National Institute of Technology Silchar
Department of Computer Science & Engineering

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M. Tech in Artificial Intelligence

Program Outcomes (POs)

At the end of the program a student is expected to have:

1. Understanding of theoretical foundations of computing and, modelling and design of Artificial Intelligence (AI) systems.
2. Recognition and analysis of ML based AI problems along with their ethical implications.
3. Application of ML techniques to solve real world problems from various domains such as healthcare, social computing, economics, etc.
4. Ability to use advanced computing techniques and tools of AI and ML to design, implement, and evaluate secure hardware and/or software systems with assured quality and efficiency.
5. Ability to explore contemporary research issues and gaps, and to propose original ideas and solutions in AI and ML.
6. Ability to communicate with customers or peers in an impressive and professional manner, in written and oral forms.
7. Ability to learn lifelong independently through continuing education and research.
8. Ability to become a complete professional with high integrity and ethics, with excellent professional conduct and with empathy towards the environmental and social needs.

A. **Program Educational Objectives (PEOs):**

1. Ability to undertake industry careers involving innovation and problem solving using AI and ML technologies.
2. Ability to emerge as AI professionals, data scientists, researchers and entrepreneurs possessing collaborative and leadership skills, for developing innovative solutions in multidisciplinary domains.
3. Ability to involve in lifelong learning to foster the sustainable development and promote knowledge transfer in the emerging areas of AI and ML technologies.

B. Program Specific Outcomes (PSOs):

1. Identification and solving of complex AI and ML problems using latest hardware and software tools and technologies.
2. Imparting the concepts of Artificial Intelligence, Machine Learning, Data Science, Deep Learning Artificial Neural Networks, Image Processing, Big Data Analysis etc. in the design and development of intelligent expert systems.
3. Ability to define a new problem, and design, model, analyse, evaluate the solution and report as a dissertation in the area of AI and ML.

SEMESTER I

Sl. No	Code	Subject	L	T	P	Credits
1	CS5201	Applied Mathematics for Computer Science	3	0	0	3
2.	CS5202	Artificial Intelligence	3	0	0	3
3	CS5203	Foundation of Machine Learning	3	0	0	3
4	CS5204	Machine Learning Lab	0	0	3	2
5	XXXX	Elective I	3	0	0	3
6	XXXX	Elective II	3	0	0	3
Total						17

Elective I

Sl. No	Code	Subject
1	CS5231	Speech Processing and Applications
2	CS5232	Natural Language Processing
3	CS5233	Artificial Intelligence for Social Good

Elective II

1	CS5241	Introduction to Robotics
2	CS5242	Optimization Techniques
3	CS5243	Data Science
4	CS5244	Big Data Analysis

SEMESTER II

Sl. No	Code	Subject	L	T	P	Credits
1	CS5205	Data Analytics and Computing	3	0	0	3
2	CS5206	Image processing & Machine Vision	3	0	0	3
3	CS5207	Neural Network and Deep Learning	3	0	0	3
4	CS5210	Seminar-I	0	0	3	2
5	XXXX	Elective III	3	0	0	3
6	XXXX	Elective IV	3	0	0	3
Total						17

Elective III

Sl. No	Code	Subject
1	CS5251	Data Mining and Information retrieval
2	CS5252	Machine Translation
3	CS5253	Machine Learning for Cyber Security
4	CS5254	Introduction to Blockchain Technology
Elective IV		
1	CS5261	Internet of Things
2	CS5262	Data Visualization, Analytics & Representation
3	CS5263	Virtual Reality
4	CS5264	Medical Image Processing

SEMESTER III & SEMESTER IV

Sl. No	Code	Subject	L	T	P	Credits	Semester
1	CS6210	Seminar-II	0	0	3	2	III
2	CS6098, CS6099	Project	0	0	28	14	III & IV
Total						16	

Overall Credit –

Sl. No	Semester I	Semester II	Semester III	Semester IV	Overall
Credits	17	17	2	14	50

CS5201	**Applied Mathematics for Computer Science**	**L**	**T**	**P**	**C**
M.Tech. (CSE), First Semester (Core)		3	0	0	3

UNIT I: THEORY OF PROBABILITY

Axioms of Probability, Conditional Probability, Baye's Rule, Random variables: Discrete and Continuous random variables, Probability function and Distribution function, Mathematical Expectation, Variance, Standard Deviation, Moments, Moment generating function, Binomial, Poisson and Normal Distributions.

UNIT II: DESCRIPTIVE STATISTICS

Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio. Presentation: tabular and graphical, including histogram and ogives, consistency and independence of data with special reference to attributes; Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, coefficient of variation, Moments, absolute moments, factorial moments, skewness and kurtosis, Sheppard's corrections; Bivariate data: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression, principle of least squares and fitting of polynomials and exponential curves

UNIT III: MATRICES

Linear and Orthogonal Transformations, Linear dependence of vectors, Characteristics equation, Eigen values and Eigen vectors, Statement and Verification of Cayley-Hamilton Theorem [without proof], Reduction to Diagonal form, Reduction of Quadratic form to Canonical form by Orthogonal Transformation, Sylvester's theorem[without proof], Solution of Second Order Linear Differential Equations with Constant Coefficients by Matrix method. Largest Eigen value and Eigen vector by Iteration method.

Text Books

1. Higher Engineering Mathematics by B.S. Grewal, 40th Edition, Khanna Publication
2. Advanced Engineering Mathematics by Erwin Kreysizig, 8th Edition, Wiley India
3. Applied Mathematics for Engineers & Physicist by L.R. Pipes and Harville
4. Theory & Problems of Probability and Statistics by M.R. Spiegal ,Schaum Series, McGraw Hills.

Course Outcomes (COs):

1. To introduce basic concepts of probability and how it can be used to design an intelligent system.
2. To introduce basic concepts of descriptive statistics and how it can be used to design an intelligent system.

3. To introduce basic concept of matrix algebra and how it can be used to design an intelligent system.

CS5202	Artificial Intelligence	L	T	P	C
M.Tech. (CSE), First Semester (Core)		3	0	0	3

UNIT I: INTRODUCTION

Definition of AI, Intelligent agents, perception and language processing, problem solving, searching, heuristic searching, game playing, Logics, logical reasoning.Forward vs Background, knowledge representation, frame problems, heuristic functions, weak methods of matching.

UNIT II: DECISION MAKING

Baye's theorem, multiple features, decision boundaries, estimation of error rates, histogram, kernels, window estimaters, nearest neighbour classification, maximum distance pattern classifier, adaptive decision boundaries.

Text Books:

1. Elain Rich and Kevin Knight, "Artificial Intelligence", 2nd Edition, Tata McGraw-Hill, 1993.
2. Earl Gose, Richard Johnsonbaugh, Steve Jost, "Pattern Recognition and Image Analysis", Prentice Hall of India Pvt. Ltd., New Delhi, 1999.
3. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001.
4. Artificial Intelligence, R.B. Mishra, PHI, India, 2010.
5. Robert Schalkoff, Pattern Recognition: Statistical Structural and Neural Approaches,Wiley – India, 2009
6. Artificial Intelligence: A new synthesis, Nils J Nilsson, Morgan Kaufmann Publishers

Course Outcomes (COs):

1. To introduce basic concepts of AI with its working principle.
2. To understand different kindsof knowledge representations techniques to solve AI problems.
3. To understand different kinds of heuristic search algorithms to get feasible solution for AI problems.
4. To design decision making models to solve different problems.

CS5203	**Foundation of Machine Learning**	**L**	**T**	**P**	**C**
M.Tech. (CSE), First Semester (Core)		3	0	0	3

UNIT I: PRELIMINARIES OF MACHINE LEARNING

Basic definitions, Types of Learning, Designing a learning System, Inductive Bias and Hypothesis, Hypothesis Evaluation.

UNIT II: FEATURE EXTRACTION AND FEATURE SELECTION

Feature extraction, Types of feature selection, Feature Handling, Normalization, Missing data, Dimension reduction

UNIT III: REGRESSION AND DECISION TREE LEARNING

Linear Regression, Logistic Regression, Decision Tree Representation, The Basic Decision Tree Learning Algorithm, Hypothesis Space Search in Decision Tree Learning, Inductive Bias in Decision Tree Learning, Issues in Decision Tree Learning

UNIT IV: CLUSTER ANALYSIS

Unsupervised learning, hierarchical clustering, k-means clustering, mean-shift clustering, Hierarchical clustering (Agglomerative and Divisive clustering),DBSCAN Clustering in ML | Density based clustering, Spectral clustering, k-medoids clustering.

UNIT V: INSTANCE BASED LEARNINGAND BAYESIAN LEARNING

Instance based learning: (K- Nearest Neighbor Learning, Locally Weighted Regression, Radial Basis Function, Case-Based Reasoning) , Bayesian Learning: (Bayes Theorem and Concept Learning, Maximum Likelihood and Least- Squared Error Hypothesis, Naïve Bayes Classifier, Bayesian Belief Networks).

References

1. “Foundations of Machine Learning” by MehryarMohri, AfshinRostamizadeh and AmeetTalwalkar,
2. “Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies” by John D. Kelleher, Brian Mac Namee, and Aoife D'Arcy
3. “Data Mining: Practical Machine Learning Tools and Techniques” by Ian H. Witten, Eibe Frank, and Mark A. Hall
4. “Data Smart: Using Data Science to Transform Information into Insight” by John W. Foreman.
5. “An Introduction to Statistical Learning with Applications in R” by James G., Witten D., Hastie T., and Tibshirani R
6. “Introduction to machine learning” by nilsnilsson.
7. Tom Mitchell, Machine Learning, McGraw-Hill.
8. SoumenChakrabarti, Mining the Web: Discovering Knowledge from Hypertext Data, Morgan-Kaufmann.

Course Outcomes (COs):

- To understand the basic concept of machine learning with its working principle.
- To understand different kinds of corealgorithms of machine learning.

- To design machine learning model with different machine learning algorithms to solve problems in industry, education, health care and beyond.

CS5204	**Machine Learning Lab**	**L**	**T**	**P**	**C**
M.Tech. (CSE), First Semester (Core)		0	0	3	2

UNIT I: BASICS

- Python Installation
- Vectorization:

  DOT product: using for loops, using numpy library dot Function
  Array: one dimensional array; multi-dimensional array; dimension and shape of array, zero, ones and empty array; number generation; indexing and slicing; Boolean indexing; fast element wise functions on array, array operations
  Statistical functions
  Set operations
  Linear algebra

UNIT II: K-NN, NB, SVM, DT, RF, Clustering

UNIT III: NEURAL NETWORK

- Graphs for different activation functions: sigmoid, Tanh, ReLu
- Parameter Initialization:

  Simple neural network building using keras library and Iris dataset
  Sequential modeling
- Optimizer, Loss function

UNIT IV: DEEP LEARNING

- Caffe: for different deep learning architectures like DBN, CNN, RNN, LSTM, DSN

  Application: object recognition
- BERT, Transformer (machine learning model)

Textbook:

1. AbhishekVijayvargia, Machine Learning for Python: An Approach to Applied Machine Learning, BPB Publications.

Course Outcomes (COs):

CS5231	**Speech Processing and Applications**	**L**	**T**	**P**	**C**
M.Tech. (CSE), First Semester (Elective I)		3	0	0	3

UNIT I: NATURE OF SPEECH SIGNAL
Speech production mechanism, Classification of speech, sounds, nature of speech signal, models of speech production. Speech signal processing: purpose of speech processing, digital models for speech signal, Digital processing of speech signals, Significance, short time analysis.

UNIT II: TIME DOMAIN METHODS FOR SPEECH PROCESSING
Time domain parameters of speech, methods for extracting the parameters, Zero crossings, Auto correlation function, pitch estimation. Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures– mathematical and perceptual – Log–Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths.

UNIT III: FREQUENCY DOMAIN METHODS FOR SPEECH PROCESSING
Short time Fourier analysis, filter bank analysis, spectrographic analysis, Format extraction, pitch extraction, Analysis - synthesis systems. Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

UNIT IV: LINEAR PREDICTIVE CODING OF SPEECH
Formulation of linear prediction problem in time domain, solution of normal equations, Interpretation of linear prediction in auto correlation and spectral domains.

UNIT V: HOMOMORPHIC SPEECH ANALYSIS
Central analysis of speech, format and pitch estimation, Applications of speech processing - Speech recognition, Speech synthesis and speaker verification.

TEXTBOOKS:
1. L.R. Rabiner and R.E Schafer: Digital processing of speech signals, Prentice Hall, 1978.
2. Daniel Jurafsky and James H Martin, “Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education, 2002.
3. Frederick Jelinek, “Statistical Methods of Speech Recognition”, MIT Press, 1997.

Course Outcomes (COs):

1. To learn the basics of speech processing.
2. To be able to understand the various stages of processing a speech signal.
3. To be able to analyse, synthesize and apply the techniques of speech recognition and speaker verification.

CS5232	**Natural Language Processing (NLP)**	**L**	**T**	**P**	**C**
M.Tech. (CSE), First Semester (Elective I)		3	0	0	3

UNIT I: INTRODUCTION

NLP tasks in syntax, semantics, and pragmatics. Applications such as information extraction, question answering, and machine translation. The problem of ambiguity. The role of machine learning. Brief history of the field.

N-Gram Language Models:The role of language models. Simple N-gram models. Estimating parameters and smoothing. Evaluating language models.

Part Of Speech Tagging And Sequence Labeling:Lexical syntax. Hidden Markov Models (Forward and Viterbi algorithms and EM training).

UNIT II: NEURAL NETWORKS

Basic introduction to perceptron, Multilayer Neural Network, Gradient Descent learning, Back propagation, Empirical Risk Minimization, regularization, Radial Basis Neural Network, Back propagation through time, Long Short Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs.

UNIT III: SYNTACTIC PARSING

Grammar formalisms and treebanks. Efficient parsing for context-free grammars (CFGs). Statistical parsing and probabilistic CFGs (PCFGs). Lexicalized PCFGs. Neural shift-reduce dependency parsing (see this paper).

UNIT IV: SEMANTIC ANALYSIS

Lexical semantics and word-sense disambiguation. Compositional semantics. Semantic Role Labeling and Semantic Parsing.

UNIT V: INFORMATION EXTRACTION (IE) AND MACHINE TRANSLATION (MT)

Named entity recognition and relation extraction. IE using sequence labeling. Basic issues in MT. Statistical translation, word alignment, phrase-based translation, and synchronous grammars.

UNIT VI: Case Studies - Bidirectional Encoder Representations from Transformers (BERT). Transformer (machine learning model), Graph Neural Networks.

Textbook:

1. Daniel Jurafsky and James H Martin. Speech and Language Processing, 2e, Pearson Education, 2009

Reference Books:

1. James A.. Natural language Understanding 2e, Pearson Education, 1994 2.
2. Bharati A., Sangal R., Chaitanya V.. Natural language processing: a Paninian perspective, PHI, 2000 3.

3. Siddiqui T., Tiwary U. S.. Natural language processing and Information retrieval, OUP, 2008

Course Outcomes (COs):

1. To learn the basics of natural language processing and understand various steps in it.
2. To discuss various issues that make natural language processing a hard task.
3. To understand the design and implementation issues in various NLP applications such as information retrieval and information extraction.
4. To demonstrate the state-of-the-art algorithms and techniques for text-based processing of natural language with respect to morphology.
5. To develop a Statistical Methods for Real World Applications and explore deep learning based NLP.

CS5233	**Artificial Intelligence for Social Good**	**L**	**T**	**P**	**C**
M.Tech. (CSE), First Semester (Elective I)		3	0	0	3

UNIT – I: Introduction, Logistics, Course Project, Basics of Optimization, Convex optimization, Linear Programming (LP) and Mixed Integer Linear Programming (MILP), Conservation Planning

UNIT – II: Wildlife corridor design, Basics of Regression and Classification, Linear and Logistic Regression, Kernel Regression, Decision Trees, Data-based Prediction

UNIT - III: Food rescue, detecting social bots on Twitter, Basics of Game Theory, Cover: Equilibrium concepts, Security Games, Bayesian Persuasion and Security Games

UNIT – IV: Autonomous Driving, Basics of Reinforcement Learning, Markov Decision Process (MDP), Q-Learning, Policy Gradient, Reinforcement Learning for Bike Repositioning

UNIT – V: AI and Ethics and Policy

UNIT VI: Basics of Deep Learning, Feedforward Neural Networks, Convolutional Neural Networks, Learning from Remote Sensing Data, Poverty and crop yield prediction

UNIT VII: Basics of Influence Maximization, Influence propagation models, submodular function optimization, Dynamic Influence Maximization under Uncertainty

UNIT VIII: AI/ML/DS for social good: opportunities and challenges, Mixture Models and Probabilistic Graphical Models, Gaussian Mixture Models (GMMs), Dynamic Bayesian Networks (DBNs), Markov Random Fields (MRFs), Response to COVID-19

UNIT IX: Cover: Object detection using Faster R-CNN, Detect human and wildlife from video data, Coordinate drone patrol and human patrol

Reference:

1. http://www.andrew.cmu.edu/user/feif/08737S18/08737_S18_Syllabus.pdf

Books and References:

1. Artificial Intelligence and Social Work Edited by MilindTambe, Eric Rice, Cambridge University Press
2. Artificial Intelligence and Conservation Edited by Fei Fang, MilindTambe, BistraDilkina, Andrew J. Plumptre, Cambridge University Press

Course Outcomes (COs):

1. To understand artificial intelligence concepts and range of problems that can be handled by machine learning and deep learning.
2. To develop knowledge of decision making and learning methods
3. To expose students to the frontiers of AI-intensive computing and information systems.
4. To describe and list the key aspects of planning in artificial intelligence.
5. To provide a sufficiently strong foundation to encourage further research.

CS5241	**Introduction to Robotics**	**L**	**T**	**P**	**C**
M.Tech. (CSE), First Semester (Elective II)		3	0	0	3

UNIT I: INTRODUCTION TO ROBOTICS
What is robot?, Classification of Robots, Advantages and Disadvantages of Robots, Robot Components, Degree of Freedom, Joints, Robot Coordinates, Reference Frames, Programming Modes, Robot Characteristics, Robot Workspace, Robot Languages, Application of Robots

UNIT II: SPATIAL DESCRIPTIONS AND TRANSFORMATION
Robot as Mechanisms, Matrix Representation, Description of Position and Orientation, Frames and Displacement mappings, Homogeneous transforms, Transformation of free vectors, examples.

UNIT III:MANIPULATORS

- **MANIPULATOR FORWARD KINEMATICS:** Link description, link connection, Denavit – Hartenberg parameters, examples.
- **MANIPULATOR INVERSE KINEMATICS**: Solvability, algebraic and geometric approaches, Degeneracy and Dexterity, Examples.
- **JACOBIANS: VELOCITIES, STATIC FORCES AND MANIPULATOR DYNAMICS ANALYSIS:** Velocity analysis, linear and rotational velocity of rigid bodies, velocity propagation, Jacobians, velocity transformation and inverse velocity, force transformation and inverse force, examples

UNIT IV: ROBOT DESIGN ROBOT CONTROLLER DESIGN: P, PI, PD, PID and AI control in Robotics, TRAJECTORY GENERATION: Joint space schemes, continuous path motion, examples.

UNIT 5: ACTUATORS AND SENSORS: ACTUATORS: Characteristics of Actuating Systems, Comparison of Actuating Systems, Hydraulic and Pneumatics Devices, Electric Motors in Robotics. **SENSORS:** Sensor Characteristics, Position Sensors, Velocity Sensors, Acceleration Sensors, Touch and Tactile Sensors, Proximity Sensors, Range Finder.

TextBooks:

1. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, *Robot Modeling and Control*, Wiley, 2006.
2. Saeed B. Niku, *Introduction To Robotics, Analysis, Systems , Application.*
3. Kevin M. Lynch and Frank C. Park, *Modern Robotics: Mechanics, Planning, and Control*, Cambridge University Press, 2017.
4. John J. Craig, *Introduction to Robotics*, Addison-Wesley Publishing, 1989.
5. Alonzo Kelly, *Mobile Robotics: Mathematics, Models, and Methods*, Cambridge University Press, 2013.
6. Sebastian Thrun, Wolfram Burgard, and Dieter Fox, *Probabilistic Robotics*, MIT Press, 2005.
7. Bruno Siciliano and OussamaKhatib, eds. Springer *Handbook of Robotics*, Springer, 2008.
8. Asada, H., and J. J. Slotine. *Robot Analysis and Control*. New York, NY: Wiley, 1986. ISBN: 9780471830290.

Course Outcomes (COs):

1. To introduce basic concepts of robotics with its mechanism.
2. To understand different kinds of robot manipulator and actuators and sensors.
3. To understand robot design for trajectory planning and continuous motion planning.

CS5242	**Optimization Techniques**	**L**	**T**	**P**	**C**
M.Tech. (CSE), First Semester (Elective II)		3	0	0	3

UNIT I: OPTIMIZATION

Need for unconstrained methods in solving constrained problems, necessary conditions of unconstrained optimization, structure methods, quadratic models, methods of line search, steepest descent method; conjugate-direction methods: methods for sums of squares and nonlinear equations; linear programming: simplex methods, duality in linear programming, transportation problem.

UNIT II: UNCONSTRAINED OPTIMIZATION

Line search method: Wolf condition, Goldstein condition, sufficient decrease and backtracking, Newtons method and Quasi Newton method; trust region method: the Cauchy point, algorithm based on Cauchy point, improving on the Cauchy point, the Dog-leg method, two-dimensional subspace reduction; nonlinear conjugate gradient method: the Fletcher Reeves method.

UNIT III: CONSTRAINED OPTIMIZATION

Penalty method, quadratic penalty method, convergence, non-smooth penalty function, L1 penalty method, augmented Lagrangian method; quadratic programming, Schur complementary, null space method, active set method for convex QP; sequential quadratic programming, convex programming.

UNIT IV: Gradient based techniques such as Adam, AdaGrad, AdaDelta, Gradient Descent (GD), Stochastic Gradient Descent (SGD) etc. Metaheuristic techniques such as Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Differential Evolution (DE) etc.

Text book:

1. Chong, E. K. and Zak, S. H., An Introduction to Optimization, 2nd Ed., Wiley India (2001).
2. Luenberger, D. G. and Ye, Y., Linear and Nonlinear Programming, 3rd Ed., Springer (2008).
3. Kambo, N. S., Mathematical Programming Techniques, East-West Press (1997).
4. Boyd, S. and Vandenberghe, L., Convex Optimization, Cambridge Univ. Press (2004).
5. Nocedel, J. and Wright, S. Numerical Optimization, Springer (2006).

Course Outcomes (COs):

1. To understanding different types of optimization problems
2. To explain the working principle optimization techniques
3. To use optimization techniques in various problems

CS5243	**Data Science**	**L**	**T**	**P**	**C**
M.Tech. (CSE), First Semester (Elective II)		3	0	0	3

UNIT I: INTRODUCTION TO PYTHON

Variable creation, Python identifiers, keywords, code blocks, Basic object types, Basic operators, Data types and associated operations, Lists, Tuples, Dictionary, Set Operations, User defined functions, Setting working Directory, Creating and saving a script file, File execution, clearing console, removing variables from environment, learning environment, Modules and Packages: Using and Creating, Commenting script files

UNIT II: INTRODUCTION TO DATA SCIENCE USING MACHINE LEARNING

Data Science Perspective of Data, Data Science Python Packages, Data Analysis Packages, Machine Learning Core Libraries, Feature Engineering, Exploratory Data Analysis, Data Visualization, Supervised Learning– Regression, Supervised Learning – Classification, Unsupervised Learning Process Flow

UNIT III: TEXT MINING AND RECOMMENDER SYSTEMS

Text Mining Process Overview, Data Assemble, Data Preprocessing (Text), Model Building, Text Similarity, Text Clustering, Topic Modeling, Text Classification, Sentiment Analysis, Deep Natural Language Processing (DNLP), Recommender Systems

Books and References:

1. Introduction to linear algebra - by Gilbert Strang.
2. Applied statistics and probability for engineers – by Douglas Montgomery.
3. Mastering python for data science, Samir Madhavan.
4. Mastering python for machine Learning, ManoharSwamynathan.

Course Outcomes (COs):

1. To introduce basic concepts of Data Science with its working principle.
2. To understand how Machine Learning can be used to build DS model with different kinds of data preparation techniques such as feature engineering, exploratory data analysis, data visualization etc.
3. To introduce basic concepts of text mining
4. To design DS model and recommender system using machine learning to solve different problems.

CS5244	**Big Data Analysis**	**L**	**T**	**P**	**C**
M.Tech. (CSE), First Semester (Elective II)		3	0	0	3

UNIT I: INTRODUCTION TO BIG DATA AND HADOOP

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 InfosphereBigInsights and Big Sheets.

UNIT II: HDFS(Hadoop Distributed File System)

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

UNIT III: Map Reduce

MapReduce workflows, unit tests with MRUnit, test data and local tests, anatomy of MapReduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output formats.

UNIT IV: Hadoop Eco System

Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators.

Hive: Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions.

Hbase: HBasics, Concepts, Clients, Example, HbaseVersus RDBMS.

Big SQL: Introduction

References:

1. Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013
2. Hadoop: The Definitive Guide, Tom White ,Third Edition, O'Reilley, 2012.
3. Hadoop Operations, Eric Sammer, O'Reilley, 2012.
4. Programming Hive, E. Capriolo, D. Wampler, and J. Rutherglen, O'Reilley, 2012.
5. HBase: The Definitive Guide, Lars George, O'Reilley, 2011.
6. Cassandra: The Definitive Guide, Eben Hewitt, O'Reilley, 2010.

Text Book:

1. Big Data Analytics, Introduction to Hadoop, Spark, and Machine-Learning, Raj kamal, PreetiSaxena, McGraw Hill, 2018.
2. Big Data, Big Analytics: Emerging Business intelligence and Analytic trends for Today's Business, Michael Minelli, Michelle Chambers, and AmbigaDhiraj, John Wiley & Sons, 2013

Course Outcomes (COs):

1. To introduce basic concepts of big data and Hadoop.
2. To understand HDFS and Map Reduce and their working principle.
3. To understand the design of HDFS with different design issues.

4. To understand Hadoop file system with some case studies.

CS5205	**Data Analytics and Computing**	**L**	**T**	**P**	**C**
M.Tech. (CSE), Second Semester (Core)		3	0	0	3

UNIT I: INTRODUCTION

Introduction to Data, Data types, Introduction to Stages of Data Processing: Data PreProcessing; Data Imputation; Data Cleaning; Data Transformation; Data Visualization; Data Analysis; Data Engineering, Data Management.

UNIT II: EXPLORATORY DATA ANALYSIS AND VISUALIZATION

Introduction to the Chicago Train Ridership data, Visualizations for Numeric Data: Exploring Train Ridership Data, Visualizations for Categorical Data: Exploring the OkCupidData,Visualizing Relationships between Outcomes and Predictors,Exploring Relationships between Categorical Predictors,Post Modelling Exploratory Visualizations.

UNIT III: FEATURE SELECTION AND ENGINEERING

Feature Selection, Classes of Feature Selection Methodologies: intrinsic (or implicit) methods, filter methods, and wrapper methods, Feature Engineering, Feature Engineering techniques: Binning, Feature Hashing, Log Transforms, n-grams, Binarisation, Bag-of-words.

UNIT IV: MODEL SELECTION AND EVALUATION

Model Selection, Introduction to machine learning, Supervised and unsupervised learning, machine learning algorithms, model evaluation approaches: Cross Validation, Confusion Matrix, Gain and Lift cgart, Kolmogorov-Smirnov Chart, Chi Square, ROC curve, Gini Coefficient, L^1 version of RSME.

References

1. James, G., Witten, D., Hastie, T., Tibshirani, R. An introduction to statistical learning with applications in R. Springer, 2013.
2. Han, J., Kamber, M., Pei, J. Data mining concepts and techniques. Morgan Kaufmann, 2011.
3. Hastie, T., Tibshirani, R., Friedman, J. The Elements of Statistical Learning, 2nd edition. — Springer, 2009.
4. Murphy, K. Machine Learning: A Probabilistic Perspective. - MIT Press, 2012.
5. Zumel, N. , Mount, J. Practical Data Science with R". Manning, 2014.
6. G. Strang (2016). Introduction to Linear Algebra, Wellesley-Cambridge Press, Fifth edition, USA.
7. Bendat, J. S. and A. G. Piersol (2010). Random Data: Analysis and Measurement Procedures. 4th Edition. John Wiley & Sons, Inc., NY, USA:
8. Montgomery, D. C. and G. C. Runger (2011). Applied Statistics and Probability for Engineers. 5th Edition. John Wiley & Sons, Inc., NY, USA.
9. David G. Luenberger (1969). Optimization by Vector Space Methods, John Wiley & Sons (NY)

Course Outcomes (COs):

1. To introduce basic concepts of Data Analytics.
2. To understand underlying behavior of data using different data exploration and data visualization techniques.
3. To introduce different feature selection techniques for feature engineering.
4. To introduce different kinds of ML techniques and their evaluation matrices.

CS5206	**Image Processing and Machine Vision**	**L**	**T**	**P**	**C**
M.Tech. (CSE), Second Semester (Core)		3	0	0	3

UNIT I: INTRODUCTION

Background, definition, Digital Image Fundamentals, Origin of DIP, Digital image representation, fundamental steps in image processing, elements of digital image processing systems, image acquisition, storage, processing, communication and display, data structures for image analysis.

UNIT II: IMAGE ENHANCEMENT

Image Enhancement in the spatial domain(Basic gray level transformations, histogram processing, Enhancement using arithmetic/logic operations, Basics of spatial filtering-comparison between smoothing and sharpening spatial filters),Image Enhancement in the frequency domain (1D Fourier transform-2D Fourier transform and its Inverse-Smoothing & sharpening frequency domain filters (Ideal, Butterworth, Gaussian), homomorphic filtering.).

UNIT III: IMAGE COMPRESSION AND SEGMENTATION

Image compression (Fundamentals, Error-free compression, Huffman coding, block coding, constant area coding, variable length coding, bit-plane coding, lossless predictive coding-source and channel encoding-decoding-Lossy compression, lossy predictive coding, transform coding.),
Image Segmentation (Thresholding, Edge Based Segmentation, Region Based Segmentation, Mean shift segmentation, Graph cut algorithm, Matching, Evaluation Issues in Segmentation, Watersheds.).

UNIT IV: COLOR IMAGE PROCESSING

Color Fundamentals, Color Models, Pseudo color Image Processing, Basics of Full Color Image Processing, Color Transformations, Smoothing and Sharpening, ColorSegmentation,Noise in Color Images.

UNIT V: MACHINE VISION

Introduction, definition, Active vision system, Machine vision components, hardware's and algorithms, image function and characteristics, segmentation, data reduction, feature extraction, edge detection, image recognition and decisions, application of machine vision such as in inspection of parts, identification, industrial robot control, mobile robot application, Competing technologies, CCD line scan and area scan sensor, Videcon and other cameras, Triangulation geometry, resolution passive and active stereo imaging, laser scanner, data processing.

Text Books

1. Rafael C.Gonzalez and Richard E. Woods,"Digital Image Processing", Richard E. Woods.
2. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing using MATLAB", Main purpose-Practical
3. Bershold Klaus, Paul Holm, "Robot vision", The MIT press.

Course Outcomes (COs):

1. To understand the fundamentals of digital images and perform image related operations by image processing techniques.
2. To articulate the valuable information from images after pre-processing by using various image enhancement operations.

3. To learn and Implement the suitable compression and segmentation techniques on digital images and explore the methods to manipulate the color properties of digital images.
4. To discuss the applications of digital image processing concepts in the development and design of a computer vision system using digital images.

CS5207	**Neural Network and Deep Learning**	**L**	**T**	**P**	**C**
M.Tech. (CSE), Second Semester (Core)		3	0	0	3

UNIT I: INTRODUCTION
Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability, Convergence theorem for Perceptron Learning Algorithm, Type of network architecture, Activation functions, Basic Learning rules.

UNIT II: FEEDFORWARD NETWORKS
Multilayer Neural Network, Gradient Descent learning, Back propagation, Empirical Risk Minimization, regularization, Radial Basis Neural Network

UNIT III: RECURRENT NEURAL NETWORKS: Back propagation through time, Long Short Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs.

UNIT IV: DEEP NEURAL NETWORKS
Introduction, Difficulty of training deep neural networks, Greedy layer wise training.

- Generative models: Restrictive Boltzmann Machines (RBMs), Introduction to MCMC and Gibbs Sampling, gradient computations in RBMs, Deep Boltzmann Machines.
- Convolutional Neural Networks: LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Back propagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks.
- Auto Encoders
- Deep Reinforcement Learning
- Deep Learning Tools: Caffe, Theano, Torch.

UNIT V: PARAMETER TUNING
Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization).

Text Books

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016..
2. Bishop, C., M., Pattern Recognition and Machine Learning, Springer, 2006.

Reference Books

1. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
2. Golub, G., H., and Van Loan, C., F., Matrix Computations, JHU Press,2013.
3. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

Course Outcomes (COs):

1. To understand basic concepts of artificial neuron and its working principle.
2. To understand different kinds of Neural Networks based on architectures and learning rules.
3. To understand the basic concepts of Deep Neural Networks (DNN) and its different kinds with working principle.
4. To understand the various parameter tuning and optimization methods**.**

CS5251	**Data Mining and Information Retrieval**	**L**	**T**	**P**	**C**
M.Tech. (CSE), Second Semester (Elective III)		3	0	0	3

UNIT I: INTRODUCTION
What is data mining,Related technologies - Machine Learning, DBMS, OLAP, Statistics, Data Mining Goals,Stages of the Data Mining Process, Data Mining Techniques,Knowledge Representation Methods,Applications

UNIT II: DATA WAREHOUSE AND OLAP
Data Warehouse and DBMS,Multidimensional data model, OLAP operations,Example: loan data set.

UNIT III: DATA PREPROCESSING
Data cleaning, Data transformation, Data reduction,Discretization and generating concept hierarchies,Installing Weka 3 Data Mining System,Experiments with Weka - filters, discretization.

UNIT IV: DATA MINING TASKS AND TOOLS
Predictive and Descriptive Data mining tasks, Association Analysis, Correlation Analysis, Classification, Decision Tree Induction, Clustering Analysis, Outlier Analysis, Regression Analysis, Sequential Pattern, Data Mining Tools: Rapidminers; Orange; KEEL; SPSS; KNIME.

UNIT V: INFORMATION RETRIEVAL
Text Indexing, Storage and Compression,Retrieval Models, Performance,Text Categorization and Filtering,Text Clustering,Web Information Retrieval, Retrieving Structured Documents.

References
1. J. Han and M. Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann/Elsevier India, 2001.
2. D. Hand, H. Mannila, and P. Smyth. Principles of Data Mining, MIT Press, 2001.
3.Recent literature from ACM SIGMOD, VLDB, IEEE Trans. Knowledge & Data Engg., Data Mining and Knowledge Discovery, ACM SIGKDD, IEEE ICDM, SIAM Data Mining, ICML.
4.Introduction to Information Retrieval Manning, Raghavan and Schutze, Cambridge University Press, draft.
5.Modern Information Retrieval Baeza-Yates and Ribeiro-Neto, Addison Wesley, 1999.
6.A comprehensive survey by Ed Greengrass
7.Mining the Web, SoumenCharabarti, Morgan-Kaufmann, 2002.

Course Outcomes (COs):

1. To perform the preprocessing of data and apply mining techniques on it.
2.To use various data analysis tools for scientific and real time applications.
3. To implement various supervised and unsupervised learning techniques in text data.

4. To solve real world problems in business and scientific information using data mining and Information Retrieval.

CS5252	**Machine Translation**	**L**	**T**	**P**	**C**
M.Tech. (CSE), Second Semester (Elective III)		3	0	0	3

UNIT I: INTRODUCTION

Why MT is hard? Ambiguity, Language Divergence and Typology: Word Order Typology, Lexical Divergences, Morphological Typology, Referential density. Classical MT and the Vauquois Triangle: Direct Translation, Transfer, Combined Direct and Tranfer Approaches in Classic MT, The Interlingua Idea: Using Meaning

UNIT II: LANGUAGE MODELLING AND STATISTICAL MACHINE TRANSLATION

Basic concept of Language modeling: n-gram, smoothing techniques, P($F|E$): the Phrase-Based Translation Model, Alignment in MT, IBM Model 1, HMM Alignment, Training Alignment Models, EM for Training Alignment Models, Symmetrizing Alignments for Phrase-Based MT, Decoding for Phrase-Based Statistical MT, IBM Model 3 and Fertitlity, Training for Model 3, Re-Odering Models, Log-linearModels for MT

UNIT III: NEURAL MACHINE TRANSLATION

Intuition of NMT, Neural Networks, The Encoder-Decoder Modeling: Sequence to Sequence with RNN, Encode-Decoder with RNNs, Training the Encoder-Decoder Model, Attention Mechanism, Beam Search, Encode-Decider with Transformers

UNIT IV: BUILDING MT SYSTEMS: SOME PRACTICAL ISSUES

Tokenization, MT Corpora, Backtranslation, Introduction to Supervised, Unsupervised, Self-Supervised MT approaches, Standard Toolkits: SRILM, KenLM, Moses, OpenNMT

UNIT V: MT EVALUATION

MT Evaluation: Quality Estimation, Using Human Raters to Evaluate MT, Automatic Evaluation: BLEU, METEOR, Automatic Evaluation: Embedding-Based Methods

References

1. Machine Translation: 15th China Conference, CCMT 2019, Nanchang, China, September 27–29, 2019, Revised Selected Papers (Communications in Computer and Information Science) Paperback – November 23, 2019.
2. Foundations of Statistical Natural Language Processing by Christopher Manning and HinrichSchütze.
3. Statistical Machine Translation by Philipp Koehn.
4. Natural Language Processing with Python by Steven Bird
5. Machine Translation by Pushpak Bhattacharyya
6. Machine Translation by Thierry Poibeau
7. Computational Linguistics: 15th International Conference of the Pacific Association for Computational Linguistics, PACLING 2017, Yangon, Myanmar, August 16-18,

communications in Computer and Information Science Book 781, Kindle Edition by KôitiHasida , Win Pa Pa

Course Outcomes (COs):

1. To learn the basic principles of machine translation
2. To analyse and use some of the commonly used algorithms for machine translation
3. To analyse and use different techniques of language modeling
4. To design and develop machine translation systems for different applications

CS5253	***Machine Learning for Cyber Security***	**L**	**T**	**P**	**C**
M.Tech. (CSE), Second Semester (Elective III)		3	0	0	3

UNIT I: MALWARE ANALYSIS
Review to basic security concepts and cryptography primitives
Review to basic machine learning concepts.
Understanding Malware, Feature Generation,From Features to Classification

UNIT II: ANOMALY DETECTION
When to Use Anomaly Detection Versus Supervised Learning,Intrusion Detection with Heuristics, Data-Driven Methods, Feature Engineering for Anomaly Detection,Anomaly Detection with Data and Algorithms,Challenges of Using Machine Learning in Anomaly Detection,Response and Mitigation Practical System Design Concerns

UNIT III:NETWORK TRAFFIC ANALYSIS
Theory of Network Defense, Machine Learning and Network Security,Building a Predictive Model to Classify Network Attacks

UNIT IV: PROTECTING THE CONSUMER WEB
Monetizing the Consumer Web,Types of Abuse and the Data That Can Stop Them,Supervised Learning for Abuse Problems,Clustering Abuse,Further Directions in Clustering

UNIT V: ADVERSARIAL MACHINE LEARNING
Terminology,The Importance of Adversarial ML,Security Vulnerabilities in Machine Learning Algorithms,Attack Technique: Model Poisoning,Attack Technique: Evasion Attack

References

1. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press.
2. William Stallings, Cryptography and Network Security: Principles and Practice, Prentice Hall of India.
3. Clarence Chio, David Freeman "Machine Learning and Security" O'Reilly Media, Inc. ISBN: 9781491979907 (2018)

Course Outcomes (COs):

1. To understand the machine learning process
2. To extract features from security data sets
3. To apply a machine learning technique to solving a security problem
4. To evaluate and assess the performance of a model

5. To create effective visualizations of security data

CS5254	**Introduction to Blockchain Technology**	**L**	**T**	**P**	**C**
M.Tech. (CSE), II Semester (Elective III)		3	0	0	3

UNIT I: INTRODUCTION

Overview of Blockchain, History of Blockchain, Technical Concepts of Blockchain Technology, Blockchain Characteristics, Design Methodology for Blockchain Applications, Domain Specific Blockchain Applications, Research Aspects, Blockchain Benefits and Challenges.

UNIT II: CRYPTO PRIMITIVES AND OVERVIEW OF CRYPTOCURRENCIES

Cryptographic Hash Functions, Digital Signature; Hashchain to Blockchain; Overview of Crypto currencies, Bitcoin overview, Mining and Consensus, Mathematical analysis of properties of Bitcoin.

UNIT III: BLOCKCHAIN COMPONENTS

Ethereum, Ethereum Virtual Machine (EVM), Ethereum Languages, Smart Contracts, Structure of a Contract, Smart contracts Vulnerabilities, Development Tools and Frameworks- Metamask, Truffle, Decentralized Applications(Dapps).

UNIT IV: INTEGRATION OF ARTIFICIAL INTELLIGENCE (AI) WITH BLOCKCHAIN

How to adopt AI in Blockchain, Role of AI in Blockchain, Methods to implement AI in Blockchain, Concept of Internet of Things (IoT), Secure and Smart IoT, Blockchain-enabled smart IoT with AI.

UNIT V: BLCOKCHAIN USE-CASES

Blockchain for Healthcare Informatics, Blockchain for Agricultural Supply chain Management, Blockchain for Financial Technology, Blockchain for Smart Applications, Blockchain for Government Applications.

References:

1. ArshdeepBahga and Vijay K. Madisetti, *Blockchain Applications: A Hands-on Approach,* ISBN: 9780996025560,2018.
2. Josh Thompsons, *Blockchain: The Blockchain For Beginners Guide To Blockchain Technology And Leveraging Blockchain Programming*, Kindle Edition,ISBN : 1546772804
3. Arvind Narayanan, J. Bonneau, E Felten, A Miller, and S Goldfeder, *Bitcoin and Crypto currency Technologies: A comprehensive Introduction*, Princeton University Press, 2016.
4. Andreas M. Antonopoulos, *Mastering Bitcoin: Programming The Open Blockchain*, O'Reilly, ISBN: 9789352135745, 2017

Course Outcomes (COs):

1. To state concepts, benefits, and the challenges of BlockchainTechnology.

2. To analyse and use some of the commonly used Crypto techniques for Blockchain.

3. To usedifferent development platforms tobuild applications on Blockchain.

4. To integrate AI techniques, IoT with Blockchain.

5. To design and develop secure systems for different application domains.

CS5261	**Internet of Things**	**L**	**T**	**P**	**C**
M.Tech. (CSE), Second Semester (Elective IV)		3	0	0	3

UNIT I: Introduction to IoT: Sensing, Actuation, Communication Protocols, Sensor Networks, IoT architecture, standards considerations. Machine-to-Machine Communications, Devices and gateways, Local and widearea networking,

UNIT II: Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management. IoT reference Model, Sensors for IoT Applications, IoTMap Device, Wireless Sensor Structure, Energy Storage Module, Power Management Module, RF Module, Sensing Module, ACOEM Eagle, EnOcean Push Button, NEST Sensor, Ninja Blocks, WearableElectronics, Implementation of IoT with Raspberry Pi, Clayster libraries, SDN for IoT,

UNIT III: Interfacing thehardware: Internal representation of sensor values, Persisting data, External representation of sensor values, Exporting sensor data, and development of the actuator project. Security Architecture in the Internetof Thing, RFID False Authentications,

UNIT IV: Application of Geographical Concepts and Spatial Technology tothe Internet of Things: Applying spatial relationships, functions, and models, Interoperability in IoT,Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino

UNIT V: Case Studies:Agriculture, Healthcare, and Activity Monitoring. Sensor-Cloud, Smart Cities and Smart Homes

References:

1. Internet of Things Principles and Paradigms by RajkumarBuyya and Amir VahidDastjerdi, Elsevier.
2. From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence by Jan Holler, VlasiosTsiatsis, Catherine Mulligan, StamatisKarnouskos, Stefan Avesand and David Boyle, Academic Press.
3. Sensors, Actuators and Their Interfaces by N. Ida, Scitech Publishers.

Course Outcomes (Cos):

1. To understand the key components that make up an IoT system.
2. To apply the knowledge and skills acquired during the course to build and test a complete, workingIoT system involving prototyping, programming and data analysis.
3. To develop technical solutions for societal problems using AIoT.

CS5262	**Data Visualization, Analytics & Representation**	**L**	**T**	**P**	**C**
M.Tech. (CSE), Second Semester (Elective IV)		3	0	0	3

UNIT I: DATA ANALYTIC THINKING

The Ubiquity of Data Opportunities, Data Processing and "Big Data", From Big Data 1.0 to Big Data 2.0, Data and Data Science Capability as a Strategic Asset, From Business Problems to Data Mining Tasks, Business Understanding, Data Understanding, Data Preparation, Modeling, Evaluation, Deployment, Analytic techniques and technologies, Answering business questions with these techniques.

UNIT II: STORY TELLING WITH DATA

Importance of context, Choosing an effective visual, Focus audience's attention, Thinking like designer, Dissecting model visuals, Lessons in story telling, Putting it all together, Case studies.

UNIT III: INTRODUCTION TO PREDICTIVE MODELLING

Sample data, Learn a model, Make predictions, Some Applications of Predictive Modeling.

UNIT IV: VISUALIZATION

Data visualization techniques: Univariate and Multivariate plots, pros and cons of data visualization, Data Visualization Tools (Google Charts, Tableau, Grafana, Chartist. js, FusionCharts, Datawrapper, Infogram, ChartBlocks, and D3. js)

References

1. An Introduction to Statistical Learning with Applications in R by Gareth James, Daniell Witten, Trevor Hastie, Robert Tibshirani
2. Data Science for Business, Foster Provost, Tom Fawcett, O'Reilley .
3. Storytelling with Data: A Data Visualization Guide for Business Professionals, Cole NussbaumerKnaflic, Wiley
4. Communicating Data with Tableau, Ben Jones, O'Reilley

Course Outcomes (COs):

1. To introduce different issues of Data Analytics.
2. To introduce a predictive model with critical analysis.
3. To introduce different kinds of data visualization tools and techniques to visualize data.

CS5263	**Virtual and Augmented Reality**	**L**	**T**	**P**	**C**
M.Tech. (CSE), Second Semester (Elective IV)		3	0	0	3

UNIT I:VIRTUAL REALITY AND VIRTUAL ENVIRONMENTS

The historical development of VR: Scientific landmarks Computer Graphics, Real-time computer graphics, Flight simulation, Virtual environments, Requirements for VR, benefits of Virtual reality, Virtual Reality Applications.

UNIT II: HARDWARE TECHNOLOGIES FOR 3D USER INTERFACES

Visual Displays, Auditory Displays, Haptic Displays, Choosing Output Devices for 3D User Interfaces.

UNIT III: 3D USER INTERFACE INPUT HARDWARE

Input device characteristics, Desktop input devices, Tracking Devices, 3D Mice, Special Purpose Input Devices, Direct Human Input, Home - Brewed Input Devices, Choosing Input Devices for 3D Interfaces.

UNIT IV: SOFTWARE TECHNOLOGIES

Database - World Space, World Coordinate, World Environment, Objects - Geometry, Position / Orientation, Hierarchy, Bounding Volume, Scripts and other attributes, VR Environment - VR Database, Tessellated Data, LODs, Cullers and Occluders, Lights and Cameras, Scripts, Interaction - Simple, Feedback, Graphical User Interface, Control Panel, 2D Controls, Hardware Controls, Room / Stage / Area Descriptions, World Authoring and Playback, VR toolkits.

UNIT V: 3D INTERACTION TECHNIQUES

3D Manipulation tasks, Manipulation Techniques and Input Devices, Interaction Techniques for 3D Manipulation, Design Guidelines - 3D Travel Tasks, Travel Techniques, Design Guidelines - Theoretical Foundations of Wayfinding, User CenteredWayfinding Support, Environment CenteredWayfinding Support, Evaluating Wayfinding Aids, Design Guidelines - System Control, Classification, Graphical Menus, Voice Commands, Gestrual Commands, Tools, Mutimodal System Control Techniques, Design Guidelines, Case Study: Mixing System Control Methods, Symbolic Input Tasks, symbolic Input Techniques, Design Guidelines, Beyond Text and Number entry.

UNIT VI: DESIGNING AND DEVELOPING 3D USER INTERFACES

Strategies for Designing and Developing Guidelines and Evaluation.

References :

1. Alan B Craig, William R Sherman and Jeffrey D Will, “Developing Virtual Reality Applications: Foundations of Effective Design”, Morgan Kaufmann, 2009.
2. Gerard Jounghyun Kim, “Designing Virtual Systems: The Structured Approach”, 2005.
3. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, “3D User Interfaces, Theory and Practice”, Addison Wesley, USA, 2005.
4. Oliver Bimber and Ramesh Raskar, “Spatial Augmented Reality: Meging Real and Virtual Worlds”, 2005.

5. Burdea, Grigore C and Philippe Coiffet, “Virtual Reality Technology”, Wiley Interscience, India, 2003.
8. William R Sherman and Alan B Craig, “Understanding Virtual Reality: Interface, Application and Design (The Morgan Kaufmann Series in Computer Graphics)”. Morgan Kaufmann Publishers, San Francisco, CA, 2002.

Course Outcomes (COs):

1. To introduce awareness on the requirements of virtual reality and virtual environments and ability to develop virtual environments
2. To discover the techniques, processes, technologies and hardware used in an individual and conceptually developed Virtual Reality and Virtual environment.
3. To explore and articulate the 3D interactive procedures and learn to interact with a VR world.
4. To identify and develop personal topics for individual research in immersive virtual reality applications.

CS5264	**Medical Imaging Processing**	**L**	**T**	**P**	**C**
M. Tech. (CSE), Second Semester (Elective IV)		3	0	0	3

UNIT – I: Image & Signal Processing

Sampling theory, and a variety of interpolation methods, including nearest-neighbour, linear, cubic & higher-order, and Fourier (using the FFT). We will use these methods to implement spatial image transformations (rigid and non-rigid).

UNIT II: Sources of Medical Images

Briefly discuss the physics of X-ray, CT, PET, MRI, and ultrasound. We will study the properties of the resulting images, and discuss the advantages and disadvantages of each imaging modality.

UNIT III: Image Enhancement

Contrast adjustment, denoising (convolution, FFT), deblurring (solving an ill-conditioned sparse linear system), edge detection (numerical approximation to a partial derivative), anisotropic diffusion (numerical solution of partial differential equations), super-resolution.

UNIT IV: Registration (alignment)

Intensity-based methods, including a variety of cost functions (correlation, least squares, mutual information, robust estimators), and optimization techniques (fixed-point iteration, gradient descent, Nelder-Mead simplex method, etc.). Implement registration for rigid and non-rigid transformations. MRI motion compensation.

UNIT V: Segmentation (tissue classification)

Discuss simple methods such as thresholding, region growing and watershed. More depth on the method of snakes (adaptive mesh), level set method (numerical solution of partial differential equations), and clustering (classifiers).

UNIT VI: Reconstruction Methods

Reconstruction techniques for CT (filtered back projection) and MRI (using the FFT). We will also include a section on the theory of the Radon transform, the Fourier transform, and how they relate to each other.

Books and References:

1. Cho, Z-H., J. Jones, and M. Singh. Foundations of Medical Imaging.
2. Macovski, A. Medical Imaging.

Course Outcomes (COs):

1. To understand the basics of image and signal processing techniques and the properties of medical images acquired from various imaging modalities.
2. To articulate the valuable information from medical images after pre-processing by enhancing the quality of the image and Express proficiency in handling rigid and non-rigid transformations.
3. To apply proper Restoration and segmentation techniques to analyse the medical images.
4. To identify the suitable reconstruction methods for CT and MRI images and able to apply these techniques on different medical images.

SEMESTER III & SEMESTER IV

SL No	Code	Subject	L	T	P	Credits	Semester
		Seminar-II	0	0	3	2	III
		Project	0	0	28	14	III & IV

Course Outcomes (COs):