their usage,
3) Will learn about numerous practical applications of the CO to modern statistical and machine learning problems,
4) Will be able to design and apply CO techniques themselves.

Unit I **8hrs**

Convex Optimization. The first part of the course focuses on defining, analyzing, and solving convex optimization problems that arise in applications. We will cover Convex sets, functions, and programs and their properties,Basics of convex analysis, cones,Linear, quadratic, and semi definite programming.

Unit II 8hrs

Optimality conditions, introduction to duality theory, theorems of alternatives, Algorithms: Unconstrained minimization, Descent methods, Newton's method, Interior-point methods.

Unit III 8Hrs

Applications. Applications of the CO machinery to Statistics, Machine learning, and Data Science problems. Maximum likelihood and elements of Robust Statistics, Regularization: ridge regression, LASSO, and their analysis.

Syllabus

Data Driven Optimization (AIT-315)

L: T: P: C: 3:0:0:3 **Credits-4**

Unit IV 8Hrs

Elements of Bayesian Statistics, SVD, Matrix Norms, Robust Principal Component Analysis, Matrix completion, Examples from big data , engineering, and machine learning.

Unit V 8Hrs

Unconstrained Optimization, Optimality conditions. Convexity. Descent directions. Line search. Acceptability of step sizes. General minimization algorithm. Gradient method. Rate of convergence.
Newton's method. Factorizations to ensure convergence. Weighted least squares. Introduction to AMPL. The Neso solver site.

Text Books:

- Optimization in Operations Research, second edition, Ronald L. Rardin, ISBN-13: 978-0-13-438455-9
- An Introduction to Statistical Learning with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, and Rovert Tibshirani, ISBN-13: 978-1461471370 (also available for free online)
- Scientific Computing, second edition, Michael T. Heat, ISBN-13: 978-1259002281

Reference Books:

• Nesterov. Introductory Lectures on Convex Optimization: A Basic Course. Kluwer-Academic. 2003

• Boyd & Vandenberghe. Convex Optimization. Cambridge University Press. 2003

• Sra, Nowozin, Wright (eds). Optimization for Machine Learning. MIT Press. 2011

• Bubeck. Convex Optimization: Algorithms and Complexity. In Foundations and Trends in Machine Learning. 2015

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Syllabus

Knowledge Based System (AIT-316)

L: T: P: C: 3:0:0:3 **Credits-4**

40hrs

Course Objectives:

The unit seeks to impart an understanding of knowledge based concepts and techniques, translating requirements into knowledge models and then generating these using expert systems. Students will be provided with theoretical foundations and practical techniques to build knowledge based systems.

Course Outcomes:

Upon successful completion of this course, the student should be able to: The students shouldbe able to;

- Have a general understanding of A. I. concepts
- Use the various search mechanisms to solve a problem.
- Understand knowledge acquisition techniques
- Use knowledge representation methods.
- Use inference techniques to improve prediction and decision support.

UNIT – I **8hrs**

Introduction to Intelligence and Artificial Intelligence- Overview of Artificial Intelligence, History of Artificial Intelligence. Characteristics of AI Programs - Symbolic processing, Knowledge Representation Search, Heuristics Applications of Artificial Intelligence.

Search - Process of Searching Representing search problems Search strategies Uninformed (blind) search Informed (heuristic) search

UNIT – II **8hrs**

Introduction to Knowledge based systems – Data, information and knowledge, Types of Knowledge and Knowledge based systems.

Syllabus

Knowledge Based System (AIT-316)

L: T: P: C: 3:0:0:3 **Credits-4**

UNIT – III **8hrs**

Knowledge Representation, Semantic Nets, Partitioned Nets, Parallel Implementation of Semantic Nets. Frames, Common Sense Reasoning and Thematic Role Frames, Architecture of Knowledge Based System, Rule Based Systems,Framebasedsystems. Forward and Backward Chaining,

UNIT – IV **8hrs**

Search Techniques. Uninformed Search: DFS, BFS, Iterative Deepening, Heuristic Search: A*, Hill Climbing etc.

Case-based reasoning (CBR) – Case, case-indexing, main components of Case-based systems.

UNIT – V **8hrs**

Uncertainty Management in Expert Systems, Fuzzy Logic, ProbabilisticMethods, Bayesian Theory, Dempster Shafer Theory, Bayes Network, Introduction to Agents and their Application in Intelligent Systems.

Textbooks:

1. Artificial Intelligence-Nilsl J Nilson

2. Artificial Intelligence-Elain Rich and Kevin Knight

References Books:

- Rajendra A. Akerkar and Priti S. Sajja, Knowledge-Based Systems; Jones & Bartlett Publishers, 1st Edition, 2009. You can also check http://isbn.nu/http://isbn.nu/9780763776473 for prices of new and used copies at online bookstores like Amazon, Abebooks.com, Half.com and a few others.
- J. Giarratano and G. Riley, `` Expert Systems -- Principles and Programming, 4th Edition,Thomson/PWS Publishing Company, 2004.
- Ernest Friedman-Hill, "Jess in Action" Manning Publications, 2003.
- A. Gonzalez and D. Dankel, ``The Engineering of Knowledge-Based Systems"; Second Edition, Prentice Hall, 2004.

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Syllabus

Knowledge Based System (AIT-316)

L: T: P: C: 3:0:0:3 **Credits-4**

- Introduction to Expert Systems. by Peter Jackson. Addison Wesley Longman, 1999. ISBN 0-201-87686-8.
- C. Nikolopoulos, "Expert Systems" Marcel Dekker Inc. 1997. ISBN 0 8247 9927 5.
- the CPE/CSC 480 textbook, Artificial Intelligence: A Modern Approach (2nd ed.) by Stuart Russell and Peter Norvig.

Syllabus
Research Methodology and IPR (AHT-302)

L:T:P:: 2:0:0 **Credits-2**

Course Objectives: Students will be able to:

1. To understand the fundaments of research in today's world controlled by technology, ideas, concept, and creativity.
2. To understand different methods of research designing and data collections.
3. To understand the methods of report writing and its different methods of interpretations.
4. To understand research ethics and methods of research publications
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and inturn brings about, economic growth and social benefits.

Course Outcomes:

1. To understand research problem formulation.
2. To study research design and method of data collections.
3. To study methods of report writing.
4. To follow research ethics.
5. To enhance student's competence to discover new inventions.

Syllabus Contents:

UNIT I: FUNDAMENTAL OF RESEARCH **8 Hour**

Meaning of research; objectives of research; basic steps of research; criteria of good research; Research methods vs. Methodology. Types of research –criteria of good research; Meaning of research problem; selection of research problem; Approaches of investigation of solutions for research problem, Errors in selecting a research problem, Scope and objectives of research problem, Review of related literature- Meaning, necessity and sources.

Unit 2: RESEARCH DESIGN AND DATA COLLECTION **8 Hour**

Research design: Types of research design- exploratory, descriptive, diagnostic and experimental; Variables- Meaning and types; Hypothesis- Meaning, function and types of hypothesis; Null/Alternative hypothesis; Sampling- Meaning and types of sampling; Probability and Non-Probability; Tools and techniques of data collection- questionnaire, schedule, interview, observation, case study, survey etc.

Unit 3:REPORT WRITING AND ITS INTERPRETATION **8 Hour**

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

Syllabus
Research Methodology and IPR (AHT-302)

L:T:P:: 2:0:0 **Credits-2**

Unit 4:RESEARCH ETHICS AND SCHOLARY PUBLISHING **8 Hour**

Ethics-ethical issues, ethical committees (human & animal); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism and its concept and importance for scholar.

Unit 5: INTELLECTUAL PROPERTY RIGHT (IPR **8 Hour**

IPR- intellectual property rights and patent law, commercialization, New developments in IPR; copy right, royalty, trade related aspects of intellectual property rights (TRIPS); Process of Patenting and Development; Procedure for grants of patents, Patenting under PCT; Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases.

Reference Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science &engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: AnIntroduction"
3. RanjitKumar,2nd Edition, "Research Methodology: A Stepby Step Guide for beginners"
4. Halbert,"ResistingIntellectualProperty",Taylor&FrancisLtd,2007.
5. Mayall,"IndustrialDesign",McGrawHill,1992.
6. Niebel,"ProductDesign",McGrawHill,1974.
7. Asimov,"IntroductiontoDesign",PrenticeHall,1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age",2016.
9. T.Ramappa,"IntellectualPropertyRightsUnderWTO",S.Chand,2008

Technical Writing and Presentation Skills (AHT-303)

L:T:P::2:0:0 **Non-credits**

Course Objectives: 28-Hours

- To develop effective writing and presentation skills in students.
- To develop textual, linguistic and presentation competencies instudents appropriate for their professional careers.

Course Outcomes:

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

CO1: Write clearly and fluently to produce effective technical documents.

CO2: Demonstrate an appropriate communication style to different types of audiences both orally and written as per demand of their professional careers.

CO3: Communicate in an ethically responsible manner.

Course Contents:

WRITING SKILLS

Unit-I **(4 hours)**

Technical Writing-Basic Principles: Words-Phrases-Sentences, Construction of Cohesive Paragraphs, Elements of Style.

Unit-II **(4 hours)**

Principles of Summarizing: Abstract, Summary, Synopsis

Unit-III **(6 hours)**

Technical Reports: Salient Features, Types of Reports, Structure of Reports, Data Collection, Use of Graphic Aids, Drafting and Writing

PRESENTATION SKILLS

Unit-IV **(6 hours)**

Speaking Skills: Accuracy vs. Fluency, The Audience, Pronunciation Guidelines, Voice Control.

Unit-V **(8 hours)**

Professional Presentations: Planning, Preparing, Presentation Strategies, Overcoming, Communication Barriers, Using Technology, Effective Presentations.

References:

1. Kumar, Sanjay & Pushp Lata, “Communication Skills”, Oxford UniversityPress,2011.
2. Quirk & Randolph, “A University Grammar of English”, Pearson,2006.
3. Rutherford, Andrea J., “Basic Communication Skills for Technology”, Pearson 2007.
4. Rizvi, M Ashraf, “Effective Technical Communication”, McGraw Hill,2009.
5. Leigh, Andrew & Maynard, Michael, “The Perfect Presentation”, Random House.
6. Barker, Larry L., “Communication”, Prentice-Hall.
7. Lesikar&Flatley, “Basic Business Communication-Skills for Empowering the Internet Generation”, Tata McGraw-Hill.