Syllabus for 4 Year B. Tech Course in Computer Science and Engineering (Artificial Intelligence)

Seventh Semester

Career Advancement & Skill Development-VII-Managerial Economics (TIU-UCS-S403)

Contact Hours/Week: 2–0–0 (L–T–P)

Credit: Sessional–2

Course Outcome

Module-1: Introduction

Fundamental Concepts of Managerial economics – Factors responsible for Managerial Decision- Cost Concept & Classification- Objectives of the Firm- Correlation between Productivity and Profitability.

Module-2: Demand and Supply Analysis

Meaning, Types and Determinants – Demand estimation- Demand Elasticities for decision making – Business and Economic Forecasting: Qualitative and Quantitative methods – Supply analysis: Meaning, Elasticities and Determinants – Market Equilibrium.

Module-3: Production Economics

Production and Production function – Types – Estimation – Cost-Output Relationship, Short run and long run Cost Curves, Law of Variable Proportion, Returns to Scale – Economies and Diseconomies of Scale and Economies of Scope. Factor Inputs.

Module-4: Revenue Analysis and Pricing Policies

Revenue Types, Relationship between Total Revenue and Price Elasticity of Demand, Pricing Policies and Practices: Objectives – Determinants – Pricing Methods – Government Policies and Pricing.

Module-5: Market Structure

Perfect Competition – Imperfect Competition: Monopoly – Monopolistic – Oligopolistic Strategy, Cartels, Kinked Demand and Price Leadership. Oligopolistic Rivalry & Theory of Games – Measurement of economic concentration – Policy against monopoly and restrictive trade practices – Competition Law.

Module-6: Introduction to Macroeconomics

Circular Flow of Income and Expenditures – Components of National Income and its significance- Multiplier Concept – Measuring Gross Domestic Product (GDP) – Inflation and Business Cycles – Government Fiscal and Monetary Policy – Balance of payments – Foreign exchange markets.

Recommended Books:

Main Reading:

1. Mote, Paul and Gupta: Managerial Economics- Concepts and Cases, Tata McGraw Hill,2007
2. Peterson and Lewis: Managerial Economics, 4th Ed., Prentice Hall, 2004

3. Dholakia and Oza: Microeconomics for Management Students, 2nd Edition, Oxford University Press
4. Bhatia and Maheshwari: Economics for Engineers, 3rd Edition, Vikas Publishing House,2018.

Machine Learning (TIU-UCS-T451)
Contact Hours/Week: 3–0–0 (L–T–P)
Credit: Theory–3

Course Outcome

CO1	explore the underlying principles, mathematical foundations, practical uses, and constraints of current machine learning methods.
CO2	recognize the criteria for assessing the effectiveness of the developed model.
CO3	investigate and devise contemporary machine learning applications, emphasizing recent advancements and innovative perspectives.
CO4	construct the learning model tailored to a specific task.
CO5	utilize cutting-edge development frameworks and software libraries to implement the model.

Course Content

Module-1: Introduction
Definition - Types of Machine Learning - Examples of Machine Learning Problems - Training versus Testing - Characteristics of Machine learning tasks - Predictive and descriptive tasks - Machine learning Models: Geometric Models, Logical Models, Probabilistic Models. Features: Feature types - Feature Construction and Transformation - Feature Selection.

Module-2: Classification and Concept Learning
Classification: Binary Classification- Assessing Classification performance - Class probability Estimation - Multiclass Classification - Regression: Assessing performance of Regression - Error measures - Overfitting- Theory of Generalization: Effective number of hypothesis - Bounding the Growth function.

Module-3: Linear and Probabilistic Models
Least Squares method - Multivariate Linear Regression - Perceptron, Multiple Layer Perceptron - Support Vector Machines - Obtaining probabilities from Linear classifiers - Kernel methods for non-Linearity - Probabilistic models for categorical data – Naïve Bayes Classifier

Module-4: Distance Based Models
Distance Based Models: Neighbors and Examples - Nearest Neighbors Classification - Distance based clustering – K-Means Algorithm - K-Medoids Algorithm - Hierarchical

clustering - Vector Quantization, Self-Organizing Feature Map - Principal Component Analysis

Module-5: Rule Based and Tree Based Models
Rule Based Models: Rule learning for subgroup discovery - Association rule mining - Tree Based Models: Decision Trees - Ranking and Probability estimation Trees - Regression trees - Classification and Regression Trees (CART)

Module-6: Trends in Machine Learning
Ensemble Learning, - Bagging and Boosting - Random Forest - Meta learning - Deep Learning - Reinforcement Learning – Applications.

Recommended Books:

Main Reading

1. P. Flach, "Machine Learning: The art and science of algorithms that make sense of data", Cambridge University Press, 2012, ISBN-10: 1107422221, ISBN-13: 978-1107422223.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Second Edition (Springer Series in Statistics), 2016, ISBN-10: 0387848576, ISBN-13: 978-0387848570.

Supplementary Reading

1. Christopher Bishop, "Pattern Recognition and Machine Learning (Information Science and Statistics)", Springer, 2007.
2. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012, ISBN-10: 0262018020, ISBN-13: 978-0262018029
3. Y. S. Abu-Mostafa, M. Magdon-Ismail, and H.-T. Lin, "Learning from Data", AMLBook Publishers, 2012 ISBN 13: 978-1600490064.
4. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997, ISBN-10: 0071154671, ISBN-13: 978-0071154673.
5. Jiawei Han, Micheline Kamber, "Data Mining Concepts and Techniques", Chris Ullman, Morgan Kaufmann Publishers,Third Edition, 2011, ISBN 0123814790, ISBN-13 9780123814791.

Natural Language Processing (TIU-UCS-T453)

Contact Hours/Week: 3–0–0 (L–T–P)
Credit: Theory–3

Course Outcome

CO1	Be familiar with the basic concepts of Natural language, different issues, applications, word classes etc. and extract information from text automatically using concepts and methods from natural language processing (NLP) including stemming, n-grams, POS tagging, and parsing

CO2	Understand the state-of-the-art algorithms and techniques for text-based processing of natural language with respect to morphology
CO3	Apply different algorithms to process the natural language
CO4	Evaluate the use of different statistical approaches for different types of NLP applications
CO5	Examine the syntax, semantics, and pragmatics of a statement made in a natural language

Course Content

Module-1: Introduction to NLP

Natural language processing issues and strategies. Tools of NLP, Linguistic organization of NLP, NLP as an Application domain.

Word Classes: Regular Expressions: Chomsky hierarchy, CFG and different parsing techniques, ◦ Morphology: Inflectional, derivational, parsing and parsing with FST, Combinational Rules, Joint and conditional probability. Probabilistic Language modeling and it's Applications.

Module-2: Language Modeling and Naïve Bayes

Markov models, N- grams. Estimating the probability of a word and smoothing. Counting words in Corpora, simple N-grams, smoothing (Add One, Written-Bell, Good-Turing).

Part of Speech Tagging and Hidden Markov Models: Part of Speech tagging, Indian Language on focus Morphology Analysis, Accuracy Measure and Probability, HMM, Viterbi algorithm for finding most likely HMM Path. HMM tagging, transformation-based tagging.

Probabilistic Context Free Grammars: Weighted context free grammars.

Module-3: Semantics:

Representing Meaning: Unambiguous representation, canonical form, expressiveness, meaning structure of language

Semantic Analysis: NLP and IR, How NLP has used IR Towards Latent Semantic.

Lexical Semantics: Lexemes (synonymy, hyponymy etc), WordNet, metonymy and their computational approaches Supervised and Unsupervised methods

Word Sense Disambiguation: Selectional restriction based, machine learning based and dictionary-based approaches.

Module-4: Pragmatics

Information Theory: Entropy, Cross-entropy, information gain. Reference resolution and phenomena, syntactic and semantic constraints. Pronoun resolution algorithm, text coherence, and discourse structure

Natural Language Generation: Introduction to language generation, architecture, discourse planning (text schemata, rhetorical relations).

Resource Constrained WSD, Parsing Algorithms, Parsing Ambiguous Sentences, Probabilistic Parsing Algorithms.

Recommended Books:

Main Reading

1. D. Jurafsky& J. H. Martin – "Speech and Language Processing – An introduction to Language processing, Computational Linguistics, and Speech Recognition", Pearson Education

Supplementary Reading:

1. Allen, James. 1995. – "Natural Language Understanding". Benjamin/Cummings, 2ed. Bharathi, A., Vineet Chaitanya and Rajeev Sangal. 1995.
2. Natural Language Processing- "A Pananian Perspective". Prentice Hall India, Eastern Economy Edition. 3. Eugene Cherniak: "Statistical Language Learning", MIT Press, 1993.
3. Manning, Christopher and Heinrich Schutze. 1999. "Foundations of Statistical Natural Language Processing". MIT Press.
4. Cognitively Inspired Natural Language Processing Abhijit Mishra, Pushpak Bhattacharyya Springer.

Knowledge Discovery & Data Mining (KDD) (TIU-UCS-E461)

Contact Hours/Week: 3–0–0 (L–T–P)

Credit: Theory–3

Course Outcome

CO1	Understand the basic concepts and techniques of data mining, including decision trees, rule-based classification, Bayes' classifiers, support vector machines, ensemble methods, association rule mining, and cluster analysis.
CO2	Apply data mining techniques to solve real-world problems, such as fraud detection, customer segmentation, and medical diagnosis.
CO3	Evaluate the effectiveness of different data mining algorithms and select the most appropriate algorithm for a given problem.
CO4	Use data mining tools and techniques to explore large datasets and extract meaningful insights.
CO5	Communicate the results of data mining projects to stakeholders in a clear and concise way.

Course Content

Module-1:

Introduction and Rule-based Classification: What is Data Mining? Why do we need data mining? Data Mining System

- Architecture and Processes. Challenges in Data Mining.

Decision Tree: General approach for solving a classification problem, Decision Tree Induction, Overfitting Pruning.

Rule-based Classification: How a rule-based classifier works, rule-ordering schemes, how to build a rule-based classifier, direct and indirect methods for rule extraction.

Module-2:
Advanced Classification Techniques: Bayes' Classifier: Bayes' theorem, Naïve Bayes classifier.
Support Vector Machines (SVM): Maximum margin hyperplanes, Linear SVM: separable case, non-separable case, Non-linear SVM.

Module-3:
Ensemble Methods, Association Rule Mining: Ensemble Methods: Bagging, Boosting, Random Forests
Association Rule Mining: Introduction, Frequent itemset generation, (Apriori principle, candidate generation and pruning), Rule generation, Compact representation of frequent item sets, FP-growth algorithm, Sub-graph mining.

Module-4:
Cluster Analysis: Introduction: Motivations, objectives and applications of clustering. Different types of clustering.
Partitional Clustering: K-means, Bisecting K-means, PAM.
Hierarchical Clustering: Agglomerative, Divisive, MIN, MAX, dendrogram representation.
Density-based Clustering: DBSCAN. Cluster evaluation, further reading – OPTICS, DENCLUE, CHAMELEON, BIRCH, CURE, ROCK.

Recommended Books:

Main Reading

1. Data Mining Concepts and Techniques, 3rd, Edition, J. Han and M. Kamber, Morgan Kaufmann Publishers, July 2011.

Supplementary Reading:

1. Introduction to Data Mining, P. N. Tan, M. Steinbach and V. Kumar, Pearson Publishers.
2. Pattern Recognition and Machine Learning, First Edition, C. Bishop, Springer, 2006.
3. Neural Networks and Learning Machines, Third Edition, S. Haykin, PHI Learning, 2009.
4. Pattern Classification, Second Edition, R. Duda, P. Hart and D. Stock, Wiley-Interscience, 2000.

Big Data Analytics (TIU-UCS-E463)
Contact Hours/Week: 3–0–0 (L–T–P)
Credit: Theory–3

Course Outcome

CO1	Understand the basic concepts of intelligent information retrieval, including user interactions, tags, clustering, classification, and recommendations.
CO2	Apply intelligent information retrieval techniques to solve real-world problems, such as search engine ranking, spam filtering, and product recommendations.
CO3	Develop and evaluate intelligent information retrieval systems.
CO4	Use Hadoop and MapReduce to process large-scale data.
CO5	Implement algorithms using MapReduce.

Course Content

Module-1:
Intelligent Information Retrieval Learning from user interactions. Rating and voting, emailing and link forwarding, bookmarking, purchasing items, reviews. Extracting intelligence from tags. Tag related metadata. Tag generation. Leveraging tags: dynamic navigation, using tag clouds, targeted search, recommendations based on tags. Extracting intelligence from content: Blogs, Wikis, Message boards.

Module-2:
Clustering, Classification and Recommendations Clustering and web intelligence. Overview of clustering algorithms. Classification and Web Intelligence. Need for classification. Overview. Automatic categorization of emails and spam filtering. Classification and fraud detection. Combining classifiers. Creating Suggestions and Recommendations. Concepts of distance and similarity. Recommendations based on similar users. Recommendations based on similar items. Recommendations based on content.

Module-3:
Introduction to Hadoop Starting Hadoop. Components of Hadoop. HDFS. Working with files in HDFS. Introduction to MapReduce. Streaming in Hadoop. Advanced MapReduce: Chaining MapReduce jobs, Joining data from different sources. Developing MapReduce programs in local mode and pseudo-distributed mode. Moving data into and out of Hadoop. Data input and output in MapReduce. Applying MapReduce patterns to Big Data. Streamlining HDFS for big data.

Module-4:
Algorithms Using MapReduce Matrix-Vector Multiplication by MapReduce. Relational-Algebra Operations. Computing Selections by MapReduce. Computing Projections by MapReduce. Union, Intersection, and Difference by MapReduce. Computing Natural Join by MapReduce. Grouping and Aggregation by MapReduce. Matrix Multiplication.

Recommended Books:

Main Reading

1. Algorithms of the Intelligent Web. H. Marmanis and D. Babenko. Manning Publishers, 2009.
2. Collective Intelligence in Action. S. Alag. Manning Publishers, 2009.
3. Hadoop in Action by Chuck Lam. Manning Publishers. 2011.
4. Hadoop in Practice by Alex Holmes. Manning Publishers. 2012.
5. Mining of Massive Datasets by Jure Leskovec, Anand Rajaraman, Jeff Ullman. Cambridge University Press. 2011.

Supplementary Reading:

1. Mining the Web: Discovering Knowledge from Hypertext Data. S. Chakrabarti, Morgan-Kaufmann Publishers, 2002.
2. Recommender Systems Handbook: Francesco Ricci, Lior Rokach, Bracha Shapira, Paul B. Kantor, Springer, 2011

Computer Vision (TIU-UCS-E465)

Contact Hours/Week: 3–0–0 (L–T–P)

Credit: Theory–3

Course Outcome

CO1	Understand the basic concepts of image formation, image processing, feature extraction, motion estimation, and structure from motion.
CO2	Apply these concepts to solve real-world problems, such as object detection, tracking, and segmentation.
CO3	Implement algorithms for image processing and computer vision using Python or other platform.
CO4	Understand the principles of machine learning and deep learning and apply them to computer vision problems.
CO5	Communicate the results of computer vision projects to stakeholders.

Course Content:

Module-1:

Image Formation Models, Monocular imaging system, Orthographic & Perspective Projection, Camera model and Camera calibration, Image representations (continuous and discrete), Edge detection. Image Processing and Feature Extraction: Harris corner detector, SIFT, HoG descriptor;

Module-2:

Displacement and Motion models, Global motion estimation: Affine and Projective; Motion Estimation: Optical flow computation, Laplacian and Gaussian pyramids, Robust optical flow estimation; KLT tracker, Advanced Trackers such as KCF;

Module-3:
Structure from motion; Depth estimation, Active stereo: Fringe projection techniques; Binocular imaging systems, Stereo Vision, Fundamental matrix estimation, RANSAC, Image rectification and disparity estimation;

Module-4:
Viola Jones face detection, Face representation: Eigen faces and 2D PCA. Deformable curves and surfaces, Snakes and active contours; Image Segmentation. Machine Learning and Deep Learning paradigms for Computer vision.

Recommended Books:
Main Reading

1. Shah M., Fundamentals of Computer Vision, 1997.
2. Szeliski R., Computer Vision: Algorithms and Applications, Springer, 2011.

Supplementary Reading:

1. Forsyth D. & Ponce J., Computer Vision - A Modern Approach, Prentice Hall, 2002.

Artificial Neural Network (TIU-UCS-T467)
Contact Hours/Week: 3–0–0 (L–T–P)
Credit: Theory–3

Course Outcome

CO1	Understand the basic concepts of neural networks, including perceptrons, multilayer perceptrons, and radial basis function networks.
CO2	Apply linear and nonlinear regression techniques to solve machine learning problems.
CO3	Understand the basics of deep learning, including convolutional neural networks and recurrent neural networks.
CO4	Implement neural networks using different frameworks, such as TensorFlow and PyTorch.
CO5	Evaluate the performance of neural networks and select the best model for a given problem.

Course Content:

Module1:
Introduction to neural networks, The human brain, Introduction to Neural Networks, Models of a neuron, Feedback and network, architectures, Knowledge representation, Prior information and invariance, Learning processes, Perceptron, Batch perceptron algorithm.

Module2:
Linear, non-linear regression, and multilayer perceptron (MLP), Linear regression, Logistic regression, Gradient Descent Algorithm, Multi-layer perceptron, Nonlinear Activation Units

and Learning Mechanisms, XOR problem, Back propagation, Practical, Consideration in Back Propagation Algorithm, Heuristics for Back-Propagation, Multi-Class, Classification Using Multi-layered Perceptrons.

Module-3:
Radial Basis Function (RBF), Multivariate interpolation problem, Radial basis functions (RBF), Recursive least squares algorithm, Comparison of RBF with MLP, Kernel regression using RBFs, Kernel Functions, Basics of constrained optimization, Comparison Between MLP and RBF.

Module-4:
Introduction to Fuzzy Neural Networks, Overview of Fuzzy system, Integration of fuzzy logic and neural networks, Fuzzy neurons, Hybrid neural nets, Trainable neural nets for fuzzy IF-THEN rules , Tuning fuzzy control parameters by neural nets , Fuzzy rule extraction from numerical data, Neuro-fuzzy classifiers, FULLINS , Applications of fuzzy neural systems.

Module-5:
Introduction to Deep learning and Convolution Neural Network, Layers and Blocks , Parameter Management , Deferred Initialization , Custom Layers , GPUs , From Fully-Connected Layers to Convolutions , Convolutions for Images , Padding and Stride , Multiple Input and Multiple Output Channels , Pooling , Batch Normalization, Convolutional Neural Networks (LeNet) ,Deep Convolutional Neural Networks (AlexNet) , Residual Networks (ResNet) , Densely Connected Networks (DenseNet) , Networks with Parallel Concatenations (GoogLeNet).

Recommended Books:

Main Reading

1. An introduction to neural networks (Kevin Gurney University of Sheffield)
2. Neural Fuzzy Systems (Robert Full´er)
3. Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering (Nikola K. Kasabov)
4. Dive into Deep Learning (Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola)