SVKM's NMIMS
Mukesh Patel School of Technology Management & Engineering

Program: M. Tech Artificial Intelligence				**Semester: I**	
Course/Module : An introduction to Artificial Intelligence and AI framework				**Module Code: MTAI01001**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -50)**	**Term End Examinations (TEE) (Marks -100 in Question Paper)**
4	**0**	**0**	**4**	**Scaled to 50 Marks**	**Scaled to 50 marks**

Pre-requisite: Students are required to have the following prerequisites:

- Linear algebra (vectors, matrices, derivatives)
- Basic probability theory
- Python programming

Objectives:

- Understanding of learning agent
- Programming for breadth first and depth first search for visiting all possible solution and picking up the most optimum solution
- Information gathering from data for decision making

Course Outcomes:

After completion of the course, students would be able to :

We will provide a broad understanding of the basic techniques for building intelligent computer systems. Topics include the history of AI, intelligent agents, state-space problem representations, uninformed and heuristic search, game playing and adversarial search, logical agents, constraint satisfaction problems, along with techniques in machine learning and other applications of AI, such as natural language processing (NLP).

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1.	Introduction to AI, history of AI, course logistics, and roadmap Intelligent agents, uninformed search	**10**
2.	Heuristic search, greedy search, A* algorithm, stochastic search Adversarial search, game playing	**10**
3.	Machine Learning 1: basic concepts, linear models, K nearest neighbors, over-fitting Machine Learning 2: perceptrons, neural networks, naive Bayes	**12**
4.	Machine Learning 3: Decision trees, ensemble, logistic regression, and unsupervised learning Constraint satisfaction problems	**12**

Signature
(Prepared by Concerned Faculty/HOD)

5.	Markov decision processes, reinforcement learning. Logical agents, propositional logic and first order logic	**12**
6.	AI applications to natural language processing (NLP) AI applications and course review	**04**
	Total	**60**

Text Books:

1. Artificial Intelligence A Modern Approach - Stuart J. Russell , Peter Norvig, Pearson Education, 2011
2. Nils Nilsson, Artificial Intelligence: A New Synthesis, Morgan Kaufmann, 1998.
3. David Poole, Alan Mackworth, Artificial Intelligence: Foundations for Computational Agents, Cambridge Univ. Press, 2010.

Reference Books:

1. Artificial Intelligence, Structures and Strategies for Complex Problem Solving, George F Luger, Pearson Education 2009
2. Ronald Brachman, Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.
3. Frank van Harmelen, Vladimir Lifschitz, Bruce Porter (Eds), Handbook of Knowledge Representation, Elsevier, 2008.
4. Ivan Bratko, Prolog Programming for Artificial Intelligence, 4th Ed., Addison-Wesley, 2011.
5. Stephen Marsland, Machine Learning: An Algorithmic Perspective, Chapman and Hall, 2009.
6. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007

Any other information: NIL

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

- Minimum 5 practical experiments covering all the topics.
- Minimum two Assignments.
- Two class tests.

Signature
(Prepared by Concerned Faculty/HOD)

Program: M. Tech Artificial Intelligence					**Semester : I**
Course/Module : Statistical Learning					**Module Code :MTAI01002**
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -50)**	**Term End Examinations (TEE) (Marks -100 in Question Paper)**
4	**0**	**0**	**4**	**Scaled to 50 Marks**	**Scaled to 50 marks**

Pre-requisite: Nil

Objectives:

- To provide advanced statistical background for analyzing data and drawing inferences from that analysis
- Predicative Analytics using liner and generalized liner model

Outcomes:

After completion of the course, students would be able to :

- Students will be able to learn advanced statistical technique and apply them to the analysis of real data sets from different fields.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	**Descriptive Statistics:** a) Measures of Central Tendencies – Grouped and Ungrouped Data; Mean, Sample Mean – Weighted mean; Median , Quartiles b) Deciles, and Percentiles, Box plot, Mode, Measures of Variability – Dispersion, Range, Standard deviation, Population v/s sample variance and standard deviation, Skewness, Kurtosis.	**4**
2	**Introduction to Probability and Sampling distribution:** a) Methods of Assigning probabilities, Probability Space, conditions of probability model, Events, simple and compound, Laws of probability, Probability density function, Cumulative distribution function, Expected values of Mean and Variance. Marginal , union, joint and conditional probabilities, Bayes' Theorem b) Random variables, discrete and continuous distributions, Expectation, moments of a distribution, Binomial, Poisson, uniform, and normal distributions, Normal approximation to the binomial distribution, Distributions of several random variables, moments of joint distributions, independence, covariance, correlation coefficient, Central Limit Theorem	**8** **8**

Signature
(Prepared by Concerned Faculty/HOD)

3	Hypothesis Testing: a) Large Sample estimation of the population parameters and Hypothesis testing: Basics of Estimating the populations mean and difference; estimating the proportion and difference; large sample test for population mean, difference; large sample test for proportion, difference. b) Estimation of a population variance: Sampling distribution of variance, estimation. c) Inferences from small sample: Student's t distribution; Small sample t test for following – A population mean, A difference between two means, Confidence interval.	**6** **6** **6**
4	**Regression Model:** a) least squares and linear regression: Introduction; Notation; Ordinary least squares; Regression to the mean; Linear regression; Residuals; Regression inference b) Multivariable regression: Multivariate regression; Multivariate examples; Adjustment; Residual variation and diagnostics; Multiple variables , Interaction Terms, Non-linear Transformations of the Predictors, Qualitative Predictors	**6** **4**
5	**Generalized linear models:** Logistic Regression, Binary outcomes, Count outcomes, Multiple Logistic Regression **ANOVA/MANOVA:** Chi-Square and Analysis of Variance, Multivariate analysis of variance **Extension of regression analysis:** Ridge Regression, The Lasso	**4** **4** **4**
Total		**60**

Text Books:

1. An Introduction to Statistical learning with application in R . Hastie T, Robert T. (2014). Springer Science Business Media: New York

Reference Books:

1. Statistics for Management, Seventh Edition, by Richard I. Levin, David S. Rubin, Pearson
2. An Introduction to Categorical Data Analysis. Agresti, A. (2012). John Wiley & sons
3. The Element of Statistical Learning, Data mining, Inference and Prediction. Hastie, T, Tibshirani, R, & Friedman, J. (2011). New York: Springer Series in Statistics.
4. Hair, Black, Babin, Anderson and Tatham (2009). Multivariate Data Analysis, Pearson

Any other information: NIL

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Signature
(Prepared by Concerned Faculty/HOD)

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

- Practical based on 10 Experiments
- Two class tests.
- Minimum two assignments

Signature
(Prepared by Concerned Faculty/HOD)

Program: M. Tech Artificial Intelligence				**Semester: I**	
Course: Computer Vision				**Module Code: MTAI01003**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -50)**	**Term End Examinations (TEE) (Marks -100 in Question Paper)**
4	**0**	**0**	**4**	**Scaled to 50 Marks**	**Scaled to 50 marks**

Pre requisite: Nil

Objectives:

Computer Vision focuses on the development of algorithms and techniques to analyse and interpret the visible world around us. This requires understanding of the fundamental concepts related to multi-dimensional signal processing, feature extraction, pattern analysis, visual geometric modelling, stochastic optimization etc. Knowledge of these concepts is necessary in this field, to explore and contribute to research and further developments in the field of computer vision. Applications range from Biometrics, Medical diagnosis, document processing, mining of visual content, to surveillance, advanced rendering etc.

Outcomes:

After completion of the course, students would be able to :

- The theoretical and practical aspects of computing with images
- Understand the geometric relationship between 2D images and the 3D world.

Detailed Syllabus: (Per Session Plan)

Unit	**Description**	**Duration**
1	Digital Image Formation and low-level processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.	**08**
2	Depth estimation and Multi-camera views: Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration. Apparel	**08**
3	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.	**10**
4	Image Segmentation:Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection. 08	**08**

Signature
(Prepared by Concerned Faculty/HOD)

5	Pattern Analysis : Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.	**10**
6	Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.	**08**
7	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.	**08**
	Total	**60** hours

Text Books:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

Reference Books:

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004
2. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

Any other information: NIL

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

- Practical based on 10 Experiments
- Two class tests.
- Minimum two assignments

Signature
(Prepared by Concerned Faculty/HOD)

Program: M. Tech Artificial Intelligence				**Semester : I**	
Course/Module : Machine Learning				**Module Code : MTAI01004**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -50)**	**Term End Examinations (TEE) (Marks -100 in Question Paper)**
4	**0**	**0**	**4**	**Scaled to 50 Marks**	**Scaled to 50 marks**

Pre-requisite: Statistical Learning

Objectives:

- To introduce and provide some core and necessary data mining techniques so that students understand how to work with large data sets and apply the appropriate data mining technique to answer business questions

Outcomes:

After completion of the course, students would be able to :

- Students will able to learn a number of well-defined data mining tasks such as classification, estimation, prediction, affinity grouping and clustering, and data visualization are discussed

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	**Resampling Methods:** Cross-Validation, Bootstrap, Cross-Validation and the Bootstrap, *k*-Fold Cross-Validation	10
2	**Linear Model Selection and Regularization:** Subset Selection, Shrinkage Methods, Ridge Regression, Lasso, Selecting the Tuning Parameter, Dimension Reduction Methods, Principal Components Regression, Partial Least Squares, PCR and PLS Regression	10
3	**Moving Beyond Linearity:** Polynomial Regression, Step Functions, Basis Functions, Regression Splines, Smoothing Splines, Local Regression, Generalized Additive Models, Non-linear Modeling, GAMs	10
4	**Tree-Based Methods:** The Basics of Decision Trees, Regression Trees, Classification Trees, Trees Versus Linear Models, Advantages and Disadvantages of Trees, Bagging, Random Forests, Boosting,	10
5	**Support Vector Machines:** Maximal Margin Classifier, Support Vector Classifiers, Support Vector Machines, SVMs with More than Two Classes, Relationship to Logistic Regression, ROC Curves, Application to Gene Expression Data	10
6	**Unsupervised Learning:** The Challenge of Unsupervised Learning, Principal Components Analysis, Clustering Methods, *K*-Means Clustering, Hierarchical Clustering, Practical Issues in Clustering, NCI60 Data Example and PCA on this dataset	10

_____

Signature
(Prepared by Concerned Faculty/HOD)

Total	60

Text Books:

1. An Introduction to Statistical learning with application in R . Hastie T, Robert T. (2014). Springer Science Business Media: New York
2. Hair, Black, Babin, Anderson and Tatham (2009). Multivariate Data Analysis, Pearson

Reference Books:

1. Statistics for Management, Seventh Edition, by Richard I. Levin, David S. Rubin, Pearson
2. An Introduction to Categorical Data Analysis. Agresti, A. (2012). John Wiley & sons
3. The Element of Statistical Learning, Data mining, Inference and Prediction. Hastie, T, Tibshirani, R, & Friedman, J. (2011). New York: Springer Series in Statistics.
4. Gujarati, Damodar N, and Dawn C. Porter. Basic Econometrics. Boston, Mass: McGraw-Hill, 2009

Any other information: NIL

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

1. Practical based on 10 Experiments
2. Two class tests.
3. Minimum two assignments

_____

Signature
(Prepared by Concerned Faculty/HOD)

SVKM's NMIMS
Mukesh Patel School of Technology Management & Engineering

Program: M. Tech. – Artificial Intelligence				Semester: I	
Course/Module : Research Project – I				Module Code: MTAI01007	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks -50)	Term End Examinations (TEE) (Marks -- in Question Paper)
0	4	0	2	Scaled to 50 marks	-

Pre-requisite: Nil

Objectives:

- Apply all learning in this semester and work on a topic of research leading to a paper in journal or seminar.

Outcomes:

After completion of the course, students would be able to:

- Learn research methodology
- Write a technical paper

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	Select a topic of research	04
2	Paper review	15
3	Make a strategy to work on a project (subject finalization)	15
4	Actual research	20
5.	Finalization of paper for publication	06
	Total	**60**

Text Books:

1. Research methodology
2. Actual paper reading

Any other information: NIL

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	Marks
Test Marks	--
Term Work Marks	50
Total Marks :	**50**

Details of Term work: As per institute norms

Signature
(Prepared by Concerned Faculty/HOD)

SVKM's NMIMS
Mukesh Patel School of Technology Management & Engineering

Program: M. Tech Artificial Intelligence				**Semester: II**	
Course/Module: Natural Language Processing				**Module Code: MTAI02001**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -50)**	**Term End Examinations (TEE) (Marks -100 in Question Paper)**
4	**0**	**0**	**4**	**Scaled to 50 Marks**	**Scaled to 50 marks**

Pre-requisite:
Students are required to have the following prerequisites:
- Basic probability and statistics
- Programming

Objectives:
- Understanding biology of Natural Language Processing; Place and Manner of Articulation; Word Boundary Detection; Argmax based computations;
- Morphology fundamentals; Morphological Diversity of Indian Languages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields.

Course Outcomes:
After completion of the course, students would be able to :
This course will examine the state-of-the-art in applied NLP, with an emphasis on how well the algorithms work and how they can be used (or not) in applications. Today there are many ready-to-use plug-and-play software tools for NLP algorithms. For this reason, this course will emphasize getting facile with quick programs using existing tools. The intended **learning outcomes** are for students to:
1. Learn about major NLP issues and solutions
2. Become agile with NLP programming
3. Be able to asses NLP problems
4. Be able to get the gist of relevant research papers
5. Understand Natural language understanding, processing, generation.

Detailed Syllabus:

Unit	**Description**	**Duration**
1.	Introduction, Machine Learning and NLP, ArgMax Computation, Syntactic Collocations; More on Term Weighting	**06**
2.	Practice with ipython Notebooks, NLTK Text; Adopt a text collection, Tokenize Your Text Collection, Create a First Look at Your Text Collection, Parts of Speech and Tagging, Part of	**06**

_____ _____

Signature **Signature**
(Prepared by Concerned Faculty/HOD) **(Approved by Dean)**

	Speech Tagging, POS Taggers, Practice Training a POS Tagger, Chunking WSD : WordNet, Wordnet; Application in Query Expansion, Wiktionary; semantic relatedness, Measures of WordNet Similarity, Similarity Measures (contd.), Resnick's work on WordNet Similarity	
3.	WordNet Lexical Relations, Work on your Keyphrase assignment, Keyphrase Identification Assignment, Run Keyphrase Extraction on Mystery Text, Names features Parsing Algorithms, Evidence for Deeper Structure; Top Down Parsing Algorithms, Noun Structure; Top Down Parsing Algorithms- contd, Non-noun Structure and Parsing Algorithms	**06**
4.	Probabilistic parsing; sequence labeling, PCFG, Probabilistic parsing; PCFG (contd.), Probabilistic parsing: Training issues Pandas Intro and Readings, Read About Syntactic and Semantic Parsing Review, Parsing, and Logic, Kaggle-based Text Classification Assignment	**06**
5.	Arguments and Adjuncts, Probabilistic parsing; inside-outside probabilities Text Clustering, Distributional Semantics readings, Clustering and Distributional Semantics	**06**
6.	Morphology, Graphical Models for Sequence Labelling in NLP, Graphical Models for Sequence Labelling in NLP (contd.)	**04**
7.	Phonetics, Consonants (place and manner of articulation) and Vowels Vowels (contd.), Forward Backward probability; Viterbi Algorithm	**04**
8.	Phonology, Sentiment Analysis and Opinions on the Web, Machine Translation and MT Tools - GIZA++ and Moses.	**04**
9.	Text Entailment, POS Tagging., Phonology; ASR	**04**
10.	HMM and Viterbi, HMM and Viterbi (contd)	**04**

_____ _____

Signature **Signature**
(Prepared by Concerned Faculty/HOD) **(Approved by Dean)**

11.	Precision, Recall, F-score, Map, Semantic Relations; UNL; Towards Dependency Parsing., Universal Networking Language	**05**
12.	Semantic Role Extraction, Baum Welch Algorithm; HMM training, Baum Welch Algorithm; HMM training	**05**
	Total	**60**

Text Books:

1. Natural Language Processing with Python online book: http://www.nltk.org/book/
2. Speech and Language Processing, 2nd Edition 2nd Edition by Daniel Jurafsky, James H. Martin

Reference Books:

1. Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit 1st Edition by Steven Bird, Ewan Klein, Edward Loper
2. Applied Text Analysis with Python: Enabling Language-Aware Data Products with Machine Learning 1st Edition by Benjamin Bengfort, Rebecca Bilbro, Tony Ojeda
3. Natural Language Processing and Computational Linguistics: A practical guide to text analysis with Python, Gensim, spaCy, and Keras Paperback – June 29, 2018 by Bhargav Srivinasa-Desikan

Any other information: NIL

Details of Internal Continuous Assessment (ICA):
Test Marks: 20
Term Work Marks: 30

Details of Term work:

1. Minimum two Assignments.
2. Two class tests.

_____ _____

Signature **Signature**
(Prepared by Concerned Faculty/HOD) **(Approved by Dean)**

Program: M. Tech Artificial Intelligence				**Semester: II**	
Course/Module: Robotics and Automation				**Module Code: MTAI02002**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -50)**	**Term End Examinations (TEE) (Marks -100 in Question Paper)**
4	**0**	**0**	**4**	**Scaled to 50 Marks**	**Scaled to 50 marks**

Pre-requisite: Linear Algebra, Vector and Matrix

Objectives:

1. To provide knowledge to students with the concept and techniques in rob manipulator control
2. To expose students to evaluate, choose and incorporate robots in engine systems and programming of robots
3. To understand and analyse various applications of robots

Course Outcomes:

After completion of the course, students would be able to :

1. Know the basics of Robots
2. Apply the knowledge of vector mathematics and geometry for kinem (direct and inverse) motion
3. Perform trajectory planning and work space analysis for robots
4. Use image representation for robots movement
5. Perform autonomous mobile robot kinematics

Detailed Syllabus:

Unit	Description	Duration
1.	**Basic concept in Robotics:** Introduction, advantage and applications of robots, automation of robots, non-industrial applications, basic structures of robots, numerical control of machine tools, resolution, accuracy and repeatability, position representation, point to point continuous path systems, point to point robotic system, continuous – path robotic system, control loop of Robotic systems, the manipulator, Cartesian coordinate robots, cylindrical coordinate robots, spherical coordinate robots, articulated robots	**07**
2.	**Kinematic Analytics & Coordinate Transformation:** Direct kinematic problem in robotics, geometry based direct kinematics Analysis coordinate & vector	**08**

_____ _____

Signature **Signature**
(Prepared by Concerned Faculty/HOD) **(Approved by Dean)**

	transformation using matrices, the orientation matrix & translator vector, homogeneous transformations, Denavit Hartenberg convention – implementing the DH convention, obtaining the DH displacement matrices, application of DH method- three axis robot arms, three axis wrist, six axis robots manipulations, assigning the tool coordinate system	
3.	**Inverse Kinematics:** General properties of solution, tool configuration vector for: Two axes planar articulated robot arm, three axis robots, four axis robots and five axis robots, inverse kinematics analysis of two axes planar articulated robot arm, three axis robot and four axis robots	**08**
4.	**Workspace analysis and trajectory planning or robots:** Robot work space envelops and examples, detail work space analysis of two axis planar articulated robot arm, four axis robots, different type of motions such as pick and place motions, continuous path motion, interpolation motion, straight line motion, workspace fixture	**07**
5.	**Robot Vision:** Image representation and analysis, template matching, polyhedral objects, shape analysis, segmentation (thresholding, region labelling), iterative processing, perspective transformation, structuring illumination, camera motion	**08**
6.	**Task Planning:** Task planner, task level programming, uncertainty, configuration, space, gross motion, planning, grasp planning, fine-motion, simulation of planar motion	**07**
7.	**Autonomous mobile Robots:** Introduction, locomotion – key issues of locomotion, legged mobile robots, leg configuration and stability, examples of legged robot locomotion, wheeled mobile robots, wheeled locomotion – the design space, wheeled locomotion: case study	**10**
8.	**Application of AI on Robotics (also robotics on AI)**	**5**
	Total	**60**

Text Books:

- Fu, Gonzales and Lee, Robotics – Control, Sensing, Vision and Intelligence, McGraw Hill. 1st Edition, 2008
- Robert Schilling, Fundamentals of Robotics – Analysis and control, Prentice Hall of India, 1990 (classic)

Reference Books:

1. JJ Craig, Introcution to Robotics, Pearson Education. 8th edition, 2004

_____ _____

Signature **Signature**
(Prepared by Concerned Faculty/HOD) **(Approved by Dean)**

2. Ronald Siegwart & Illah R Nourbaksh, Introduction to autonomous mobile Robots, EEE ed PHI 2004
3. Mittal and Nagrath, Robotics and Control, Tata McGraw Hill, 3rd edition, 2003

Any other information: NIL

Details of Internal Continuous Assessment (ICA):
Test Marks: 20
Term Work Marks: 30

Details of Term work:
1. Minimum two Assignments.
2. Two class tests.

Program: M. Tech. Artificial Intelligence	**Semester : II**

_____ _____

Signature **Signature**
(Prepared by Concerned Faculty/HOD) **(Approved by Dean)**

Course/Module: Advanced Statistical Learning				**Module Code : MTAI02003**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -50)**	**Term End Examinations (TEE) (Marks -100 in Question Paper)**
4	**0**	**0**	**4**	**Scaled to 50 Marks**	**Scaled to 50 marks**

Pre-requisite: Statistical learning

Objectives:

- To introduce and provide some core and necessary data mining techniques so that students understand how to work with large data sets and apply the appropriate data mining technique to answer business questions

Outcomes:

After completion of the course, students would be able to :

- Students will able to learn a number of well-defined data mining tasks such as classification, estimation, prediction, affinity grouping and clustering, and data visualization are discussed

Detailed Syllabus:

Unit	Description	Duration
1	**ANOVA/MANOVA:** Chi-Square and Analysis of Variance, Multivariate analysis of variance	6
2	**Extension of regression analysis:** Ridge Regression, The Lasso	4
	Multivariate Analysis: a) Canonical Analysis, Canonical Roots/Variates b) Using Bayes' Theorem for Classification, Procedure of Discriminant Analysis, Linear Discriminant Analysis, Estimating Misclassification, Probabilities, Quadratic Discriminant Analysis c) Conjoint analysis d)Principal Components Analysis (PCA) and Factor Model: Procedure Principal Component Analysis (PCA), Maximum Likelihood Estimation Method, Factor Rotations, Varimax Rotation, Estimation of Factor Scores.	6 8 6 10
	e) Cluster Analysis: Measures of Association for Continuous Variables, Measures of Association for Binary Variables, Agglomerative Hierarchical Clustering, Ward's Method, K-Means Procedure, K-Nearest Neighbors	10

_____ _____

Signature **Signature**
(Prepared by Concerned Faculty/HOD) **(Approved by Dean)**

4	**Time Series Analysis:** Characteristics of Time Series Data, Stationarity,Unit root; Detrending and De-seasonalizing , Autoregressive Moving Average (ARIMA) model; Exponential Smoothing Techniques; Forecasting through ARIMA and ARMA with Exponential smoothing; ACF and PACF, Univariate Time Series Models	10
Total		60

Text Books:

1. An Introduction to Statistical learning with application in R . Hastie T, Robert T. (2014). Springer Science Business Media: New York
2. Hair, Black, Babin, Anderson and Tatham (2009). Multivariate Data Analysis, Pearson

Reference Books:

1. Statistics for Management, Seventh Edition, by Richard I. Levin, David S. Rubin, Pearson
2. An Introduction to Categorical Data Analysis. Agresti, A. (2012). John Wiley & sons
3. The Element of Statistical Learning, Data mining, Inference and Prediction. Hastie, T, Tibshirani, R, & Friedman, J. (2011). New York: Springer Series in Statistics.
4. Gujarati, Damodar N, and Dawn C. Porter. Basic Econometrics. Boston, Mass: McGraw-Hill, 2009

Any other information: NIL

Details of Internal Continuous Assessment (ICA):
Test Marks: 20
Term Work Marks: 30

Details of Term work:

1. Two class tests.
2. Minimum two assignments

Program: M. Tech Artificial Intelligence	**Semester: II**
Course/Module: Deep Learning	**Module Code: MTAI02004**
Teaching Scheme	**Evaluation Scheme**

_____ _____

Signature **Signature**
(Prepared by Concerned Faculty/HOD) **(Approved by Dean)**

Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks -50)	Term End Examinations (TEE) (Marks -100 in Question Paper)
4	**0**	**0**	**4**	**Scaled to 50 Marks**	**Scaled to 50 marks**

Pre-requisite: Machine Learning and Data Mining

Objectives: Expand the knowledge gained in Database Management Systems in several directions like Non-Relational data models, deductive (Intelligent) database systems, Distributed systems, web based systems and object oriented systems etc.

Course Outcomes:

After completion of the course, students would be able to :

1. Design database using concept of extended entity relationship model.
2. Implement functions and procedures using concepts of PL/SQL
3. Implement object oriented concepts in database.
4. Compare and contrast different types of advance database management systems.
5. Describe database Administration and its management.

Detailed Syllabus:

Unit	Description	Duration
1.	**Introduction to deep learning: Neural network basics:** Supervised Learning with Neural Networks, Computation graph, Broadcasting in Python	**07**
2.	**Shallow neural networks:** Computing a Neural Network's Output, Vectorizing across multiple examples, Explanation for Vectorized Implementation, Activation functions, Derivatives of activation functions, Gradient descent for Neural Networks, Back-propagation intuition, Random Initialization	**07**
3.	**Deep Neural Networks:** Deep L-layer neural network, Forward Propagation in a Deep Network, Getting your matrix dimensions right, Building blocks of deep neural networks, Forward and Backward Propagation, Parameters verses Hyper parameters	**07**
4.	**Improving Deep Neural Networks: Hyper parameter tuning, Regularization and Optimization: Practical aspects of Deep Learning:** Initialization, Regularization, Gradient Checking	**05**

_____ _____

Signature **Signature**
(Prepared by Concerned Faculty/HOD) **(Approved by Dean)**

5.	**Optimization algorithms:** Mini-batch gradient descent, Understanding mini-batch gradient descent, exponentially weighted averages, Understanding exponentially weighted averages, bias correction in exponentially weighted averages, Gradient descent with momentum	**06**
6.	Hyperparameter tuning, Batch Normalization and Programming Frameworks	**06**
7.	**Convolutional Neural Networks:** Foundations of Convolutional Neural, Deep convolutional models: case studies, Object detection, Special applications: Face recognition & Neural style transfer	**06**
8.	**Sequence Models:** Recurrent Neural Networks **Data Flow programming: TensorFlow**	**04** **12**
	Total	**60**

Text Books:

1. Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville
2. Deep Learning Hardcover – 3 Jan 2017 by Ian Goodfellow, Yoshua Bengio, Aaron Courville, Francis Bach

Reference Books:

1. Deep Learning - 3 Jan 2017 by Ian Goodfellow, Yoshua Bengio, Aaron Courville, Francis Bach
2. Deep Learning, Vol. 2: From Basics to Practice by Andrew Glassner

Any other information: NIL

Details of Internal Continuous Assessment (ICA):
Test Marks: 20
Term Work Marks: 30

Details of Term work:

1. Minimum two Assignments.
2. Two class tests.

_____ _____

Signature **Signature**
(Prepared by Concerned Faculty/HOD) **(Approved by Dean)**

Program: M. Tech. Artificial Intelligence				**Semester : II**	
Course/Module : Speech Recognition				**Module Code : MTAI02005**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -50)**	**Term End Examinations (TEE) (Marks -100 in Question Paper)**
4	**0**	**0**	**4**	**Scaled to 50 Marks**	**Scaled to 50 marks**

Pre-requisite: CS/CP

Objectives:

In the course student will build working speech recognition systems, build their own synthetic voice and build a complete telephone spoken dialog system. This work will be based on existing toolkits. Details of algorithms, techniques and limitations of state of the art speech systems will also be presented. This course is designed for students wishing understand how to process real data for real applications, applying statistical and machine learning techniques as well as working with limitations in the technology

Outcomes:

After completion of the course, students would be able to :

Speech Processing offers a practical and theoretical understanding of how human speech can be processed by computers. It covers speech recognition, speech synthesis and spoken dialog systems.

Detailed Syllabus:

Unit	**Description**	**Duration**
1	Human Speech, Computer Speech	04
2	ASR: Signal Processing, ASR: Template matching, ASR: HMMs slides Reading 1, ASR: Acoustic Modeling, ASR: Language Modeling, ASR: Systems ASR: Language Modeling 2	04 04 04 04
3	TTS: Text Analysis, TTS: Pronunciation, TTS: Prosody, TTS: Waveform I, TTS: Waveform II, TTS: Voice building, TTS: Evaluation, TTS: Signal Processing, TTS: Talking Heads and Singing	04 04

_____ _____

Signature **Signature**

(Prepared by Concerned Faculty/HOD) **(Approved by Dean)**

4	Multilingual Speech Processing, SPICE Speech to Speech Translation I, Speech to Speech Translation II, Spoken Dialog Systems: Intro, Spoken Dialog Systems: Components, Spoken Dialog Systems: VoiceXML, Spoken Dialog Systems: beyond simple dialogs; Olympus intro, Spoken Dialog Systems: Olympus II, Spoken Dialog Systems: deployment, Spoken Dialog Systems: Personal Digital Assistants, Spoken Dialog Systems: Evaluation	16
5	Voice Conversion I, Speaker ID Voice Conversion/Deidentification, Computer Aided Language Learning, Present and Future Speech Problems	16
Total		60

Text Books:

1. Spoken Language Processing by Xuedong Huang, Alex Acero and Hsiao-wuen Hon, Prentice Hall (ISBN 0-13-22616-5).
2. Automatic Speech Recognition: A Deep Learning Approach (Signals and Communication Technology) 2015th Edition

Reference Books:

1. Robust Automatic Speech Recognition: A Bridge to Practical Applications 1st Edition by Jinyu Li (Author), Li Deng (Author), Reinhold Haeb-Umbach (Author), Yifan Gong (Author)
2. Speech And Language Processing 2ed_draft2007 by Jurafsky Martin

Any other information: NIL

Details of Internal Continuous Assessment (ICA):
Test Marks: 20
Term Work Marks: 30

Details of Term work:

1. Practical based on 10 Experiments
2. Two class tests.
3. Minimum two assignments

Program: M. Tech. – Artificial Intelligence	**Semester: II**

_____ _____

Signature **Signature**
(Prepared by Concerned Faculty/HOD) **(Approved by Dean)**

Course/Module : Research Project – II				**Module Code: MTAI02008**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -50)**	**Term End Examinations (TEE) (Marks -- in Question Paper)**
0	4	0	2	**Scaled to 50 marks**	**-**

Pre-requisite: Nil

Objectives:

- Apply all learning in this semester and work on a topic of research leading to a paper in journal or seminar.

Outcomes:

After completion of the course, students would be able to:

- Learn research methodology
- Write a technical paper

Detailed Syllabus: (per session plan)

Unit	**Description**	**Duration**
1	Select a topic of research	04
2	Paper review	15
3	Make a strategy to work on a project (subject finalization)	15
4	Actual research	20
5.	Finalization of paper for publication	06
	Total	**60**

Text Books:

1. Research methodology
2. Actual paper reading

Any other information: NIL

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**--**
Term Work Marks	**50**
Total Marks :	**50**

Details of Term work: As per institute norms

_____ _____

Signature **Signature**
(Prepared by Concerned Faculty/HOD) **(Approved by Dean)**

SVKM's NMIMS
Mukesh Patel School of Technology Management & Engineering

Program: M. Tech. – Artificial Intelligence				Semester : III	
Course/Module: Capstone project				Module Code : MTAI03001	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks -50)	Term End Examinations (TEE) (Marks --)
4	4	0	6	Marks Scaled to 50	---

Pre-requisite: All subject of M. Tech AI

Objectives:

- Student to understand topics in Artificial Intelligence and Data Science and its application to solve any one or more industry problems

Outcomes:

After completion of the course, students would be able to :

- It is expected to come up with a paper in reputed journal with guidance from any faculty members

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	Contemporary research papers review	5
2	Identification of problem statement	5
3	Data collection and validation	5
4	Tool identification and usage	5
5	Technique to solve the problem including Model building	5
6	Model validation	5
7	Research	10
8	Publication	5
9	Next steps	5
10	Final Project presentation in front of industry/expert panel	10
Total		60

Text Books:

1. Contemporary research paper review

Reference Books:

1. NA

Any other information: NIL

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Signature
(Prepared by Concerned Faculty/HOD)

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

1. Practical based on 10 Experiments
2. Two class tests.
3. Minimum two assignments

Signature
(Prepared by Concerned Faculty/HOD)

SVKM's NMIMS
Mukesh Patel School of Technology Management & Engineering

Program: M. Tech. – Artificial Intelligence				Semester :III	
Course/Module: Big Data Technology				Module Code : MTAI03002	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks -50)	Term End Examinations (TEE) (Marks -100 in Question Paper)
3	0	0	3	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Python/Programming language/SQL

Objectives:

Big data Analytics refers to skills, practices and techniques used in converting large scale data and its storage about computation challenges to convert data into information and knowledge that aid making business decision. This discipline consists of an understanding of:

- Distributed storage and computation and usage of concept like Map Reduce, developed and widely used by Google search engine
- The use of the above analysis and visualization to aid decision making

Outcomes:

After completion of the course, students would be able to :

- Upon completion of this course one will be able to setup, manage and exploit big data cluster for analytics from social media. This will make student ready to setup and manage environment of cluster, cloud, grid and stream computing.
- One will be able to setup Hadoop or Casandra cluster for handling big data and distributed file system and computing. Helps work on large scale systems and social media systems.
- One will be able to provide cyber security as an expert to high net asset systems with critical data

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	Introduction to Big Data	02
2	Big Data • MapReduce • Hadoop eco system • Word Count MapReduce • Different tools on Big data Platform • Vector data (newspaper article or document search) • PageRank Algorithm • Twitter Data Analytic - Social Media mining • Images	01 02 02 02
3	• Data Visualization • Implementation of a search engine • Stream data analytics	02 02

Signature
(Prepared by Concerned Faculty/HOD)

4	Hive, storage of Hive data (database) in HDFS, Query writing to achieve business tasks, Database management, Query optimization, Views and Partition	8
5	Pig – Data flow programming, Storing data in HDFS / Hood	8
6	MongoDB, Database creation, Query building, regular expression	8
7	A mini project related to AI	8
Total		45

Text Books:

1. Big Data, Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization, By DT Editorial Services, 2016
2. Programming Hive. By Jason Rutberglen, Dean Wampler, Edward Copriolo, 2012
3. Programming Pig by Anal Gates, 2011 (look for newer edition of book)
4. MongoDB: The Definitive Guide, by Kristina Chodorow, 2013

Reference Books:

1. Hadoop, The Definitive Guide, by Tom White, 2015
2. Mining of Massive Datasets, by Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman, 2015

Any other information: NIL

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

1. Practical based on 10 Experiments
2. Two class tests.
3. Minimum two assignments

Signature
(Prepared by Concerned Faculty/HOD)

SVKM's NMIMS
Mukesh Patel School of Technology Management & Engineering

Program: M. Tech. – Artificial Intelligence				**Semester :III**	
Course/Module: Advanced Computer Vision				**Module Code : MTAI03003**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -50)**	**Term End Examinations (TEE) (Marks -100 in Question Paper)**
3	0	0	3	**Marks Scaled to 50**	**Marks Scaled to 50**

Pre-requisite: Computer Vision

Objectives:

- Understand advancement and contemporary Computer Vision research

Outcomes:

After completion of the course, students would be able to :

- Students will be able to understand contemporary research work on computer vision field in the world
- Hand on case studies on newer algorithms on computer vision

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	Sketch2Photo: Internet Image Montage. ACM SIGGRAPH ASIA 2009, ACM Transactions on Graphics.	3
2	Unsupervised Representation Learning with Deep Convolutional Generative Adversarial Networks.	3
3	Image Style Transfer Using Convolutional Neural Networks.	3
4	Network Dissection: Quantifying Interpretability of Deep Visual Representations	4
5	Deep Sliding Shapes for Amodal 3D Object Detection in RGB-D Images	4
6	Deep Learning on Point Sets for 3D Classification and Segmentation	4
7	Frustum PointNets for 3D Object Detection from RGB-D Data	4
8	Explaining and Harnessing Adversarial Examples.	4
9	Adversarial Patch.	4
10	Learning Features by Watching Objects Move.	4
11	Matching Networks for One Shot Learning.	4
12	Final Project Poster Session	4
Total		**45**

Text Books:

1. Contemporary research papers from 2016 to 2018

Signature
(Prepared by Concerned Faculty/HOD)

2. Computer Vision: Algorithms and Applications Richard Szeliski, 2011

Reference Books:

1. Computer vision guide

Any other information: NIL

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

1. Practical based on 10 Experiments
2. Two class tests.
3. Minimum two assignments

Signature
(Prepared by Concerned Faculty/HOD)

SVKM's NMIMS
Mukesh Patel School of Technology Management & Engineering

Program: M. Tech. – Artificial Intelligence				Semester : III	
Course/Module: Advanced Data Mining for AI				Module Code : MTAI03004	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks -50)	Term End Examinations (TEE) (Marks -100 in Question Paper)
3	0	0	3	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Data mining
1. An introduction to database systems, covering SQL and related programming systems.
2. A sophomore-level course in data structures, algorithms, and discrete math.
3. A sophomore-level course in software systems, software engineering, and programming languages.

Objectives:
Advancement in research and knowledge discovery process, key data mining techniques, efficient high performance mining algorithms, exposure to applications of data mining (bioinformatics and intrusion detection). The course titled "Web Mining," was designed as an advanced graduate course, although it has become accessible and interesting to advanced postgraduates.

Outcomes:
After completion of the course, students would be able to :

- Distributed file systems and map-reduce as a tool for creating parallel algorithms that succeed on very large amounts of data.
- Similarity search, including the key techniques of min-hashing and locality sensitive hashing.
- Data-stream processing and specialized algorithms for dealing with data that arrives so fast it must be processed immediately or lost.
- The technology of search engines, including Google's PageRank, link-spam detection, and the hubs-and-authorities approach.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	Distributed file systems and map-reduce as a tool for creating parallel algorithms that succeed on very large amounts of data.	03
2	Similarity search, including the key techniques of minhashing and locality sensitive hashing.	03
3	Data-stream processing and specialized algorithms for dealing with data that arrives so fast it must be processed immediately or lost.	06
4	The technology of search engines, including Google's PageRank, link-spam detection, and the hubs-and-authorities approach.	06

Signature
(Prepared by Concerned Faculty/HOD)

5	Frequent-item-set mining, including association rules, market-baskets, the A-Priori Algorithm and its improvements.	03
6	Algorithms for clustering very large, high-dimensional datasets.	06
7	Two key problems for Web applications: managing advertising and recommendation systems.	06
8	Algorithms for analyzing and mining the structure of very large graphs, especially social-network graphs.	06
9	Techniques for obtaining the important properties of a large dataset by dimensionality reduction, including singular-value decomposition and latent semantic indexing.	06
Total		45

Text Books:

1. Introduction to Data Mining, Tan, Steinbach and Kumar, Addison Wesley, 2006
2. Data Mining: Concepts and Techniques, J. Han & M. Kamber, Morgan Kaufmann, 2006.

Reference Books:

1. Data Mining Analysis and Concepts, M. Zaki and W. Meira (the authors have kindly made an online version available): http://www.dataminingbook.info/uploads/book.pdf
2. Mining of Massive Datasets, J. Leskovec, A. Rajaraman and J. Ullman http://infolab.stanford.edu/~ullman/mmds/book.pdf
3. Data Mining, Charu Aggarwal, Springer, 2015. Should be available online off SpringerLink.

Any other information: NIL

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

1. Practical based on 10 Experiments
2. Two class tests.
3. Minimum two assignments

Signature
(Prepared by Concerned Faculty/HOD)

SVKM's NMIMS
Mukesh Patel School of Technology Management & Engineering

Program: M. Tech. – Artificial Intelligence				Semester : III	
Course/Module: Financial Analytics using time series and LSTM				Module Code : MTAI03005	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks -50)	Term End Examinations (TEE) (Marks -100 in Question Paper)
3	0	0	3	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Probability/Python/Deep learning/Neural Network

Objectives:
Aim to understand sequential data, relationship between previous data and current data by building a Long Short-term memory model of Neural Network

Outcomes:
After completion of the course, students would be able to :

1. Understand Neural network
2. Advance research in LSTM

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	Understanding Neural network	2
2	Understanding Time Series	10
3	Different models in time series (ARIMA, ARMA etc.)	2
4	AI Neural Network in financial Data	2
5	Recurrence Neural Network and its advantage and disadvantage	2
6	Long Short-term Memory Model	5
7	Model Building	3
8	Model Validation	3
9	Working with Time series data (Sensex)	3
10	Model Validation	3
11	Model Deployment	5
12	Conclusion with a project	5
Total		45

Signature
(Prepared by Concerned Faculty/HOD)

Text Books:

1. RECURRENT NEURAL NETWORKS, Design and Applications, by L.R. Medsker, L.C. Jain, 2016
2. Few more latest text books

Reference Books:

1. http://www.statslab.cam.ac.uk/~rrw1/opt/O.pdf

Any other information: NIL

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

1. Practical based on 10 Experiments
2. Two class tests.
3. Minimum two assignments

Signature
(Prepared by Concerned Faculty/HOD)

SVKM's NMIMS
Mukesh Patel School of Technology Management & Engineering

Program: M. Tech. – Artificial Intelligence				Semester :III	
Course: Probabilistic Robotics				Module Code : MTAI03006	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Internal Continuous Assessment (ICA) (Marks -50)	Term End Examinations (TEE) (Marks -100 in Question Paper)
3	0	0	3	Marks Scaled to 50	Marks Scaled to 50

Pre-requisite: Probability/Python/Programming language/Robotics

Objectives:

Robotics is the science of perceiving and manipulating the physical world through computer-controlled mechanical devices. Examples of successful robotic systems include mobile platforms for planetary exploration, robotics arms in assembly lines, cars that travel autonomously on highways, actuated arms that assist surgeons.

Robotics systems have in common that they are situated in the physical world, perceive their environments through sensors, and manipulate their environment through things that move.

Outcomes:

After completion of the course, students would be able to :

1. **Environments**. Physical worlds are inherently unpredictable. While the degree of uncertainty in well-structured environments such assembly lines is small, environments such as highways and private homes are highly dynamic and unpredictable.
2. **Sensors**. Sensors are inherently limited in what they can perceive. Limitations arise from two primary factors. First, range and resolution of a sensor is subject to physical laws. For example, Cameras can't see through walls, and even within the perceptual range the spatial resolution of camera images is limited. Second, sensors are subject to noise, which perturbs sensor measurements in unpredictable ways and hence limits the information that can be extracted from sensor measurements.
3. **Robots**. Robot actuation involves motors that are, at least to some extent, unpredictable, due effects like control noise and wear-and-tear. Some actuators, such as heavy-duty industrial robot arms, are quite accurate. Others, like low-cost mobile robots, can be extremely inaccurate.
4. **Models**. Models are inherently inaccurate. Models are abstractions of the real world. As such, they only partially model the underlying physical processes of the robot and its environment. Model errors are a source of uncertainty that has largely been ignored in robotics, despite the fact that most robotic models used in state-or-the-art robotics systems are rather crude.
5. **Computation**. Robots are real-time systems, which limits the amount of computation that can be carried out. Many state-of-the-art algorithms (such as most of the algorithms described in this book) are approximate, achieving timely response through sacrificing accuracy.

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	INTRODUCTION	3

Signature
(Prepared by Concerned Faculty/HOD)

2	RECURSIVE STATE ESTIMATION	3
3	GAUSSIAN FILTERS	3
4	NONPARAMETRIC FILTERS	3
5	ROBOT MOTION	3
6	MEASUREMENTS	3
7	MOBILE ROBOT LOCALIZATION	3
8	GRID AND MONTE CARLO LOCALIZATION	3
9	OCCUPANCY GRID MAPPING	3
10	SIMULTANEOUS LOCALIZATION AND MAPPING	3
11	THE EXTENDED INFORMATION FORM ALGORITHM	3
12	THE SPARSE EXTENDED INFORMATION FILTER	3
13	MAPPING WITH UNKNOWN DATA ASSOCIATION	3
14	FAST INCREMENTAL MAPPING ALGORITHMS	3
15	MARKOV DEVISION PROCESSES	3
Total		45

Text Books:
1. Probabilistic Robotics, by Sebastian Thrun, Wolfram Burgard, Dieter Fox, 2012

Reference Books:
1. Robotics Hand book

Any other information: NIL

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:
1. Practical based on 10 Experiments
2. Two class tests.
3. Minimum two assignment

Signature
(Prepared by Concerned Faculty/HOD)

SVKM's NMIMS
Mukesh Patel School of Technology Management & Engineering

Program: M. Tech. – Artificial Intelligence				**Semester : III**	
Course/Module: Optimization				**Module Code: MTAI03007**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Internal Continuous Assessment (ICA) (Marks -50)**	**Term End Examinations (TEE) (Marks -100 in Question Paper)**
3	0	0	3	**Marks Scaled to 50**	**Marks Scaled to 50**

Pre-requisite: Basis Mathematics/Python

Objectives:
Aim to understand different optimization techniques and its application

Outcomes:
After completion of the course, students would be able to :
1. Lagrangian methods
2. Linear programming in the nondegenerate case
3. Network problems
4. Practice and applications

Detailed Syllabus: (per session plan)

Unit	Description	Duration
1	Preliminaries	3
2	Lagrangian Methods	3
3	The Lagrangian Dual	3
4	Solutions to Linear Programming Problems	3
5	The Simplex Method	3
6	The Simplex Tableau	3
7	Algebra of Linear Programming	4
8	Shadow Prices and Lagrangian Necessity	4
9	Two Person Zero-Sum Games	4
10	Maximal Flow in a Network	5
11	Minimum Cost Circulation Problems	5
12	Transportation and Transshipment Problems ()	5

Signature
(Prepared by Concerned Faculty/HOD)

Total	45

Text Books:

1. Linear Programming and Network Flows, by Bazaraa, M., Jarvis, J. and Sherali, H, fourth edition, 2014, Wiley.
2. Introduction to Linear and Non-Linear Programming, Luenberger, D. second edition, 2014, Addison-Wesley.
3. Linear programming: foundations and extensions. Vanderbei, R. J. Kluwer 2015 (61.50 hardback).
4. Optimization, by Richard Weber, 2010

Reference Books:

1. http://www.statslab.cam.ac.uk/~rrw1/opt/O.pdf

Any other information: NIL

Total Marks of Internal Continuous Assessment (ICA): 50 Marks

Distribution of ICA Marks:

Description of ICA	**Marks**
Test Marks	**20**
Term Work Marks	**30**
Total Marks :	**50**

Details of Term work:

1. Practical based on 10 Experiments
2. Two class tests.
3. Minimum two assignments

Signature
(Prepared by Concerned Faculty/HOD)