M.Tech in Applied AI And Communications

Semester	Course Code	Course Name	Type	L	T	P	Credits
Semester 1 12 credits		Programming For Data Science	DC	2	0	2	3
		Statistics For Machine Learning	DC	3	0	0	3
		Machine Learning Algorithms And Applications	DC	2	0	2	3
		Fundamentals of Communication And Signal Processing	DC	3	0	0	3
Semester 2 15 credits		Deep Learning Techniques	DC	2	0	2	3
		Data Visualization	DC	2	0	2	3
		Data Transformation	DE	2	0	2	3
		Elective 1	DE	3	0	0	3
		Mini Project	DC	-	-	-	3
Semester 3 14 credits		Elective 2	DE	3	0	0	3
		Elective 3	DE	3	0	0	3
		Dissertation - Phase I	DC	-	-	-	8
Semester 4 13 credits		Dissertation - Phase II	DC	-	-	-	10
		Personality Development & Communication Skills	HU	2	0	2	3

Electives	L	T	P	Credits
Natural Language Processing	2	0	2	3
Next-Gen Communication	2	0	2	3

Internet of Things And Embedded Systems	2	0	2	3
Communication Networks for IoT	2	0	2	3
Big Data Analytics	2	0	2	3
Deployment of ML Models	2	0	2	3
AI in Healthcare	2	0	2	3
Applied Signal Processing	2	0	2	3
Computer Vision	2	0	2	3
Data Structures	2	0	2	3

<table>
<tr><td>Course Code</td><td>-</td><td>Course Title</td><td colspan="4">Programming For Data Science</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">-</td><td rowspan="2">Credit Assigned:</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td>Prerequisite(if Any)</td><td>-</td><td>Type of Course</td><td colspan="4">MS Applied AI and Communications</td></tr>
<tr><td colspan="7">Course Outcomes:
On successful completion of the course, students shall be able to:
1. Understand syntactical and programming concepts.
2. Understand object-oriented concepts.
3. Analyze and apply different methods for error handling.
4. Understand important Python libraries related to data science and how to apply them to given programming tasks.</td></tr>
</table>

5. Understand concepts like environments and version control.

Course Content:

Module 1 : Introduction to Data Science using Python

What is Data Science, what does a data scientist do? Various examples of Data Science in the industries, How Python is deployed for Data Science applications, Various steps in the Data Science process like data wrangling, data exploration and selecting the model. Introduction to Python programming language, Important Python features, how is Python different from other programming languages, Python installation, Anaconda Python distribution for Windows, Linux and Mac, How to run a sample Python script, Python IDE working mechanism, Running some Python basic commands, Python variables, data types and keywords.

Module 2 : Python basic constructs

Introduction to a basic construct in Python, Understanding indentation like tabs and spaces, Python built-in data types, Basic operators in Python, Loop and control statements like break, if, for, continue, else, range() and more., File Handling (I/O) and Exception Handling, Pandas, Understanding the OOP paradigm like encapsulation, inheritance, polymorphism and abstraction ,What are access modifiers, instances, class members, Classes and objects, Function parameter and return type functions, Lambda expressions.

Module 3 : NumPy for Data Transformation

Introduction to mathematical computing in Python, What are arrays and matrices, array indexing, array math, Inspecting a NumPy array, NumPy array manipulation

Module 4 : Scipy for Mathematical Computing

Introduction to SciPy, Functions building on top of NumPy, cluster, linalg, signal, optimize, integrate, subpackages, SciPy with Bayes Theorem.

Module 5 : Data manipulation & Data Visualization

Loading data from various files (.dat, .json, .h5, .txt, .csv, .xlsx etc.), Example applications, Introduction to Matplotlib, Using Matplotlib for plotting graphs and charts like Scatter, Bar, Pie, Line etc., Histogram and more, Matplotlib APIs

Text Books:

1. Wes McKinney: Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, O'Reilly Media, 2017
2. How to think like a computer scientist: Learning with Python by Jeffrey Elkner, Allen B. Downey, and Chris Meyers

Reference Books:

1. "Python Programming: A Complete Guide For Beginners To Master And Become An Expert" by Brian Draper

<table>
<tr><td>Course Code</td><td>-</td><td>Course Title</td><td colspan="4">Statistics For Machine Learning</td></tr>
<tr><td rowspan="3">Category</td><td rowspan="3">-</td><td rowspan="3">Credit Assigned:</td><td colspan="4"></td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Prerequisite(if Any)</td><td>-</td><td>Type of Course</td><td colspan="4">MS Applied AI and Communications</td></tr>
<tr><td colspan="7">Course Outcomes:
On successful completion of the course, students shall be able to:
1. Have an understanding of descriptive and inferential statistics constructs for statistical analysis
2. Gain Knowledge of probability theory and its implementation for data analysis.</td></tr>
<tr><td colspan="7">Course Content:
Module 1 : Fundamentals of Probability and Statistics

Probability spaces, Conditional probability, Independence, Random Variables, Discrete and Continuous random variables, Expectation Operator, Functions of random variables, Generating random variables, Multivariate Random Variables, Joint distributions of discrete and continuous variables, Functions of several random variables, Joint Moments, Generating multivariate random variables

Module 2 : Random Processes - Convergence, Markov Chains and Applications

Definition, Stationary of random processes, Mean and autocovariance, functions, Independent identically-distributed sequences, Power spectral density, Gaussian process, Poisson process, Random walk, Convergence of Random Processes, Types of convergence, Law of large numbers, Central limit theorem, Monte Carlo simulation, Time-homogeneous discrete-time Markov chains, Recurrence, Periodicity, Convergence, Markov-chain Monte Carlo, Descriptive statistics, Histogram, Sample mean and variance, Order statistics, Sample covariance, Sample covariance matrix

Module 3 : Frequentist Statistics, Regression, Bayesian Statistics and Hypothesis Testing</td></tr>
</table>

Independent identically-distributed sampling, Mean square error, Consistency, Confidence intervals, Nonparametric model estimation, Parametric model estimation, Linear Regression models, Least-squares estimation, Overfitting, Global warming. Bayesian parametric models, Conjugate prior, Bayesian estimators, The hypothesis-testing framework, Parametric testing, Nonparametric testing: The permutation test, Multiple testing

Module 4 : Linear Algebra

Vector space, norm, linear mapping, range, null space, matrix multiplication

Module 5 : Optimization Techniques

Normal equation, Steepest Descent, Conjugate gradient, Optimality condition, Methods based on a local quadratic model, Line search methods

Text Books:

1. Probability and Statistics for Data Science, by Carlos Fernandez-Granda
2. Probability for Statistics and Machine Learning: Fundamentals and Advanced Topics, by Anirban Das Gupta
3. Probability, random variables, and stochastic processes, by Athanasios Papoulis.
4. S. Lang, *Introduction to Linear Algebra*, Springer-Verlag, 2/e, 1997
5. Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong. Mathematics for machine learning.Cambridge University Press, 2020.

Reference Books:

1. Machine learning: a probabilistic perspective by Kevin Murphy
2. Statistical Learning Theory by Vladimir N. Vapnik

Course Code	-	Course Title	Machine Learning Algorithms & Applications
Category	-	Credit Assigned:	L: 2, T: 0, P: 2, C: 3

Prerequisite(if Any)	-	Type of Course	MS Applied AI and Communications

Course Outcomes:

On successful completion of the course, students shall be able to:

1. You will be proficient in Supervised and Unsupervised Learning
2. Learn and master Various machine learning algorithms to solve classification, regression and clustering problems.
3. Understand Predictive analytics and modeling
4. Overcome challenges for Model optimization and evaluation metrics

Course Content:

Module 1: Introduction to Machine Learning

Introduction to machine learning, types of learning, Learning Hypothesis, Linear Regression, Inductive classification, applications of Machine Learning ,

Module 2: Hypothesis Evaluation

Training and test splits, Data Pre-processing, cross-validation and parameter tuning, K-fold cross validation, Confusion matrix, Estimating hypothesis accuracy, sample and true error.

Module 3: Decision Trees: Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity. Occam's razor. Overfitting, noisy data, and pruning.

Module 4: Neural Networks

Artificial Neural Networks: Neurons and biological motivation. Linear threshold units, Perceptron: Representational limitation and gradient descent training, Logistic regression, Multilayer networks and Back-propagation.

Module 5: Bayesian learning and unsupervised learning

Bayesian Learning: Naive Bayes learning algorithm. Parameter smoothing. Bayes nets and Markov nets for representing dependencies. Hidden Markov Model, and Bayesian networks.

Clustering and unsupervised learning: Clustering. Hierarchical Aglomerative Clustering. k-means partitional clustering. Expectation maximization (EM) for soft clustering.

Text Books:

1. Mitchell Tom (1997). Machine Learning, Tata McGraw-Hill
2. Bishop C., Pattern Recognition and Machine Learning, Springer-Verlag (2006).

Reference Books:

1. Machine learning: a probabilistic perspective by Kevin Murphy
2. Patterson D.W, Introduction to AI and Expert Systems, Mc GrawHill (1998).
3. Mitchell Tom, Machine Learning. McGraw Hill, 1997.
4. Ethem Alpaydin, Introduction to Machine Learning, PHI

<table>
<tr><td>Course Code</td><td>-</td><td>Course Title</td><td colspan="4">Fundamentals of Communication & Signal Processing</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">-</td><td rowspan="2">Credit Assigned:</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Prerequisite(if Any)</td><td>-</td><td>Type of Course</td><td colspan="4">MS Applied AI and Communications</td></tr>
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Course Outcomes:

On successful completion of the course, students shall be able to:

Knowledge: Demonstrate understanding of the fundamental concepts and principles of communication systems and signal processing, including types of signals, modulation techniques, and signal processing techniques.

Application: Apply signal processing techniques to analyze and interpret different types of signals in both time and frequency domains, and design appropriate signal processing algorithms for noise reduction, filtering, and spectral analysis.

Analysis: Analyze and evaluate the performance of communication systems, including information theory concepts such as entropy, channel capacity, and error correction coding, and make informed decisions on system design and optimization.

Synthesis: Synthesize knowledge and skills from various areas of communication and signal processing to develop innovative solutions for real-world communication problems, such as channel coding, modulation schemes, and multiple access techniques.

Evaluation: Evaluate the impact of different communication channel models and their effect on system performance, and critically assess the advantages and limitations of various communication and signal processing techniques for different applications and scenarios.

Course Content:

Module 1: *CONTINUOUS-TIME, AND DISCRETE-TIME SIGNALS AND SYSTEMS*
Signals, Signal Energy and Power, Transformations of the Independent Variable, Periodic Signals, Even and Odd Signals, Exponential and Sinusoidal Signals, Complex Exponential and Sinusoidal Signals, Unit Impulse and Unit Step Functions, Systems and Properties. LTI Systems: The Convolution Integral/ Sum, The Unit Impulse, The Representation of Signals in Terms of Impulses, The Unit Impulse Response, Representation of LTI Systems, Properties of LTI Systems.

Module 2: *CONTINUOUS AND DISCRETE-TIME FOURIER SERIES AND FOURIER TRANSFORM*
The Response of LTI Systems to Complex Exponentials, Fourier Series Representation, Linear Combinations of Harmonically Related Complex Exponentials, Determination of the Fourier Series Representation, Convergence of the Fourier Series, Properties, Parseval's Relation. Representation of Aperiodic Signals: Fourier Transform, Convergence of Fourier Transforms, Properties.

Module 3: *SAMPLING*
Introduction, Representation of a Continuous-Time Signal by Its Samples: The Sampling Theorem, Impulse-Train Sampling, Reconstruction of a Signal from Its Samples Using Interpolation, The Effect of Undersampling: Aliasing, Discrete-Time Processing of Continuous-Time Signals, Sampling of Discrete-Time Signals, Impulse-Train Sampling, Discrete-Time Decimation, and Interpolation. Analog-to-Digital and Digital-to-Analog Conversion Sampling theorem and Nyquist rate Quantization and quantization noise Pulse Code Modulation (PCM) and Delta Modulation (DM) Digital-to-Analog Conversion (DAC) techniques Analog-to-Digital Conversion (ADC) techniques

Module 4: Introduction to Communication Systems
Overview of communication systems Analog and digital communication Communication channels and noise Modulation techniques (AM, FM, PM) Demodulation techniques. Analog Communication Systems Amplitude Modulation (AM) and its properties Frequency Modulation (FM) and its properties Phase Modulation (PM) and its properties Comparison of AM, FM, and PM Analog communication system design and Modulation index performance. Digital Communication Systems Pulse Amplitude Modulation (PAM) and its properties Pulse Code Modulation (PCM) and its properties Digital Modulation techniques (PSK, QPSK, FSK, QAM) Error detection and correction techniques (parity, CRC, Hamming code) Digital communication system design and performance

Module 5: Channel Coding and Error Control Channel capacity and information theory Shannon's theorem and channel coding theorem Block codes, convolutional codes, and turbo codes Error control techniques (ARQ, FEC, interleaving) Performance analysis of channel coding and error control schemes Unit 6: Noise and Interference in Communication Types of noise in communication systems Signal-to-Noise Ratio (SNR) and Bit Error Rate

(BER) Effect of noise on communication system performance Interference and its impact on communication systems Techniques for noise and interference mitigation.

Text Books:

1. A.V. Oppenheim, A.S. Wilsky and H. Nawab S, “Signals & Systems”, Prentice-Hall, 2005.
2. Lathi, B. P., and R. A. Green. Linear Systems and Signals. 2018.
3. "Modern Digital and Analog Communication Systems" by B.P. Lathi and Zhi Ding
4. Ashok Ambardar, “Introduction to Analog and Digital Signal Processing”, PWS Publishing Newyork, 2002.

Reference Books:

1. S. Haykin and Barry Van Veen, “Signals & Systems”, John Wiley and Sons Inc., New Delhi, 2008.
2. "Principles of Communication Systems" by Herbert Taub, Donald L. Schilling, and Goutam Saha
3. "Digital Communications: Fundamentals and Applications" by Bernard Sklar
4. "Communication Systems Engineering" by John G. Proakis and Masoud Salehi
5. "Introduction to Digital Communications" by Michael B. Pursley

Course Code	-	Course Title	Deep Learning Techniques
Category	-	Credit Assigned:	L: 2, T: 0, P: 2, C: 3
Prerequisite(if Any)	-	Type of Course	MS Applied AI and Communications

Course Outcomes:

On successful completion of the course, students shall be able to:

1. You will be proficient in Basic concepts of artificial intelligence
2. Have an Understanding of neural networks, perceptrons, MLN and their applications
3. Gain Knowledge of deep neural networks and their implementations.

Course Content:

Module 1:

Neural network working, Backpropagation and Gradient Descent algorithms. Introduction to deep neural network, Role of vectorization in various operations in deep learning. Comparisons of shallow and deeper networks.

Module 2:
Hyperparameter and its tuning in converging deep networks. Gradient descent optimization algorithms and its importance such as Adam's algorithm and RMSProp. Introduction and importance of domain knowledge in deep learning.

Module 3:
Convolutional neural networks, its architecture, deep CNN, parameter sharing, and applications.
Recurrent neural networks and its architectural variants such as LSTM, GRU. Architectural aspects and applications. Hybridization of deep models.

Module 4:
Popular and State-of-the-art Models- Working of RBM and Implementation, AlexNet, VGG16, Inception, Xception etc., Auto-encoders (AE), Variational AE, Generative Adversarial Networks

Module 5:
Applications of deep learning models to computer vision, natural language processing, and wind estimation. Research direction in deep learning.

Text Books:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press, 2016.

Reference Books:

1. Dive into Deep Learning, Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola
2. François Chollet, Deep Learning with Python, Manning Publications, 2017.
3. N. CRISTIANINI, J. S-TAYLOR (2000), An Introduction to Support Vector Machines and Other Kernel- based Learning Methods, Cambridge University Press, 1st Edition.
4. B. SCHOLKOPF, A. J. SMOLA (2001), Learning with Kernels: Support Vector Machines, Regularization, Optimization, and Beyond, The MIT Press, 2001, 1st Edition.

Course Code	-	Course Title	Data Visualization			
Category	-	Credit Assigned:	L	T	P	C

			2 | 0 | 2 | 3
Prerequisite(if Any)	-	Type of Course	MS Applied AI and Communications

Course Outcomes:

On successful completion of the course, students shall be able to:

1. Build insights from data using visual representations
2. Implement analytical solutions using Visualization tools.

Course Content:

Module 1 : Introduction to Data Visualization

What is Data Visualization? How to capitalize visual insights? Nomenclature in Data Visualization

Module 2 : Data Analytics using Visual Representation

Making the best out of data points, Constraints for Plots, How to create meaningful insights from visual representations

Module 3 : Visualization tool Basics

Introduction to PowerBI, Use cases and BI Tools, Data Warehousing, workflows and reports, Data Extraction, SaaS Connectors, Working with Databases and Programming languages, Power Query Editor, Advance Editor, Query Dependency Editor, Data Transformations, Shaping and Combining Data, M Query and Hierarchies

Module 4 : DAX

Data Modeling and DAX, Time Intelligence Functions, DAX Advanced Features

Module 5 : Data Visualization with Analytics

Slicers, filters, Drill Down Reports, Query, Q & A and Data Insights, Settings, Administration and Direct Connectivity, Embedded API and Mobile

Text Books:

1. Tufte,E., (2001), The Visual Display of Quantitative Information, 2nd Edition, Graphics Press
2. Tufte,E., (1990), Envisioning Information, Graphics Press

Reference Books:

1. Microsoft Power BI Quick Start Guide: Build dashboards and visualizations to make your data come to life

<table>
<tr><td>Course Code</td><td>-</td><td>Course Title</td><td colspan="4">Data Transformation</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">-</td><td rowspan="2">Credit Assigned:</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td>Prerequisite(if Any)</td><td>-</td><td>Type of Course</td><td colspan="4">MS Applied AI and Communications</td></tr>
<tr><td colspan="7">Course Outcomes:
On successful completion of the course, students shall be able to:
1. You will have an Understanding and knowledge of Database Management System and various characteristics of DBMS
2. Understanding of Relational Models and Structured Query Language
3. Writing sql queries for data transformation</td></tr>
<tr><td colspan="7">Course Content:
Module 1 : Introduction to Querying Language and RDBMS
Introduction to Structured Query Language, Various types of databases, Distinction between client server and file server databases, Understanding SQL Server Management Studio, SQL Table basics, Data types and functions, Transaction-SQL, Authentication for Windows, Data control language, Identification of the keywords in SQL

Module 2 : Database normalization and entity-relationship model
Entity-Relationship Model, Entity and Entity Set, Attributes and types of Attributes, Relationship Sets, Degree of Relationship, Mapping Cardinalities, One-to-One, One-to-Many, Many-to-one, Many-to- many, Symbols used in E-R Notation, Normalization and functional Dependencies: 1NF, 2NF, 3NF, Boyce Codd NF, 4NF and 5NF

Module 3 : Operators for Querying Databases
Introduction to relational databases, Fundamental concepts of relational rows, tables, and columns, Several operators (such as logical and relational), constraints, domains, indexes, stored procedures, primary, foreign and unique keys, Understanding group functions</td></tr>
</table>

Module 4 : Querying Databases using Join, tables, and variables
Advanced concepts of SQL tables, SQL functions, Operators & queries, Table creation, Data retrieval from tables, Combining rows from tables using inner, outer, cross, and self joins, Deploying operators such as intersect, except, union, Temporary table creation, Set operator rules, Table Variables, Understanding SQL functions, Scalar functions, Aggregate functions, Functions that can be used on different datasets, such as numbers, characters, strings, and dates, Inline SQL functions, General functions, Duplicate Functions, Understanding SQL subqueries and their rules, Statements and operators with which subqueries can be used, Using the set clause to modify subqueries, Understanding different types of subqueries, such as where, select, insert, update, delete, etc., Methods to create and view subqueries

Module 5 : Advanced Queries for Large Databases
Learning SQL views, Methods of creating, using, altering, renaming, dropping, and modifying views, Understanding stored procedures and their key benefits, Working with stored procedures, Studying user-defined functions, Error handling, User-defined functions and rank, Types of UDFs such as scalar, Inline table value, Multi-statement table, Stored procedures, Triggers, Records grouping, searching, sorting, modifying data, Clustered indexes creation, Use of indexes to cover queries, Common table expressions, Index guidelines, Python as front end, Large datasets, Querying using No-SQL

Text Books:

1. Fundamentals of Database Systems by R. Elmasri and S. B. Navathe
2. Database Systems Design, Implementation, & Management by Carlos Coronel Steven Morris
3. Database Management Systems by Raghu Ramakrishnan, Johannes Gehrke
4. An Introduction to Database Systems By C. J. Date

Reference Books:

1. "Database Systems : A Practical Approach to Design, Implementation and Management" by CONNOLLY

Course Code	-	Course Title	Personality Development & Communication Skills			
Category	-	Credit Assigned:	L	T	P	C
			2	0	2	3

Prerequisite(if Any)	-	Type of Course	MS Applied AI and Communications

Course Content:

Module 1 : Personal Skills

Self-Assessment; Identifying Strength & Limitations, Habits, Will-Power and Drives, Developing Self-Esteem and Building Self-Confidence, Significance of Self-Discipline, Understanding Perceptions, Attitudes, and Personality Types Mind-Set: Growth and Fixed; Values and Beliefs, Motivation and Achieving Excellence; Self-Actualisation Need, Goal Setting, Life and Career Planning; Constructive Thinking

Module 2: Conflict Resolution Skills

Interpersonal Conflicts, Types Of Conflicts: Becoming A Conflict Resolution Expert, Types Of Stress: Self-Awareness About Stress, Regulating Stress: Making The Best Out Of Stress

Module 3 : Habits Guiding Principles

Habits: Identifying Good And Bad Habits , Habits: Habit Cycle, Breaking Bad Habits, Using The Zeigarnik Effect For Productivity And Personal Growth, Forming Habits Of Success

Module 4 : Professional skills

Organizational skills- teamwork- business and technical correspondence- job oriented skills-professional etiquettes.

Module 5 : Management Skills

Managing Time and Beating Procrastination, Managing People: Leading and Working with Team (Coordination and Cooperation); Developing Accountability, Commitment and Responsibility; Behaving Conscientiously, Managing Stress and Maintaining Positive Outlook, Managing Health, Boosting Memory, Enhancing Study Skills, Managing Money and Love; Balancing Personal and Professional Life

Text Books:

1. Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.

Reference Books:

1. Klaus, Peggy, Jane Rohman & Molly Hamaker. The Hard Truth about Soft Skills. London: HarperCollins E-books, 2007.
2. Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.
3. Stein, Steven J. & Howard E. Book. The EQ Edge: Emotional Intelligence and Your Success. Canada: Wiley & Sons, 2006.

Electives

<table>
<tr><td>Course Code</td><td>-</td><td>Course Title</td><td colspan="4">Natural Language Processing</td></tr>
<tr><td rowspan="3">Category</td><td rowspan="3">-</td><td rowspan="3">Credit Assigned:</td><td colspan="4"></td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td>Prerequisite(if Any)</td><td>-</td><td>Type of Course</td><td colspan="4">MS Applied AI and Communications</td></tr>
<tr><td colspan="7">Course Outcomes:
On successful completion of the course, students shall be able to:
1. Formulate natural language understanding tasks
2. Design and implement basic applications of Natural Language Understanding</td></tr>
<tr><td colspan="7">Course Content:
Module 1 : Natural Language Understanding
Introduction to natural language understanding, Inception, applications, challenges and best practices
Module 2 : Text Mining, Cleaning, and Pre-processing
Various Tokenizers, Tokenization, Frequency Distribution, Stemming, POS Tagging, Lemmatization, Bigrams, Trigrams & Ngrams, Lemmatization, Entity Recognition
Module 3 : Text classification, sentiment analysis
Overview of Machine Learning, Words, Term Frequency, Countvectorizer, Inverse Document Frequency, Text conversion, Confusion Matrix, Naive Bayes Classifier
Module 4 : Sentence Structure, Sequence Tagging, Sequence Tasks, and Language Modeling
Language Modeling, Sequence Tagging, Sequence Tasks, Predicting Sequence of Tags, Syntax Trees, Context-Free Grammars, Chunking, Automatic Paraphrasing of Texts, Chinking
Module 5 : AI Chatbots and Recommendation Engine</td></tr>
</table>

Using the NLP concepts, build a recommendation engine and an AI chatbot assistant using AI
Text Books: 1. Speech and Language Processing, Daniel Jurafsky, James H.Martin, 2. E. BENDER (2013), Linguistic Fundamentals for NLP, Morgan Claypool Publishers.. 3. J. ALLEN (1995), Natural Language Understanding, Pearson Education, 1995. 4. Yoav Goldberg Neural Network Methods for Natural Language Processing, Morgan and Claypool (2017)
Reference Books: 1. Introduction to Natural Language Processing, Jacob Eisenstein

<table>
<tr><td>Course Code</td><td>-</td><td>Course Title</td><td colspan="4">Big Data Analytics</td></tr>
<tr><td rowspan="3">Category</td><td rowspan="3">-</td><td rowspan="3">Credit Assigned:</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td>Prerequisite(if Any)</td><td>-</td><td>Type of Course</td><td colspan="4">MS Applied AI and Communications</td></tr>
<tr><td colspan="7">Course Outcomes:
On successful completion of the course, students shall be able to:
Gain expertise in Big Data Engineering with concepts like big data frameworks, RDDs, and many more.</td></tr>
<tr><td colspan="7">Course Content:
Module 1 : Working with Big Data Tools and technology
Dimensions of Big Data, Different data types, HDFS, MapReduce Brief and Architecture, Working with Apache Spark

Module 2 : Hadoop Framework
Hadoop Framework (Installation single/multi-node), Data format and movement, Map-Reduce for Hadoop Applications

Module 3 : Introduction to Spark</td></tr>
</table>

Introduction to Spark, Spark overcomes the drawbacks of working on MapReduce, Understanding in-memory MapReduce, Interactive operations on MapReduce, Spark stack, fine vs. coarse-grained update, Spark Hadoop YARN, overview of Spark and how it is better than Hadoop, Deploying Spark without Hadoop, Spark history server and Cloudera distribution

Module 4 : Spark Basics and Working with RDDs in Spark
Spark installation guide, Spark configuration, Memory management, Executor memory vs. driver memory, Working with Spark Shell, resilient distributed datasets (RDD), Learning to do functional programming in Spark, architecture of Spark, Spark RDD, Creating RDDs, RDD partitioning, Operations and transformation, Deep dive into Spark RDDs, RDD general operations, Read-only partitioned collection of records, Using the concept of RDD for faster and efficient data processing, RDD action for the collect, count, collects map, save-as-text-files, and pair RDD functions

Module 5 : Advanced Spark and RDD Operations
Aggregating Data with Pair RDDs, Writing and Deploying Spark Applications, Parallel Processing, Spark RDD Persistence, Spark Mllib, Integrating Apache Flume and Apache Kafka, Spark Streaming, Spark SQL and Data Frames

Text Books:

1. Donald Miner and Adam Shook: MapReduce Design Patterns, O'Reilly Media
2. Tom White: Hadoop Definitive Guide, O'Reilly Media
3. Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia: Learning Spark: Lightning-Fast Big Data Analysis

Reference Books:

1. Big Data & Hadoop, V.K. Jain, Khanna Publishing House
2. Big Data Black Book, DT Editorial Services, Wiley India

Course Code	-	Course Title	Deployment of ML Models			
Category	-	Credit Assigned:	L	T	P	C
			2	0	2	3

Prerequisite(if Any)	-	Type of Course	MS Applied AI and Communications

Course Outcomes:

On successful completion of the course, students shall be able to:

1. Design ML Systems to solve practical problems.
2. Know how ML system works in production and insights about challenges
3. Identify systems faults and apply strategies to identify root causes in ML systems.
4. Pick up the right framework and compute infrastructure and trade-off space.
5. Troubleshoot training and ensuring the reproducibility of results.

Course Content:

Module 1 : Introduction to MLOps

What is MLOps, how and why we use MLOps, MLOps challenges, advantages, applications

Module 2 : MLOps Workflow Management

Introduction to MLOps workflow management, Phases in the analysis life cycle, Evaluation, testing

Module 3 : MLOps Data Lifecycle

MLOps Lifecycle, Components of MLOps life cycle, Challenges, Advantages and best practices

Module 4 : Modeling Pipelines for Scale

Model Resource Management Techniques, High-Performance Modeling, Model Analysis, Interpretability

Module 5 : Deploying Machine Learning Models in Production

Introduction to Machine Learning using Cloud, Deploying Machine Learning Models using Cloud Computing

Text Books:

1. “Machine Learning Engineering” by Andriy Burkov, 2020
2. "ML Ops: Operationalizing Data Science" by David Sweenor, Steven Hillion, Dan Rope, Dev Kannabiran, Thomas Hill, Michael O'Connell
3. "Building Machine Learning Powered Applications" by Emmanuel Ameisen
4. "Building Machine Learning Pipelines" by Hannes Hapke, Catherine Nelson, 2020, O’Reilly

Reference Books:

1. "Introducing MLOps" by Mark Treveil, et al. O'Reilly Media, Inc. 2020
2. "Machine Learning for Data Streams with Practical Examples in MOA", Bifet, Albert and Gavald`a,icard and Holmes, Geoff and Pfahringer, Bernhard, MIT Press, 2018

<table>
<tr><td>Course Code</td><td>-</td><td>Course Title</td><td colspan="4">Data Structures</td></tr>
<tr><td>Category</td><td>-</td><td>Credit Assigned:</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td></td><td></td><td></td><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td>Prerequisite(if Any)</td><td>-</td><td>Type of Course</td><td colspan="4">MS Applied AI and Communications</td></tr>
</table>

Course Outcomes:
On successful completion of the course, students shall be able to:

1. Practice advanced algorithms and programming techniques necessary for developing sophisticated computer application programs
2. Get accustomed with various programming constructs such as divide-and-conquer, backtracking, and dynamic programming.
3. Learn new techniques for solving specific problems more efficiently and for analyzing space and time requirements.

Course Content:

Module 1 : Data Structures Basics

Review of order rotation & growth of functions, Recurrences, probability distributions, Complexity analysis of algorithms, Basic data structures such as stacks, queues, linked lists, and applications

Module 2 : Hash Tables and Binary Trees

Direct access tables and hash tables, hash functions and relates analysis, Binary Search trees and Operations, AVL Trees and balancing operations, R B Trees, properties, operations

Module 3 : Advanced Trees Operations

B – Trees – definition – properties, operations, data structures for disjoint sets, Graph algorithms, MST single source all pair shortest paths, BFS, DFS, topological sort, strongly connected components

Module 4 : Advanced Searching And Sorting

Quicksort randomized version, searching in linear time, More graph algorithms – maximal independent sets, coloring vertex cover, Introduction to perfect graphs.

Module 5 : Advanced Algorithms

KMP Algorithm, Johnson's Algorithm, Rabin Karp algorithm, etc.

Text Books:

1. Kruse, Tondo, Leung, Mogalla, Data Structures and Program Design in C, Pearson
2. T. H. Cormen, C. E. Leiserson, R. L. Rivest, Introduction to Algorithms, Prentice hall.
3. E. Horowitz, S. Sahni, S. Rajasekaran, Fundamentals of Computer Algorithms, University Press, Second Edition

Reference Books:

1. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein
2. H. S. Wilf, Algorithms and complexity, Prentice hall.

Course Code	-	Course Title	Next-Gen Communication
Category	-	Credit Assigned:	L: 2, T: 0, P: 2, C: 3
Prerequisite(if Any)	-	Type of Course	MS Applied AI and Communications

Course Outcomes:

On successful completion of the course, students shall be able to:

1. Knowledge: Demonstrate understanding of the latest advancements and trends in next-generation communication technologies, including concepts such as 5G, Internet of Things (IoT), edge computing, and artificial intelligence (AI) in communication systems.
2. Application: Apply knowledge of next-generation communication technologies to design and implement communication systems that leverage 5G, IoT, edge computing, and AI, and analyze their performance in real-world scenarios.

3. Analysis: Analyze the advantages, limitations, and challenges of next-generation communication technologies, including their impact on communication infrastructure, network architecture, security, and privacy, and propose solutions to overcome these challenges.
4. Synthesis: Synthesize knowledge and skills from various areas of next-generation communication, including wireless communication, network architecture, data analytics, and AI, to develop innovative communication solutions for emerging applications and use cases.
5. Evaluation: Evaluate the social, economic, and ethical implications of next-generation communication technologies, including their potential benefits and risks in areas such as healthcare, smart cities, transportation, and industry, and make informed decisions on their adoption and deployment.

Course Content:

Module 1: Introduction to Next-Gen Communication

Overview of next-generation communication systems Evolution of communication technologies Key drivers and challenges in next-gen communication Applications and use cases of next-gen communication Future trends and expectations in next-gen communication

Module 2: 5G and Beyond

Introduction to 5G and its key features 5G architecture and network components 5G radio access technologies (NR, mmWave, Massive MIMO) 5G core network and services (SDN, NFV, network slicing) 5G deployment scenarios and use cases (eMBB, URLLC, mMTC) Emerging technologies for beyond 5G (6G, terahertz communication, quantum communication)

Module 3: Internet of Things (IoT) Communication

Introduction to IoT and its communication requirements IoT communication protocols (LPWAN, Zigbee, LoRaWAN, etc.) IoT communication architectures and network topologies IoT applications and use cases (smart cities, industrial IoT, healthcare, etc.) IoT security and privacy considerations Emerging trends in IoT communication (5G-IoT integration, edge computing, AIoT)

Module 4: Cloud and Fog Computing in Communication

Overview of cloud computing and its impact on communication Cloud-based communication services (VoIP, UCaaS, CCaaS, etc.) Cloud computing architectures and deployment models Fog computing and its role in communication Fog-based communication services and use cases Challenges and opportunities in cloud and fog computing for next-gen communication

Module 5: Artificial Intelligence (AI) in Communication Introduction to AI and its applications in communication Machine learning and deep learning techniques for communication AI-driven communication network management and optimization AI-enabled communication services (speech recognition, natural language processing, etc.) AI for network security, resource allocation, and quality of service (QoS) Ethical, legal,

and social implications of AI in communication

Recommended Books:

Text Books:

1. "5G NR: The Next Generation Wireless Access Technology" by Erik Dahlman, Stefan Parkvall, and Johan Skold
2. "Internet of Things: Principles and Paradigms" by Rajkumar Buyya, Amir Vahid Dastjerdi, and Siddhartha Misra
3. "Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, Ricardo Puttini, and Zaigham Mahmood
4. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig "Quantum Communication, Computing, and Measurement" by Prem Kumar, Gerd Leuchs, and Thomas Scheidler

Reference Books:

Course Code	-	Course Title	Internet of Things and Embedded Systems
Category	-	Credit Assigned:	L: 2, T: 0, P: 2, C: 3
Prerequisite(if Any)	-	Type of Course	MS Applied AI and Communications

Course Outcomes:
On successful completion of the course, students shall be able to:

1. Define and explain various fundamentals of the Internet of Things
2. Learn various fundamentals of embedded C and Micropython programming
3. Examine the evolution of embedded systems, interfacing
4. Learn various wireless and low-energy protocols
5. Create, interface, and develop an application programming frameworrk for cloud connectivity.

Course Content:

Module 1: Getting Started with Fundamentals of Programming using C, Micropython:: Introduction of IoT boards and platforms, Installing IoT integrated development environment. Overview, essentials, and GPIO configurations of IoT platforms. Hands-on IDE, exploring the IoT board GPIOs: Digital Inputs and Outputs, Touch Sensor, Pulse-Width Modulation (PWM), Reading Analog Inputs. Concepts of serial communication, monitoring, plotting, and debugging.

Module 2: Sensor Operation and Interfacing: Interfacing of various sensors like Hall Effect Sensor, Motion Sensor, pressure, temperature, humidity sensor, etc. used in various engineering applications.

Module 3: Interrupts and Timers, Flash Memory, Web Servers: Store Permanent Data (Write and Read), Deep Sleep Mode: Timer, Touch, External Wake Up. Control Outputs: HTML and CSS Basics, Password Protection, Display Sensor Readings, Remote controlling of devices.

Module 4: BLE and Wi-Fi, Cloud-based IoT platform: Bluetooth Low Energy: Introduction, Notify and Scan, Server and Client. Wi-Fi: Access Point, Station modes. Integration of IoT boards with cloud services and their operations.

Module 5: Design and Applications of IoT systems: Design of various industrial, home, medical, agricultural, smart city, automation, wearable, consumer, and transportation applications of IoT.

Text Books:

1. Rui Santos, Learn ESP32 with Arduino IDE, (2nd Edition)
2. Tim Cox, Getting Started with Python for the Internet of Things, Packt

Reference Books:

Course Code	-	Course Title	Communication Networks for IoT

<table>
<tr><td>Category</td><td>-</td><td>Credit Assigned:</td><td><table><tr><td>L</td><td>T</td><td>P</td><td>C</td></tr><tr><td>2</td><td>0</td><td>2</td><td>3</td></tr></table></td></tr>
<tr><td>Prerequisite(if Any)</td><td>-</td><td>Type of Course</td><td>MS Applied AI and Communications</td></tr>
<tr><td colspan="4">Course Outcomes:
On successful completion of the course, students shall be able to:

1. Distinguish between various network topologies and types of switching
2. Examine various medium access protocols and network hardware components
3. Differentiate various types of networking devices
4. Know the fundamental concepts of IP and routing protocols
5. Integrate and create the building blocks of XoIP</td></tr>
<tr><td colspan="4">Course Content:

Module 1: Basics of Network and its types: Topologies, Evolution of Networks and Ethernet, Introduction to packet-switched networks, Internet, and LANs. Servers, Clients, Ports and Protocols.

Module 2: The TCP/IP, UDP model: Bits, Frames, Packets, Segments, HTTP captures, Port Numbers

Module 3: Fundamentals of IP addressing: Characteristics and IPv4 Address Format, Classless/ Classful addressing, subnetting, CIDR notations

Module 4: Networking Devices and data flow, IP Routing: Repeaters, Hubs, Switches and Routers, Firewalls, IDS, IPS and WLC. Routing and Forwarding, General Routing Protocols, Routing for Adhoc Wireless Network, Static, Dynamic, DHCP

Module 5: XoIP protocols: signaling protocols H.323 protocols, Session Initiation Protocol (SIP). Media Transport protocols, RTP, RTCP, RTSP, QoS. Addressing, Routing, Troubleshooting</td></tr>
<tr><td colspan="4">Text Books:
1. Behrouz A. Forouzan, Data Communications and Networking, (5th Edition), McGraw Hill</td></tr>
<tr><td colspan="4">Reference Books:</td></tr>
</table>

<table>
<tr><td>Course Code</td><td>-</td><td>Course Title</td><td colspan="4">AI in Health Care</td></tr>
<tr><td>Category</td><td>-</td><td>Credit Assigned:</td><td colspan="4"><table><tr><td>L</td><td>T</td><td>P</td><td>C</td></tr><tr><td>2</td><td>0</td><td>2</td><td>3</td></tr></table></td></tr>
<tr><td>Prerequisite(if Any)</td><td>-</td><td>Type of Course</td><td colspan="4">MS Applied AI and Communications</td></tr>
<tr><td colspan="6">Course Outcomes:
On successful completion of the course, students shall be able to:

1. Knowledge: Demonstrate understanding of the fundamental concepts of artificial intelligence (AI) and its applications in health care, including machine learning algorithms, natural language processing, computer vision, and data analytics in medical settings.
2. Application: Apply AI techniques to analyze and interpret medical data, such as electronic health records (EHRs), medical images, and genomics data, for tasks such as disease diagnosis, treatment planning, and personalized medicine.
3. Analysis: Analyze the ethical, legal, and social implications of using AI in health care, including issues related to patient privacy, bias in AI algorithms, data security, and regulatory compliance, and propose solutions to mitigate these concerns.
4. Synthesis: Synthesize knowledge and skills from various areas of AI, health care, and data science to design and develop innovative AI-based solutions for health care problems, such as predictive analytics, decision support systems, and telemedicine applications.
5. Evaluation: Evaluate the effectiveness and efficiency of AI-based health care solutions, including their impact on patient outcomes, health care costs, and clinical workflows, and critically assess the benefits, risks, and limitations of using AI in different health care settings.</td></tr>
<tr><td colspan="6">Course Content:

Module 1: Introduction to AI in Health Care Overview of health care industry and its challenges Introduction to artificial intelligence (AI) and machine learning (ML) in health care Ethical, legal, and social implications of AI in health care Use cases and applications of AI in health care, such as diagnostics, personalized medicine, telemedicine, etc. Current state and future prospects of AI in health care

Module 2: Data Science and Analytics in Health Care Basics of health care data and its characteristics (structured,</td></tr>
</table>

unstructured, big data, etc.) Data collection, preprocessing, and management in health care Statistical analysis and visualization of health care data Machine learning techniques for health care data analysis, such as classification, regression, clustering, etc. Feature selection and feature engineering for health care data Evaluation and validation of AI models in health care

Module 3: Applications of AI in Health Care Medical image analysis using AI, including computer-aided diagnosis (CAD), radiomics, etc. Natural language processing (NLP) for health care, including clinical documentation, electronic health records (EHRs), etc. Predictive modeling and risk stratification for diseases and conditions Personalized medicine and treatment recommendation using AI Health care monitoring and wearables, including remote patient monitoring (RPM), Internet of Things (IoT) devices, etc. AI-powered decision support systems for health care providers

Module 4: Ethics, Privacy, and Regulatory Considerations in AI Health Care Ethical considerations in AI in health care, including fairness, bias, interpretability, etc. Privacy and security challenges in health care data and AI models Regulatory frameworks and compliance requirements in AI health care, including HIPAA, GDPR, etc. Legal and ethical issues in AI-driven decision making and patient care Responsible AI practices and guidelines in health care

Module 5: Future Trends and Challenges in AI Health Care Emerging trends in AI health care, such as precision medicine, digital therapeutics, etc. Challenges and limitations of AI in health care, including data quality, interoperability, clinical adoption, etc. Future prospects and impact of AI on health care delivery, outcomes, and patient experience Opportunities for innovation and entrepreneurship in AI health care Case studies and real-world examples of successful AI implementations in health care

Text Books:

1. "Artificial Intelligence in Health Care: Anticipating Challenges, Ethics, and Governance" by A. K. Aggarwal, A. Samuels, and D. V. Samuels
2. "Machine Learning for Healthcare: Techniques, Tools, and Applications" edited by Kelleher, Mac Namee, and D'Arcy
3. "AI in Healthcare: Building a Safer, Smarter, and Healthier Future" by Dr. Anthony Chang

Reference Books:

1. "Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again" by Eric Topol
2. "Artificial Intelligence for Humans: Fundamental Algorithms" by Jeff Heaton

Course Code	-	Course Title	Applied Signal Processing

<table>
<tr><td>Category</td><td>-</td><td>Credit Assigned:</td><td><table><tr><td>L</td><td>T</td><td>P</td><td>C</td></tr><tr><td>2</td><td>0</td><td>2</td><td>3</td></tr></table></td></tr>
<tr><td>Prerequisite(if Any)</td><td>-</td><td>Type of Course</td><td colspan="2">MS Applied AI and Communications</td></tr>
<tr><td colspan="5">Course Outcomes:
On successful completion of the course, students shall be able to:

1. Knowledge: Demonstrate understanding of the fundamental concepts and techniques of signal processing, including signal representation, filtering, modulation, and spectral analysis, and their applications in various fields such as telecommunications, audio processing, and image processing.
2. Application: Apply signal processing techniques to analyze, manipulate, and enhance signals in real-world applications, such as audio and image processing, wireless communication, radar systems, and biomedical signal processing, using appropriate software tools and programming languages.
3. Analysis: Analyze the performance and limitations of signal processing techniques, including their accuracy, robustness, and computational complexity, and identify potential issues and challenges in practical signal processing applications, such as noise, interference, and signal degradation.
4. Synthesis: Synthesize knowledge and skills from various areas of signal processing, mathematics, and engineering to design and implement signal processing systems or algorithms for specific applications, such as audio and image compression, channel equalization, and feature extraction.
5. Evaluation: Evaluate the effectiveness of signal processing techniques in solving real-world problems, such as improving signal quality, enhancing signal features, and extracting information from noisy or corrupted signals, and critically assess the performance and limitations of different signal processing approaches in specific application domains.</td></tr>
<tr><td colspan="5">Course Content:

Module 1: Introduction to Signal Processing Basics of signals and systems Time-domain and frequency-domain analysis of signals Signal representation and manipulation Signal classification and properties Signal processing tools and techniques

Module 2: Signal Analysis and Filtering Signal sampling and quantization Fourier analysis and frequency domain representation Filtering techniques (linear and nonlinear) Signal modeling and prediction Signal denoising and restoration

Module 3: Time-Frequency Analysis and Wavelet Transform Short-time Fourier transform (STFT) Spectrogram and time-frequency representation Wavelet transform and multi-resolution analysis Discrete wavelet transform</td></tr>
</table>

(DWT) and its applications Wavelet denoising and feature extraction

Module 4: Signal Processing for Communications Modulation and demodulation techniques Digital signal processing for communication systems Channel coding and error correction Equalization and synchronization Multiple access techniques (FDMA, TDMA, CDMA) Wireless communication and signal processing

Module 5: Advanced Topics in Applied Signal Processing Adaptive signal processing techniques Signal processing for audio and speech applications Signal processing for image and video applications Signal processing for biomedical applications Signal processing for sensor networks and IoT Emerging trends in applied signal processing (machine learning, deep learning, etc.)

Text Books:

1. "Digital Signal Processing: Principles, Algorithms, and Applications" by John G. Proakis and Dimitris G. Manolakis
2. "Wavelet Transform and Its Applications" by Sudhakar Radhakrishnan and B. S. Manjunath
3. "Signal Processing for Communications" by Paolo Prandoni and Martin Vetterli

Reference Books:

4. "Adaptive Filter Theory" by Simon Haykin
5. "Applied Signal Processing: A MATLAB™-Based Proof of Concept" by Kung Yao and Saied M. Amiri

<table>
<tr><td>Course Code</td><td>-</td><td>Course Title</td><td colspan="4">Computer Vision</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">-</td><td rowspan="2">Credit Assigned:</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td>Prerequisite(if Any)</td><td>-</td><td>Type of Course</td><td colspan="4">MS Applied AI and Communications</td></tr>
<tr><td colspan="7">Course Outcomes:
On successful completion of the course, students shall be able to:</td></tr>
</table>

Course Content:

Module 1: Introduction to Computer Vision Basics of computer vision and its applications Image acquisition and representation Image processing techniques (filtering, thresholding, etc.) Feature extraction and feature descriptors Image segmentation and object detection

Module 2: Image Features and Descriptors Image feature detection and extraction (Harris, SIFT, SURF, etc.) Feature descriptors (BRIEF, ORB, etc.) Feature matching techniques (nearest neighbor, RANSAC, etc.) Feature-based image alignment and registration Image stitching and panoramic image creation Image-based localization and tracking

Module 3: Image Recognition and Object Detection Object recognition techniques (template matching, HOG, etc.) Local feature-based object detection (R-CNN, Fast R-CNN, etc.) Single shot object detection (YOLO, SSD, etc.) Deep learning-based object detection (Faster R-CNN, RetinaNet, etc.) Object tracking and multi-object tracking Scene understanding and semantic segmentation

Module 4: 3D Computer Vision 3D point clouds and depth maps Depth sensing and depth cameras 3D reconstruction from multiple views Structure from motion (SFM) and visual SLAM Dense 3D reconstruction and 3D modeling Augmented reality and virtual reality

Module 5: Advanced Topics in Computer Vision Deep learning for computer vision (CNNs, RNNs, etc.) Domain adaptation and transfer learning in computer vision Image synthesis and style transfer Video analysis and understanding Human action recognition and pose estimation Emerging trends in computer vision (attention mechanisms, explainable AI, etc.)

Text Books:

1. "Computer Vision: Algorithms and Applications" by Richard Szeliski
2. "Programming Computer Vision with Python" by Jan Erik Solem
3. "Deep Learning for Computer Vision with Python" by Adrian Rosebrock
4. "Computer Vision: Models, Learning, and Inference" by Simon J. D. Prince

Reference Books:

5. "Multiple View Geometry in Computer Vision" by Richard Hartley and Andrew Zisserman