SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE
(AUTONOMOUS)
(Affiliated to JNTUK, Kakinada), (Recognized by AICTE, New Delhi)
UG Programmes CE,CSE,ECE,EEE,IT & ME are Accredited by NBA
CHINNA AMIRAM (P.O):: BHIMAVARAM :: W.G.Dt., A.P., INDIA :: PIN: 534 204
Estd:1980

LIST OF OPEN ELECTIVES
OFFERED BY VARIOUS DEPARTMENTS TO OTHER DEPARTMENTS
IN
III YEAR I SEMESTER

Offered by	Course Code	Course Name	Offered to
ARTIFICIAL INTELLIGENCE & DATA SCIENCE	B20ADOE01	R Programming	**CE, ECE, EEE & ME**
	B20ADOE02	Foundation of Data Science	
CIVIL ENGINEERING	B20CEOE01	Remote Sensing and GIS	**AIDS, CSE, CSBS, ECE, EEE, IT & ME**
	B20CEOE02	Disaster Management	
COMPUTER SCIENCE & BUSINESS SYSTEM	B20CBOE01	Python Programming	**CE**
	B20CBOE02	Database Management Systems	**CE, ECE EEE & ME**
COMPUTER SCIENCE & ENGINEERING	B20CSOE01	Data Structures	**CE, ECE EEE & ME**
	B20CSOE02	Java Programming	
	B20CSOE03	Web Technologies	
ELECTRONICS & COMMUNICATION ENGINEERING	B20ECOE01	Basic Electronics	**CE & CSE**
	B20ECOE02	Signals & Systems	**AIDS, CE, CSE, CSBS, IT & ME**
ELECTRICAL & ELECTRONICS ENGINEERING	B20EEOE01	Elements of Electrical Engineering	**CE & CSE**
	B20EEOE02	MATLAB Programming for Engineering Applications	**AIDS, CE, CSE, CSBS, IT & ME**
INFORMATION TECHNOLOGY	B20ITOE01	Data Structures & Algorithms	**CE, ECE, EEE & ME**
	B20ITOE02	Java Programming	
MECHNAICAL ENGINEERING	B20MEOE01	Operations Research	**AIDS, CE, CSE, ECE. EEE & IT**
	B20MEOE02	Mechatronics	**AIDS, CE, CSBS, CSE, ECE. EEE & IT**
	B20MEOE03	Essentials of Mechanical Engineering	
ENGINEERING MATHEMATICS & HUMANITIES	B20BSOE01	Mathematics for Machine Learning	**AIDS, CE, CSE, CSBS, ECE. EEE, IT & ME**

Subject Code	Category	L	T	P	C	I.M	E.M	Exam
B20ADOE01	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

R PROGRAMMING

(Offered by AIDS)

(Offered to CE, ECE, EEE & ME)

Course Objectives: Students are expected to

1	Use R for statistical programming, computation, graphics, and modelling
2	Write functions and use R in an efficient way
3	Fit some basic types of statistical models
4	Use R in their own research
5	Expand their knowledge of R on their own

Course Outcomes: By the end of the course, the students will be able to:

S.No	Outcome	Knowledge Level
1	Demonstration and implement of basic R programming framework and data structures	K2
2	Explain critical R programming language concepts such as control structures and recursion	K3
3	Applying mathematical and statistical operations data structures in R	K3
4	Examine data-sets to create testable hypotheses and identify appropriate statistical tests	K3
5	Make use of appropriate statistical tests using R and Create and edit visualizations with regression models	K4
6	Define model choices and results	K2

SYLLABUS

UNIT-I (10 Hrs)	Introduction, How to run R, R Sessions and Functions, Basic Math, Variables, Data Types, Vectors, Conclusion, Advanced Data Structures, Data Frames, Lists, Matrices, Arrays, Classes.
UNIT-II (10 Hrs)	R Programming Structures, Control Statements, Loops, - Looping Over Nonvector Sets, - If-Else, Arithmetic and Boolean Operators and values, Default Values for Argument, Return Values, Deciding Whether to explicitly call return- Returning Complex Objects, Functions are Objective, No Pointers in R, Recursion, A Quicksort Implementation-Extended Extended Example: A Binary Search Tree.

UNIT-III (10 Hrs)	Doing Math and Simulation in R, Math Function, Extended Example Calculating Probability- Cumulative Sums and Products-Minima and Maxima- Calculus, Functions Fir Statistical Distribution, Sorting, Linear Algebra Operation on Vectors and Matrices, Extended Example: Vector cross Product- Extended Example: Finding Stationary Distribution of Markov Chains, Set Operation, Input /out put, Accessing the Keyboard and Monitor, Reading and writer Files.
UNIT-IV (10 Hrs)	Graphics, Creating Graphs, The Workhorse of R Base Graphics, the plot() Function –Customizing Graphs, Saving Graphs to Files.
UNIT-V (8 Hrs)	Probability Distributions, Normal Distribution- Binomial Distribution- Poisson Distributions Other Distribution, Basic Statistics, Correlation and Covariance, T-Tests,- ANOVA. Linear Models, Simple Linear Regression, -Multiple Regression Generalized Linear Models, Logistic Regression, - Poisson Regression- other Generalized Linear Models-Survival Analysis, Nonlinear Models, Splines- Decision- Random Forests.
Text Books:	
1.	The Art of R Programming, Norman Matloff, Cengage Learning
2.	R for Everyone, Lander, Pearson
Reference Books:	
1.	Cookbook, Paul Teetor, Oreilly.
2.	R in Action, Rob Kabacoff, Manning
Additional Learning Resources:	
1	https://www.tutorialspoint.com/r/index.htm

SRKR ENGINEERING COLLEGE AUTONOMOUS Estd. 1980

Subject Code	Category	L	T	P	C	I.M	E.M	Exam
B20ADOE02	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

FOUNDATION OF DATA SCIENCE

(Offered by AIDS)

(Offered to CE, ECE, EEE & ME)

Course Objectives: Students are expected to

1	Impart knowledge on basics of data science, data manipulation and exploratory data analysis concepts that is vital for data science.
2	Develop skills for applying tools and techniques to analyze, visualize and interpret data.

Course Outcomes: By the end of the course, the students will be able to

S.No	Outcome	Knowledge Level
1	Demonstrate knowledge on the concepts of data science to perform mathematical computations using efficient storage and data handling methods in NumPy..	K2
2	Apply Data Preparation and Exploration methods using Pandas to perform data manipulation.	K3
3	Create data visualization using charts, plots and histograms to identify trends, patterns and outliers in data using Matplotlib and Seaborn	K3
4	Develop methods to analyze and interpret time series data to extract meaningful statistics.	K3

SYLLABUS

UNIT-I (10 Hrs)	**INTRODUCTION TO DATA SCIENCE** Basic terminologies of data science, Types of data, Five steps of data science, Arrays and vectorized computation using NumPy - The NumPy ndarray: A multidimensional array object, Universal functions: Fast element-wise Array functions, Array-oriented Programming with arrays, File input and output with arrays, Linear algebra, Pseudo random number generation.
UNIT-II (10 Hrs)	**DATA EXPLORATION WITH PANDAS** Process of exploring data, Pandas data structures – Series, Data frame, Index objects; Essential functionality, Summarizing and computing descriptive statistics – Correlation and covariance, Unique values, Value counts and membership; Data loading, Storage, and file formats - Reading and writing data in text format , Binary data formats, Interacting with web APIs, Interacting with databases

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UNIT-III (10 Hrs)	**DATA CLEANING, PREPARATION AND DATA WRANGLING** Handling missing data, Data transformation, String manipulation - String object methods, Regular expressions, Vectorized string functions in Pandas; Data wrangling: join, Combine and reshape - Hierarchical indexing, Combining and merging datasets, Reshaping and pivoting.
UNIT-IV (10 Hrs)	**DATA VISUALIZATION WITH MATPLOTLIB** Plotting and visualization- A brief matplotlib API primer, Plotting with Pandas and Seaborn, Other python visualization tools; Data aggregation and Group operations Group By mechanics, Data aggregation, Apply: General split-apply-combine, Pivot tables and Cross-tabulation.
UNIT-V (8 Hrs)	**TIME SERIES ANALYSIS** Date and time data types and tools, Time series basics, Date ranges, Frequencies, and shifting. Time zone handling, Periods and period arithmetic, Resampling and frequency Conversion – Downsampling, upsampling and interpolation, Resampling with periods; Moving window functions.

Text Books:	
1.	Wes McKinney, Python for Data Analysis, O'Reilly, 2nd Edition, 2017
Reference Books:	
1.	Sinan Ozdemir, Principles of Data Science, Packt Publishers, 2nd Edition, 2018.
2.	Rachel Schutt, Cathy O'Neil,Doing Data Science: Straight Talk from the Frontline, O'Reilly, 2014.
ADDITIONAL LEARNING RESOURCES:	
1	https://swayam.gov.in/nd1_noc19_cs60/preview
2	https://towardsdatascience.com/
3	https://www.w3schools.com/datascience/
4	https://github.com/jakevdp/PythonDataScienceHandbook
5	https://www.kaggle.com

SRKR ENGINEERING COLLEGE AUTONOMOUS

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REMOTE SENSING AND GIS

(Offered by CE)

(Offered to AIDS, CSE, CSBS, ECE, EEE, IT & ME)

Course Objectives: Students are expected to

1	Introduce the fundamentals of remote sensing data acquisition.
2	Familiarize with the structure and function of computer-based Geographic Information Systems.
3	Demonstrate the multidisciplinary nature of Geo informatics applications.

Course Outcomes: By the end of the course, the students will be able to

S.No	Outcome	Knowledge Level
1	Relate the scientific theories to the interaction of electromagnetic spectrum with terrestrial matter.	K2
2	Identify different types of satellites, sensor platforms and choose appropriate remote sensing data products for mapping, monitoring, and management applications.	K2
3	Interpret processed satellite images and outputs for extracting relevant information	K2
4	Structure the concept of a spatial decision support system in its analog and digital forms.	K2
5	Explain the applications of Geo informatics in various fields of human Endeavour	K2

SYLLABUS

UNIT-I (8 Hrs)	**Introduction to Remote Sensing:** Introduction, Basic components of remote sensing, electromagnetic radiation & electromagnetic spectrum and its interaction with atmosphere, energy interaction with the earth surfaces, Sensors: types and characteristics, passive sensor, active sensor, Platforms: air borne remote sensing & space borne remote sensing.
UNIT-II (8Hrs)	**Image Analysis:** Introduction, elements of visual interpretations, Digital Image Processing-Image pre processing, Image rectification, Image enhancement, Image classification: Supervised classification, Unsupervised classification.
UNIT-III (8Hrs)	**Introduction to Geographic Information System(GIS):** Introduction, key components, application areas of GIS, Spatial data models: Raster data models, Vector data models, Raster versus Vector, Data input methods, Map

	projections.
UNIT-IV (8Hrs)	**Spatial Analysis:** 2D: Overlay Analysis – Applications, Network Analysis – Applications – 3D: Digital Elevation Model, Digital Surface Model, Digital Terrain Model– Applications in Area, Volume calculations and scenario planning.
UNIT-V (8Hrs)	**RS and GIS applications:** Land Cover and Land Use, Agriculture, Forestry, Geology, Geomorphology, Urban applications Flood zoning and mapping, Ground water prospects and Potential Recharge Zones, Watershed Management. Environmental Impact Assessment.
Text Books:	
1	Remote Sensing and GIS by Basu deb Bhatta, Oxford University Press
2	Remote Sensing and Geographical Information Systems by M. Anji Reddy, BS Publications
Reference Books:	
1	Principles of Geographical Information Systems by Peter A Burrough and Rachel A. Mc. Donnel, Oxford Publications
2	Remote Sensing and Image Interpretation, Lillesand, T.M, R.W. Kiefer andJ.W. Chipman, 7th Edition (2015), Wiley India Pvt. Ltd., New Delhi

Estd. 1980
SRKR
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DISASTER MANAGEMENT

(Offered by CE)

(Offered to AIDS, CSE, CSBS, ECE, EEE, IT & ME)

Course Objectives: Students are expected to

1	Apprise about disasters, their types and impact on affected communities
2	Familiarize with disaster management paradigms adopted by the government at various levels
3	Emphasize the role of engineering and technology in disaster mitigation and management

Course Outcomes: By the end of the course, the students will be able to

S.No	Outcome	Knowledge Level
1	Differentiate between the types of disasters, their causes and impact on environment and society.	K2
2	Analyze relationship between development and disasters	K2
3	Express the relation between development and disasters	K2
4	Summarize the role of education and community engagement in disaster mitigation	K2
5	Paraphrase the role of engineering and technology in disaster management.	K2

SYLLABUS

UNIT-I (8Hrs)	**Concepts and definitions:** Disaster, disaster Management, hazard, vulnerability, Risk, capacity building, mitigation .Types of Disasters ,five priorities for action, relationship between disaster and human development –Disasters classification; Natural disasters –floods, Drought, earthquake, cyclone, Landslide. Manmade disasters –industrial pollution, nuclear radiation, chemical spills, bioterrorism, transportation accidents. Hazard and vulnerability profile of India.
UNIT-II (8Hrs)	Disaster Impacts: Introduction, Life and live stock loss, Habitation, agricultural and livelihood loss, Additional health hazards, Contamination of drinking water sources, impact on Children, Environmental loss. Impacts of climate change, green house gases.
UNIT-III (8Hrs)	Disaster management cycle-its phases, prevention, mitigation, preparedness, relief & recovery; structural and non-structural measures, basic strategies and practices of disaster risk reduction, global policies and practices, risk management framework, vulnerability and capacity assessment.

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UNIT-IV (8Hrs)	Education and Community Preparedness: Education in disaster risk reduction-Essentials of school disaster education-Community capacity and disaster resilience-Community baseddisasterrecovery-Communitybaseddisastermanagementandsocialcapital-Designing Resilience- building community capacity for action.
UNIT-V (8 Hrs)	Role of Technology in Disaster Management: Disaster management for infrastructures, mitigation program for earthquakes flow chart, geospatial information in agriculture drought assessment-multimedia technology in disaster risk management and training-Transformable indigenous knowledge in disaster reduction.
Textbooks:	
1	Disaster Management–Global Challenges and Local Solutions ’by Rajibshah & RR Krishnamurthy (2009), Universities press.
2	‘Disaster Management–Future Challenges and Opportunities ’by Jagbir Singh (2007), IK International Publishing House Pvt. Ltd.
Reference Books:	
1	‘Disaster Management’ edited by HK Gupta (2003), Universities press.
2	‘Disaster Science &Management’ by Tushar Bhattacharya, Tata McGraw Hill Education Pvt.Ltd., New Delhi.

Estd. 1980
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B20CBOE01	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

PYTHON PROGRAMMING

(Offered by CSBS)

(Offered to CE)

Course Objectives: Students are expected to

1.	Learn about Python syntax, semantics, and the runtime environment.
2.	Learn the use of lists, tuples, dictionaries and sets in Python programs.
3.	Learn the python package building and Python modules for reusability.
4.	Familiarized in general coding techniques and object-oriented programming.
5.	Develop the skills of designing GUI and handling exceptions in python.

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1.	Understand the basic principles of python programming.	K2
2.	Apply the knowledge of python programming to perform operations on data structures.	K3
3.	Solve the coding tasks using functions and modular programming.	K3
4.	Use OOP principles and File concepts to solve different problems.	K3
5.	Handle different exceptions raised in python and apply GUI for providing interface to various problems.	K3

SYLLABUS

UNIT-I (10 Hrs)	**Introduction**: Introduction to Python, Program Development Cycle, Input, Processing, and Output, Displaying Output with the Print Function, Comments, Variables, Reading Input from the Keyboard, Performing Calculations, Operators. Type conversions, Expressions, More about Data Output. **Data Types, and Expression**: Strings Assignment, and Comment, Numeric Data Types and Character Sets, Using functions and Modules. **Decision Structures and Boolean Logic**: if, if-else, if-elif-else Statements, Nested Decision Structures, Comparing Strings, Logical Operators, Boolean Variables. **Repetition Structures**: Introduction, while loop, for loop, Input Validation Loops, Nested Loops.
UNIT-II (10 Hrs)	**Strings and Text Files**: Accessing Character and Substring in Strings, Strings and Number Systems, String Methods Text Files. **Data structures**:

	Lists- creating a list, accessing, slicing and other operations **Tuples**- creating a tuple, accessing and other operations **Dictionaries**- creating a dictionary, accessing keys and values and other operations Sets-creating a set, modifying, removing and other operations
UNIT-III (10 Hrs)	**Design with Function:** Functions as Abstraction Mechanisms, Problem Solving with Top Down Design, Design with Recursive Functions, Case Study Gathering Information from a File System, Managing a Program's Namespace, Higher Order Function. **Modules**: Modules, Standard Modules, Packages.
UNIT-IV (10 Hrs)	**File Operations**: Reading config files in python, Writing log files in python, Understanding read functions, read(), readline() and readlines(), Understanding write functions, write() and writelines(), Manipulating file pointer using seek, Programming using file operations **Object Oriented Programming:** Concept of class, object and instances, Constructor, class attributes and destructors, Inheritance , overlapping and overloading operators, Adding and retrieving dynamic attributes of classes
UNIT-V (10 Hrs)	**Errors and Exceptions**: Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, User-defined Exceptions, Defining Clean-up Actions **Graphical User Interfaces**: The Behaviour of Terminal Based Programs and GUI - Based, Programs, Coding Simple GUI-Based Programs, Other Useful GUI Resources.

SRKR ENGINEERING COLLEGE AUTONOMOUS Estd. 1980

Text Books:	
1.	Fundamentals of Python First Programs, Kenneth. A. Lambert, 2nd Edition, Cenagage learning,2018.
2.	Python Programming: A Modern Approach, Vamsi Kurama, Pearson,2018.
Reference Books:	
1.	Introduction to Python Programming, Gowrishankar.S, Veena A, first edition ,CRC Press,2018.
2.	Introduction to Programming Using Python, Y. Daniel Liang, Pearson,2013.
e-Resources:	
1.	https://www.tutorialspoint.com/python3/python_tutorial.pdf

Code	Category	L	T	P	C	I.M	E.M	Exam
B20CBOE02	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

DATABASE MANAGEMENT SYSTEMS

(Offered by CSBS)

(Offered to CE, ECE EEE & ME)

Course Objectives: Students are expected to

1.	Introduce about database management systems.
2.	Give a good formal foundation on the relational model of data.
3.	Introduce the concepts of basic SQL as a universal Database language.
4.	Demonstrate the principles behind systematic database design approaches by covering conceptual design, logical design through normalization.
5.	Provide an overview of Transaction processing and physical design of a database system, by discussing Database indexing techniques and storage techniques

Course Outcomes: After the completion of the course, student will be able to

S.No	Outcome	Knowledge Level
1.	Understand fundamental concepts and architectures of database systems.	K2
2.	Develop database for an organization using E-R and Relational data models.	K3
3.	Apply knowledge of SQL to Create, Manipulate and Query databases.	K4
4.	Examine anomalies in database design and Apply Normalization concepts to refine the design.	K4
5.	Understand concepts, issues and solutions related to transaction processing and efficient data storage.	K2

SYLLABUS

UNIT-I (6Hrs)	**Introduction**: Database System Characteristics (Database Vs File System), Database Users (Actors on Scene, Workers behind the scene), Advantages of Database Systems, Database Applications, Brief introduction of different Data Models; Concepts of Schema, Instance and Data Independence; Three Tier Schema Architecture for Data Independence; Database System Structure, Centralized and Client- Server Architecture for the Database.
UNIT-II (10 Hrs)	**Entity Relationship Model**: Introduction, Entities, Attributes, Entity Set, Relationship, Relationship Set, Mapping Cardinalities, Key and Participation Constraints, Weak Entity Sets, Specialization and Generalization using ER Diagrams, Aggregation. **Relational Model**: Introduction to Relational Model, Concepts of Domain, Attribute, Tuple, Relation, Importance of Null Values, Constraints (Domain, Key constraints, Integrity Constraints) and their importance.

	BASIC SQL: Simple Database Schema, Data Types, Table Definitions (Create, Alter), Different DML Operations (Insert, Delete, Update), Translating E-R Diagrams to Relations.
UNIT-III (12 Hrs)	**Basic SQL Querying:** (Select and Project) using *where* clause, Arithmetic & Logical operations, SQL Functions (Date and Time, Numeric, String conversion), Set Operations, Nested Queries, Correlated Queries, Grouping, Aggregation, Ordering, Implementation of Different Types of Joins, Views (Updatable and Non-Updatable).
UNIT-IV (10 Hrs)	**Schema Refinement** (Normalization): Purpose of Normalization or Schema Refinement, Concept of Functional Dependency, Normal Forms based on Functional Dependency (1NF, 2NF and 3 NF), Concept of Surrogate Key, Boyce-Codd Normal Form(BCNF), Lossless Join and Dependency Preserving Decomposition, Multi Valued Dependencies and Fourth Normal Form(4NF).
UNIT-V (12 Hrs)	**Transaction Concepts**: Transaction State, Implementation of Atomicity and Durability, Concurrent Executions, Serializability, Recoverability, Implementation of Isolation, Testing for Serializability, Failure Classification, Storage, Recovery and Atomicity, ARIES Recovery algorithm. **Indexing Techniques**: B+ Trees: Search, Insert, Delete algorithms, File Organization and Indexing, Cluster Indexes, Primary and Secondary Indexes, Index data Structures, Hash Based Indexing and Tree based Indexing.

Textbooks:	
1.	Database Management Systems, 3/e, Raghurama Krishnan, Johannes Gehrke, TMH
2.	Database System Conceppts,5/e, Silberschatz, Korth, TMH
Reference Books:	
1.	Introduction to Database Systems, 8/e C J Date, PEA.
2.	Database Management System, 6/e Ramez Elmasri, Shamkant B. Navathe, PEA
3.	Database Principles Fundamentals of Design Implementation and Management, Corlos Coronel, Steven Morris, Peter Robb, Cengage Learning.
e-Resources	
1.	https://nptel.ac.in/courses/106/105/106105175/
2.	https://www.geeksforgeeks.org/introduction-to-nosql/

SRKR ENGINEERING COLLEGE AUTONOMOUS

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B20CSOE01	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

DATA STRUCTURES

(Offered by CSE)

(Offered to CE, ECE EEE & ME)

Course Objectives: Students are expected to

1.	Be familiar with basic techniques of algorithm analysis
2.	Master the implementation of data structures like stacks, queues, linked lists, binary trees, graphs.
3.	Be familiar with basic techniques for algorithm development like recursion.
4.	Be familiar with several sub-quadratic sorting algorithms including quick sort, merge sort and heap sort.
5	Master analyzing problems and writing program solutions to problems using the above techniques.

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1.	Demonstrate the concept of recursion, the way arrays, records, linked structures, stacks, queues, trees, and graphs are represented in memory	K4
2.	Implement stacks, linked lists, queues and trees and apply them to solve different Computer Science problems and Engineering problems.	K3
3.	Compare alternative implementations of data structures with respect to performance.	K3
4.	Apply the principal algorithms for sorting and searching to the given data and analyze the computational efficiency.	K4
5.	Make use of Graphs to solve real life applications.	K3

SYLLABUS

UNIT-I (10 Hrs)	**Basic Concepts, Arrays, Structures:** System Life Cycle, Algorithm Specification, Data Abstraction, Performance Analysis, Space Complexity, Time Complexity, Asymptotic Notation, Comparing Time Complexities. Array as an Abstract Data Type, Polynomial Abstract Data Type, Structures and Unions, Internal Implementation of Structures, Self-Referential Structures **Simple Searching and Sorting Techniques:** Introduction to Searching, Sequential Search, Binary Search, Interpolation Search, Selection Sort, Bubble Sort, Insertion Sort, Shell Sort, Introduction to Merge Sort **Introduction to Recursion**: Towers of Hanoi, Quick Sort, Merge Sort, Complexity Analysis of Basic Sorting and Searching techniques

UNIT-II (10 Hrs)	**Stacks, Queues** Stack Abstract Data Type, Queue Abstract Data Type, Stacks and Queues using arrays, Introduction to Evaluation of Expressions, Evaluating Postfix Expressions, Infix to Postfix and Prefix conversion, Circular Queues using arrays. Pointers, Dynamically Allocated Storage using pointers, Dynamically Linked Stacks and Queues
UNIT-III (10 Hrs)	**Linked Lists:** **Singly Linked Lists**: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list, Radix Sort **Circular Linked** Lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from Circular Linked Lists **Doubly Linked Lists**: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from Doubly Linked Lists **Polynomials:** Representing Polynomials as Singly Linked Lists, Adding Polynomials, Erasing Polynomials
UNIT-IV (08 Hrs)	**Trees:** Representation of Trees, Binary Trees Abstract Data Type, Properties of Binary Trees, Binary Tree Representations, Binary Tree Traversals, Additional Binary Tree Operations, Threaded Binary Trees, Heap Abstract Data Type, Insertion into a max heap, Deletion from a max heap, Heap Sort, Introduction to Binary Search Trees, Searching a Binary Search Tree, Inserting an Element into a Binary Search Tree, Deleting an Element from a Binary Search Tree, Height of a Binary Search Tree.
UNIT-V (12 Hrs)	**Graphs:** Graph Abstract Data Type, Definitions, Graph Representations, Elementary Graph Operations, Depth First Search, Breadth First Search, Connected Components, Spanning Trees, Minimum Cost Spanning Trees, Prim's and Kruskal's Algorithms, Shortest Paths and Transitive Closure, Single Source All Destination - Dijkstra's Algorithm
Text Books:	
1.	Fundamentals of Data Structures in C, 2nd edition, Horowitz, Sahani and Anderson-Freed, Universities Press, 2008.
Reference Books:	
1.	Data Structures using C by Aaron M. Tenenbaum
2.	Data Structures with C by Seymour lipschutz
3.	Data Structures using C by R. KrishnaMoorthy G. IndiraniKumaravel

SRKR ENGINEERING COLLEGE AUTONOMOUS

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B20CSOE02	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

JAVA PROGRAMMING

(Offered by CSE)

(Offered to CE, ECE EEE & ME)

Course Objectives: Students are expected to

1.	To identify Java language components and how they work together in applications
2.	To learn the fundamentals of object-oriented programming in Java, including defining classes, invoking methods, using class libraries.
3.	To learn how to extend Java classes with inheritance and dynamic binding and how to use exception handling in Java applications
4.	To understand how to design applications with threads in Java
5	To understand how to use Java APIs for program development

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1.	Demonstrate the concept of Object Oriented Programming & Java Programming Constructs	K2
2.	describe the basic concepts of Java such as operators, classes, objects, inheritance, packages, Enumeration and various keywords	K2
3.	Apply the concept of exception handling and Input/ Output operations	K3
4.	design the applications of Java & Java applet	K4
5.	Analyze & Design the concept of Event Handling and Abstract Window Toolkit	K4

SYLLABUS

UNIT-I (10 Hrs)	**Program Structure in Java**: Introduction, Writing Simple Java Programs, Elements or Tokens in Java Programs, Java Statements, Command Line Arguments, User Input to Programs, Escape Sequences Comments, Programming Style. **Data Types, Variables, and Operators:** Introduction, Data Types in Java, Declaration of Variables, Data Types, Type Casting, Scope of Variable Identifier, Literal Constants, Symbolic Constants, Formatted Output with printf() Method, Static Variables and Methods, Attribute Final, Introduction to Operators, Precedence and Associativity of Operators, Assignment Operator (=), Basic Arithmetic Operators, Increment (++) and Decrement (--) Operators, Ternary Operator, Relational Operators, Boolean Logical Operators, Bitwise Logical Operators. **Control Statements:** Introduction, if Expression, Nested if Expressions, if–else Expressions, Ternary Operator?:, Switch Statement, Iteration Statements, while Expression, do–while Loop, for Loop, Nested for Loop, For–Each for Loop, Break Statement, Continue Statement.

UNIT-II (10 Hrs)	**Classes and Objects**: Introduction, Class Declaration and Modifiers, Class Members, Declaration of Class Objects, Assigning One Object to Another, Access Control for Class Members, Accessing Private Members of Class, Constructor Methods for Class, Overloaded Constructor Methods, Nested Classes, Final Class and Methods, Passing Arguments by Value and by Reference, Keyword this. **Methods**: Introduction, Defining Methods, Overloaded Methods, Overloaded Constructor Methods, Class Objects as Parameters in Methods, Access Control, Recursive Methods, Nesting of Methods, Overriding Methods, Attributes Final and Static.
UNIT-III (10 Hrs)	**Arrays**: Introduction, Declaration and Initialization of Arrays, Storage of Array in Computer Memory, Accessing Elements of Arrays, Operations on Array Elements, Assigning Array to Another Array, Dynamic Change of Array Size, Sorting of Arrays, Search for Values in Arrays, Class Arrays, Two-dimensional Arrays, Arrays of Varying Lengths, Three-dimensional Arrays, Arrays as Vectors. **Inheritance**: Introduction, Process of Inheritance, Types of Inheritances, Universal Super Class Object Class, Inhibiting Inheritance of Class Using Final, Access Control and Inheritance, Multilevel Inheritance, Application of Keyword Super, Constructor Method and Inheritance, Method Overriding, Dynamic Method Dispatch, Abstract Classes, Interfaces and Inheritance. **Interfaces**: Introduction, Declaration of Interface, Implementation of Interface, Multiple Interfaces, Nested Interfaces, Inheritance of Interfaces, Default Methods in Interfaces, Static Methods in Interface, Functional Interfaces, Annotations.
UNIT-IV (10 Hrs)	**Packages and Java Library**: Introduction, Defining Package, Importing Packages and Classes into Programs, Path and Class Path, Access Control, Packages in Java SE, Java.lang Package and its Classes, Class Object, Enumeration, class Math, Wrapper Classes, Auto-boxing and Autounboxing, Java util Classes and Interfaces, Formatter Class, Random Class, Time Package, Class Instant (java.time.Instant), Formatting for Date/Time in Java, Temporal Adjusters Class, Temporal Adjusters Class. **Exception Handling:** Introduction, Hierarchy of Standard Exception Classes, Keywords throws and throw, try, catch, and finally Blocks, Multiple Catch Clauses, Class Throwable, Unchecked Exceptions, Checked Exceptions, try-with-resources, Catching Subclass Exception, Custom Exceptions, Nested try and catch Blocks, Rethrowing Exception, Throws Clause.
UNIT-V (10 Hrs)	**String Handling in Java**: Introduction, Interface Char Sequence, Class String, Methods for Extracting Characters from Strings, Methods for Comparison of Strings, Methods for Modifying Strings, Methods for Searching Strings, Data Conversion and Miscellaneous Methods, Class String Buffer, Class String Builder. **Multithreaded Programming**: Introduction, Need for Multiple Threads Multithreaded Programming for Multi-core Processor, Thread Class, Main Thread- Creation of New

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	Threads, Thread States, Thread Priority-Synchronization, Deadlock and Race Situations, Inter-thread Communication - Suspending, Resuming, and Stopping of Threads. **Java Database Connectivity**: Introduction, JDBC Architecture, Installing MySQL and MySQL Connector/J, JDBC Environment Setup, Establishing JDBC Database Connections, ResultSet Interface, Creating JDBC Application, JDBC Batch Processing, JDBC Transaction Management
Text Books:	
1.	JAVA one step ahead, Anitha Seth, B.L.Juneja, Oxford.
2.	The complete Reference Java, 8th edition, Herbert Schildt, TMH.
Reference Books:	
1.	Introduction to java programming, 7th edition by Y Daniel Liang, Pearson
2.	Murach's Java Programming, Joel Murach
3.	Theory of Automata, Languages and Computation, Rajendra Kumar, McGraw Hill, 2014
e-Resources:	
1.	https://nptel.ac.in/courses/106/105/106105191/
2.	https://www.w3schools.com/java/java_data_types.asp

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Code	Category	L	T	P	C	I.M	E.M	Exam
B20CSOE03	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

WEB TECHNOLOGIES

(Offered by CSE)

(Offered to CE, ECE EEE & ME)

Course Objectives:

1.	Translate user requirements into the overall architecture and implementation of new systems and Manage Project and coordinate with the Client
2.	Write backend code in PHP language and Writing optimized front end code HTML and JavaScript
3.	Understand, create and debug database related queries and Create test code to validate the applications against client requirement
4.	Monitor the performance of web applications & infrastructure and Troubleshooting web application with a fast and accurate a resolution

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1.	Illustrate the basic concepts of HTML and CSS & apply those concepts to design static web pages	K2
2.	Identify and understand various concepts related to dynamic web pages and validate them using JavaScript	K2
3.	Outline the concepts of Extensible markup language & AJAX	K3
4.	Develop web Applications using Scripting Languages & Frameworks	K4
5.	Create and deploy secure, usable database driven web applications using PHP	K4

SYLLABUS

UNIT-I (10 Hrs)	**HTML**: Basic Syntax, Core Elements, Links and Addressing, Images, Iframe Images, Text, Hyper Text Links, Colors and Background, Lists, Tables and Layouts, Frames, Forms GET and POST methods.
UNIT-II (10 Hrs)	**Dynamic HTML, CSS**: Cascading style sheets, Levels of Style Sheets, Style Specification Formats, Selector Forms. JavaScript - Introduction to JavaScript, Objects, Primitives Operations and Expressions, Control Statements, Arrays, Functions, Pattern Matching using Regular Expressions.

UNIT-III (10 Hrs)	**Working with XML**: Document type Definition (DTD), XML schemas, Document object model, Parsers- DOM and SAX. **AJAX A New Approach**: Introduction to AJAX, Basics of AJAX, XML Http Request Object, Integrating PHP and AJAX.
UNIT-IV (10 Hrs)	**PHP Programming**: Introduction to PHP, Creating PHP script, Running PHP script. Working with variables and constants: Using variables, Using constants, Data types, Operators. **Controlling program flow**: Conditional statements, Control statements, Arrays, functions.
UNIT-V (10 Hrs)	**MYSQL:** Installation, Accessing MYSQL using PHP, Form Handling, Cookies, Session Tracking, Tables, inserting data into Tables, Selecting Data from a Table, Updating Table, Deleting data from Table, Webpage creation.

Text Books:	
1.	Programming the World Wide Web, 7th Edition Robet W Sebesta, Pearson, 2013.
2.	WebTechnologies,1st Edition 7th impression, Uttam K Roy, Oxford, 2012.
3.	Pro Mean Stack Development,1st Edition, ELad Elrom, A press O'Reilly,2016
4.	Java Script & jQuery the missing manual, 2nd Edition, David sawyer mcfarland, O'Reilly, 2011.
5.	Web Hosting for Dummies, 1st Edition, Peter Pollock, John Wiley & Sons, 2013.
6.	RESTful web services, 1st Edition, Leonard Richardson, Ruby, O'Reilly, 2007.
Reference Books:	
1.	Ruby on Rails Up and Running, Lightning fast Web development, 1st Edition, Bruce Tate, Curt Hibbs, Oreilly, 2006.
2.	Programming Perl, 4th Edition, Tom Christiansen, Jonathan Orwant, O'Reilly, 2012.
3.	Web Technologies, HTML, JavaScript, PHP, Java, JSP, XML and AJAX, Black book, 1st Edition, Dream Tech, 2009.
4.	An Introduction to Web Design, Programming, 1st Edition, Paul S Wang, Sanda S Katila, Cengage Learning, 2003.

SRM ENGINEERING COLLEGE Estd. 1985

Code	Category	L	T	P	C	I.M	E.M	Exam
B20ECOE01	**OE**	**3**	**-**	**-**	**3**	**30**	**70**	**3 Hrs.**

BASIC ELECTRONICS

(Offered by ECE)

(Offered to CE, & CSE)

Course Objectives:

1	To give exposure on the semiconductor physics of the intrinsic and extrinsic semiconductors and basics of various diodes.
2	To give exposure on various passive components, circuit theorems and common meters.
3	To give exposure on the fundamentals of BJT and IC's.

Course Outcomes: After completion of the course, the student will be able to

S.No	Outcome	Knowledge Level
1	Understand and apply the basic concepts of charge carriers in semiconductors, drift and diffusion current densities.	K3
2	Identify various passive components and understand the concept of KVL and KCL.	K2
3	Understand and apply the structure and operation of various diodes, rectifier circuits.	K3
4	Understand and apply the characteristics of BJT in CE, CB, CC configurations and IC fabrication.	K3
5	Understand and apply the concept of number systems, logic gates and flip flops.	K3

SYLLABUS

UNIT-I (8 Hrs)	**Semiconductor Materials and Properties :** Classification of Materials, Intrinsic and Extrinsic semiconductors, Conduction in semiconductors, Charge mobility, Charge densities, Diffusion current density, Drift current density, Hall effect.
UNIT-II (8 Hrs)	**Passive Components and Basic Meters:** Types of passive components, Types of resistors, Resistor colour code, Capacitors, Concept of charging and discharging, Types of capacitances, Inductors, Mutual inductance, Inductance of two coils, KCL, KVL, Voltmeter, Ammeter, Multimeter, Basics of CRO.

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UNIT-III (10Hrs)	**Fundamentals of Diodes and Special diodes:** Elementary concepts, V-I characteristics and applications of PN junction diode, Varactor diode, Zener diode, LED, Photo diode, Rectifiers: Half Wave and Full Wave with and without Capacitor filters.
UNIT-IV (10 Hrs)	**Fundamentals of Transistors and Integrated Circuits (IC):** Transistor construction, Basic Operation, Input and Output characteristics, Transistor in three configurations and their comparison, Introduction to Integrated Circuits, Classification of ICs and fabrication of Monolithic ICs.
UNIT-V (8 Hrs)	**Introduction to Number Systems and Boolean Algebra.**Number Systems: Binary, Decimal, Octal, HexaDecimal, Logic gates: AND, OR, NOT, XOR, NAND and NOR, Flip Flops - RS Flip Flop, JK Flip Flop, T Flip Flop, D Flip Flop and Latches
Text Books:	
1.	Electronic Devices and Circuits Theory by Robert L. Boylestad & Louis Nashelsky, PHI edition
2.	Electronic Devices and Circuits: An Introduction, Alan Mottershead, PHI Edition.
Reference Books:	
1.	Basic Electronics by **Bernard Grob**, 4th edition, International Student edition, MCGraw Hill publishers.
2.	Electronic Devices and Circuits by **Sanjeev Guptha**, Dhanapat Rai publications
e-Resources:	
1.	https://books.google.co.in/books?id=Qta8v9hJBMAC&printsec=copyright#v=onepage&q&f=false
2.	https://books.google.co.in/books?id=z5nL2x7Z5X4C&printsec=frontcover&source=gbs_ge_summary_r&hl=en#v=onepage&q&f=false

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Code	Category	L	T	P	C	I.M	E.M	Exam
B20ECOE02	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

SIGNALS AND SYSTEMS

(Offered by ECE)

(Offered to AIDS, CE, CSE, CSBS, IT & ME)

Course Objectives: Students are expected

1.	To introduce the fundamental concepts and techniques associated with the understanding of signals and systems.
2.	To familiarize with techniques suitable for analyzing both continuous-time and discrete time LTI systems using transforms.
3.	To familiarize with development of the mathematical skills to solve problems involving convolution, filtering, and sampling.

Course Outcomes: Students will be able to

Sl.no	Outcome	Knowledge Level
1.	Outline the basic concepts of signals and systems.	K2
2.	Analyze the spectral characteristics of Continuous Time and Discrete Time periodic and aperiodic signals using Fourier analysis.	K4
3.	Analyze system properties based on impulse response and Fourier analysis.	K4
4.	Apply Laplace- transforms for analyzing Continuous -time signals and systems.	K3
5.	Apply Z- transforms for analyzing discrete-time signals and systems, and the process of sampling and the effects of under sampling.	K4

SYLLABUS

UNIT-I (10 Hrs)	**Introduction to Continuous –Time and Discrete –Time signals and systems:** Continuous–Time and Discrete–Time signals, Signal Energy and Power, Periodic Signals, Even and odd Signals, Continuous-Time complex Exponential and Sinusoidal Signals, Discrete–Time complex Exponential and Sinusoidal Signals and their Periodicity, The Continuous–Time and Discrete–Time Unit Impulse and Unit step Functions, Continuous–Time and Discrete–Time Systems, Operations on signals, Interconnections of Systems, Basic System Properties, Continuous–Time and Discrete Time LTI Systems: The Graphical interpretation of Convolution Integral and The Convolution Sum, Causal LTI Systems Described by Differential and Difference Equations, Singularity Functions, MATLAB Demos (one or two examples for illustration purpose only)*.

UNIT-II (8 Hrs)	**Fourier Series Representation of Periodic Signals:** Introduction, Fourier Series Representation of continuous time Periodic Signals (Complex Exponential and Trigonometric Fourier Series only), Convergence of the Fourier Series, Properties of continuous time Fourier Series, Fourier Series representation of discrete time periodic signals, Properties of discrete time Fourier Series (Elementary Level on DTFS).
UNIT-III (8 Hrs)	**Continuous and Discrete time Fourier Transform** Introduction, Representation of Aperiodic signals, The continuous time Fourier Transform, The Fourier Transform for periodic signals, Properties of the continuous time Fourier Transform, Systems characterized by linear constant coefficient differential equations, Discrete time Fourier Transform, Properties of the Discrete time Fourier Transform, Systems characterized by linear constant coefficient difference equations (Elementary Level on DTFT). MATLAB Demos(one or two examples for illustration purpose only)*
UNIT-IV (6 Hrs)	**Laplace Transform** Introduction, The Laplace Transform, Region of convergence for Laplace Transforms, The Inverse Laplace Transform, Properties of Laplace Transforms, the initial and Final value theorems, Analysis and characterization of LTI systems using the Laplace Transforms.
UNIT-V (8 Hrs)	**Sampling Theorem and Z-transform**: Introduction to Sampling Theorem, Statement of Sampling Theorem for Low pass and Band pass signals (Theorem Proof for Low Pass signals only), Reconstruction of a signal from its samples using interpolation, Discussion on Oversampling, Critical sampling and Under sampling (aliasing), The Z-Transform (Bilateral and unilateral), The Inverse Z-Transform, Properties of Z-Transform, Initial and Final Value theorems, Some common Z-transform pairs, Analysis and characterization of LTI discrete systems using the Z-Transforms. MATLAB Demos (one or two examples for illustration purpose only)*.
**** Note: No questions are to be set on MATLAB demos***	
Text Books:	
1.	Signals Systems and Communication-B. P. Lathi, BS Publication.
2.	Signals and Systems- Alan V. Oppenheim, Alan S. Willsky and Ian T. Young, PHI, 2ndEdn.
Reference Books:	
1.	Signals and Systems – P.RamakrishnaRao, TMH.
2.	Signals and Systems- A.AnandaKumar,PHI.
E- Resources:	
1.	https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/video-lectures/
2.	https://swayam.gov.in/nd1_noc20_ee06/preview

Code	Category	L	T	P	C	I.M	E.M	Exam
B20EEOE01	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs**

ELEMENTS OF ELECTRICAL ENGINEERING

(Offered by EEE)

(Offered to CE, & CSE)

Course Objectives: Students will learn

1.	About the fundamentals of DC circuits.
2.	About the fundamentals of AC circuits.
3.	About the generation &utilization of electricity
4.	About the power conversion and energy storage of electricity
5.	About the electrical hazards, electrical safety measures and equipment protection devices

Course Outcomes: Students will be able to

Sl.no	Outcome	Knowledge Level
1.	**Apply** concepts of Ohm's Law, Kirchhoff's laws, Mesh analysis, Superposition theorem for solving DC circuits.	K3
2.	**Apply** Phasor representation concept to **analyze** single-phase AC circuits Consisting of series RL - RC - RLC combinations.	K3, K4
3.	**Apply** energy conversion principles to understand operation of generation &utility components	K3
4.	**Apply** basic knowledge to understand operation of rectifier, Inverter, batteries and uninterrupted power supply (UPS)	K3
5.	**Explore**the Electrical safety measures and protection of electrical equipment.	K3

SYLLABUS

UNIT-I (10 Hrs)	**DC CIRCUIT FUNDAMENTALS** Basic electrical quantities: Voltage, Current, Power and Energy, Circuit elements, Kirchhoff's law, DC resistive circuit analysis, Star - Delta and Delta - Star transformation, Voltage and Current division, Mesh analysis, Superposition theorem, Simple problems.
UNIT-II (10 Hrs)	**AC CIRCUIT FUNDAMENTALS** Sinusoidal Voltages, Average & RMS values, Phase angle, Impedance of RLC elements, Phasor representation - real power -Reactive power - apparent power - power factor. Analysis of single-phase ac circuits consisting of RL - RC - RLC series circuits, simple problems.

UNIT-III (10 Hrs)	**ELECTRICAL ENERGY CONVERSION & UTILIZATION** Construction of D.C machine - D.C Generator Working principle – EMF Equation – Types - D.C Motor Working principle - Torque equation – Types - Applications, Illumination - laws of Illumination, fluorescent lamp, LED lamp, Electrical energy consumption in India.
UNIT-IV (10 Hrs)	**POWER CONVERTERS AND STORAGE** Need of power conversion, Rectifier- Single phase full wave diode rectifier with C-filter, rectifier applications, Inverter- Single phase full bridge inverter operation, Inverter Applications, Electricity storage- Batteries, types of batteries, Lead acid battery, Li - ion batteries, Ratings and basic parameters of batteries, Domestic Uninterrupted power supply (UPS) system.
UNIT-V (10 Hrs)	**ELECTRICAL SAFETY AND EQUIPMENT PROTECTION**: Hazards in electrical systems, Different types of hazards, Electric Shock, Electrical safety measures, Earthing, Different methods of earthing. Domestic Protective Devices - Fuses and their ratings, Miniature Circuit Breaker (MCB), Earth Leakage Circuit Breaker (ELCB), Power ratings of different domestic loads - Fans, Lights, Air conditioners, Refrigerators, etc.
Text Books:	
1.	Basic Electrical Engineering- S. K. Sahdev, Pearson Publications, ISBN 978-93-325-4216-7
2.	Dr P.S. Bimbhra, Power Electronics – 4th Edition, Kanna Publisher
Reference Books:	
1.	Iqbal Husain, “Electric and Hybrid Vehicles Design Fundamentals”, CRC Press, Taylor & Francis Group, 2011
2.	Generation Distribution and Utilization of Electrical Energy by C.L Wadhwa.3rd Edition

Code	Category	L	T	P	C	I.M	E.M	Exam
B20EEOE02	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs**

MATLAB PROGRAMMING FOR ENGINEERING APPLICATIONS

(Offered by EEE)

(Offered to AIDS, CE, CSE, CSBS, IT & ME)

Course Objectives: Students will learn

1.	About the MATLAB basics, built-in functions, matrix operations, plotting commands.
2.	Conditional and looping statements to write MATLAB programs.
3.	About the different statistical approaches for better interpretation of data using MATLAB.
4.	About the MATLAB programming to solve engineering systems described by the mathematical equations.
5.	About the MATLAB programming for numerical methods.

Course Outcomes: Students will be able to

Sl.no	Outcome	Knowledge Level
1.	**Use** the built-in functions, matrix operations, plotting commands, arithmetic operations in MATLAB programs.	K3
2.	**Apply** the conditional and looping statements to write MATLAB programs.	K3
3.	**Apply** different statistical approaches for better interpretation of data using MATLAB.	K3
4.	**Apply** MATLAB programming to solve engineering systems described by the mathematical equations.	K3
5.	**Apply** MATLAB programming for numerical methods.	K3

SYLLABUS

UNIT-I (10 Hrs)	**INTRODUCTION TO MATLAB** History, purpose and importance, data types, conversion of data types, operators, built-in functions, creating vectors, matrices, manipulation of vectors and matrices, Matrix Operations, addition, subtraction, multiplication, transpose, Inverse, Determinant, Identity matrix, using simple xy Plotting Functions, line plots, subplots, bar plots, surface plots, pie plots, Saving and loading data.
UNIT-II (10 Hrs)	**MATLAB PROGRAMMING** Program Design and Development, Relational Operators and Logical Variables, Logical Operators, If statement, Else-if statement, Else statement, Switch Statement,For Loops, While Loops, Debugging MATLAB Programs, Simple programming examples.

UNIT-III (10 Hrs)	**STATISTICS, PROBABILITY AND INTERPOLATION** Statistics and Histograms, The Normal Distribution, Mean, Mode, Median and Standard Deviation, Uniformly Distributed Numbers, Normally Distributed Random Numbers, Generating Random Integers, Interpolation, Two-Dimensional Interpolation, curve fitting using least square method.
UNIT-IV (10 Hrs)	**SOLVING EQUATIONS** Linear algebra, Rank, Eigen values, Eigen vectors, Linear algebraic equations solving using matrices (up to three variables), Gauss elimination method, Matrix inverse method, quadratic equation, ordinary differential equation (upto second order), solution of partial differential equation (two variable).
UNIT-V (10 Hrs)	**NUMERICAL METHODS** Gauss Seidel method, Newton Raphson method for solving nonlinear equations, Rungekutta-4 method for solving ordinary differential equations, Trapezoidal method for solving numerical integration.
Text Books:	
1.	MATLAB and Simulink Crash Course for Engineers by Eklas Hossain, Oregon Institute of Technology Klamath Falls, OR, USA, Springer publication, 2022.
2.	Applied Numerical Methods Using MATLAB, by Won Young Yang Chung, Wenwu Cao, Tae-Sang Chung, John Morris, A John Wiley & Sons, Inc., Publication, 2005
Reference Books:	
1.	MATLAB ® for Engineering Applications by William J. Palm III, Fourth edition, New York, NY: McGraw-Hill Education, 2018.
2.	MATLAB Programming for Engineers, Stephen J.Chapman, third edition, Thomson Learning publication, 2005.

Code	Category	L	T	P	C	I.M	E.M	Exam
B20ITOE01	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs**

DATA STRUCTURES & ALGORITHMS

(Offered by IT)

(Offered to CE, ECE, EEE & ME)

Course Objectives:

1.	Introduce the fundamental concept of data structures and abstract data types
2.	Emphasize the importance of data structures in developing and implementing efficient algorithms
3.	Describe how arrays, records, linked structures, stacks, queues, trees, and graphs are represented in memory and used by algorithms

Course Outcomes: By the end of the course, the students will be able to:

S.No	Outcome	Knowledge Level
1.	Illustrate different techniques for searching and sorting for given data.	K2
2.	Identify different parameters to analyze the performance of algorithms and implement linear data structures.	K4
3.	Design algorithms to perform operations with Non-Linear data structures.	K3

SYLLABUS

UNIT-I (10 Hrs)	**Data Structures** - Definition, Classification of Data Structures, Operations on Data Structures, Abstract Data Type (ADT), Preliminaries of algorithms. Time and Space complexity, Asymptotic Notations **Searching** - Linear search, Binary search, Interpolation Search, Fibonacci search. **Sorting**- Insertion sort, Selection sort, Exchange (Bubble sort, quick sort), distribution (radix sort), merging (Merge sort) algorithms.
UNIT-II (10 Hrs)	**Stacks:** Introduction to Stacks, Array Representation of Stacks, Operations on Stacks, Applications-Reversing list, Factorial Calculation, Infix to Postfix Conversion, Evaluating Postfix Expressions. **Queues:** Introduction to Queues, Representation of Queues-using Arrays, Implementation of Queues-using Arrays, Application of Queues-Circular Queues, Dequeues, Priority Queues, Multiple Queues.
UNIT-III (10 Hrs)	**Linked Lists:** Introduction, Single linked list, Representation of Linked list in memory, Operations on Single Linked list-Insertion, Deletion, Search and Traversal, Reversing Single Linked list, Applications on Single Linked list- Implementation of Stack and Queues,

	Polynomial Expression Representation, Addition and Multiplication, Sparse Matrix Representation using Linked List, Advantages and Disadvantages of Single Linked list, Double Linked list-Insertion, Deletion, Circular Linked list-Insertion, Deletion.
UNIT-IV (8 Hrs)	**Trees:** Basic Terminology in Trees, Binary Trees-Properties, Representation of Binary Trees using Arrays and Linked lists. Binary Search Trees- Basic Concepts, BST Operations: Insertion, Deletion, Tree Traversals, Applications-Expression Trees, Heap Sort, Balanced Binary Trees- AVL Trees, Insertion, Deletion and Rotations.
UNIT-V (12 Hrs)	**Graphs:** Basic Concepts, Representations of Graphs-Adjacency Matrix and using Linked list, Graph Traversals (BFT & DFT), Applications- Minimum Spanning Tree Using Prims &Kruskals Algorithm, Dijkstra's shortest path, Transitive closure, Warshall's Algorithm.

Text Books:	
1.	Data Structures Using C. 2nd Edition.ReemaThareja, Oxford.
2.	Data Structures and algorithm analysis in C, 2nded, Mark Allen Weiss.
Reference Books:	
1.	Fundamentals of Data Structures in C, 2nd Edition, Horowitz, Sahni, Universities Press.
2.	Data Structures: A PseudoCode Approach, 2/e, Richard F.Gilberg, Behrouz A. Forouzon, Cengage.
3.	Data Structures with C, Seymour Lipschutz TMH

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Code	Category	L	T	P	C	I.M	E.M	Exam
B20ITOE02	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs**

JAVA PROGRAMMING

(Offered by IT)

(Offered to CE, ECE, EEE & ME)

Course Objectives:

1.	To identify Java language components and how they work together in applications
2.	To learn the fundamentals of object-oriented programming in Java, including defining classes, invoking methods, using class libraries.
3.	To learn how to extend Java classes with inheritance and dynamic binding and how to use exception handling in Java applications
4.	To understand how to design applications with threads in Java
5	To understand how to use Java APIs for program development

Course Outcomes: By the end of the course, the student will be able to:

S.No	Outcome	Knowledge Level
1.	Apply the concepts of Object-Oriented Programming & Java Programming Constructs	K3
2.	Understand the basic concepts of Java such as operators, classes, objects, and various keywords	K2
3.	Apply the concept of Inheritance, Interfaces and Overriding the methods	K3
4.	Analyze the applications of Java using Multithreading, Exception handling	K4
5.	Analyze & Design the concept of Event Handling and Abstract Window Toolkit	K4

SYLLABUS

UNIT-I (10 Hrs)	**Program Structure in Java:** Introduction, Writing Simple Java Programs, Elements or Tokens in Java Programs, Java Statements, Command Line Arguments, User Input to Programs, Escape Sequences Comments, Programming Style. **Data Types, Variables, and Operators :**Introduction, Data Types in Java, Declaration of Variables, Data Types, Type Casting, Scope of Variable Identifier, Literal Constants, Symbolic Constants, Formatted Output with printf() Method, Static Variables and Methods, Attribute Final, Introduction to Operators, Precedence and Associativity of Operators, Assignment Operator (=), Basic Arithmetic Operators, Increment (++) and Decrement (- -) Operators, Ternary Operator, Relational Operators, Boolean Logical Operators, Bitwise Logical Operators. **Control Statements:** Introduction, if Expression, Nested if Expressions, if–else Expressions, Ternary Operator?:, Switch Statement, Iteration Statements, while Expression, do–while Loop, for Loop, Nested for Loop, For–Each for Loop, Break

	Statement, Continue Statement.
UNIT-II (10 Hrs)	**Classes and Objects:** Introduction, Class Declaration and Modifiers, Class Members, Declaration of Class Objects, Assigning One Object to Another, Access Control for Class Members, Accessing Private Members of Class, Constructor Methods for Class, Overloaded Constructor Methods, Nested Classes, Final Class and Methods, Passing Arguments by Value and by Reference, Keyword this. **Methods:** Introduction, Defining Methods, Overloaded Methods, Overloaded Constructor Methods, Class Objects as Parameters in Methods, Access Control, Recursive Methods, Nesting of Methods, Attributes Final and Static.
UNIT-III (10 Hrs)	**Arrays**: Introduction, Declaration and Initialization of Arrays, Storage of Array in Computer Memory, Accessing Elements of Arrays, Operations on Array Elements, Assigning Array to Another Array, Dynamic Change of Array Size, Sorting of Arrays, Search for Values in Arrays, Class Arrays, Two-dimensional Arrays, Arrays of Varying Lengths, Three dimensional Arrays, Arrays as Vectors. **Inheritance:** Introduction, Process of Inheritance, Types of Inheritances, Universal Super Class-Object Class, Inhibiting Inheritance of Class Using Final, Access Control and Inheritance, Multilevel Inheritance, Application of Keyword Super, Constructor Method and Inheritance, Method Overriding, Dynamic Method Dispatch, Abstract Classes, Interfaces and Inheritance. **Interfaces:** Introduction, Declaration of Interface, Implementation of Interface, Multiple Interfaces, Nested Interfaces, Inheritance of Interfaces, Default Methods in Interfaces, Static Methods in Interface, Functional Interfaces, Annotations.
UNIT-IV (8 Hrs)	**Packages and Java Library:** Introduction, Defining Package, Importing Packages and Classes into Programs, Access Control, Packages in Java SE: Java.lang Package, Java utiland Time Packages. **Exception Handling:** Introduction, Keywordsthrows and throw, try, catch, and finally Blocks, Multiple Catch Clauses, Class Throwable, Custom Exceptions, Nested try and catch Blocks,ThrowsClause. **String Handling in Java**: Introduction, Class String handling Methods, Class String Buffer. **Multithreaded Programming:** Introduction, Thread Class, Main Thread- Creation of New Threads, Thread States, Runnable Interface, Thread Priority-Synchronization.
UNIT-V (12 Hrs)	**GUI programming with Swing:**Introduction, limitations of AWT, MVC Architecture, containers. Understanding Layout Managers: Flow, Border, Grid, Card, GridBag. **Event Handling:** The Delegation event model-Events, Event sources, Event Listeners, Event classes, Handling mouse and keyboard events, Adapter classes, Inner classes, Inner classes, Inner classes, Anonymous Inner classes. A Simple Swing Application.Exploring swing controls-JLabel, JText field, The Swing Buttons-JButton, JToggle Button, JCheck Box, JRadio Button, JTabbed Pane, JScroll Pane, JList,

	JCombo Box, Swing Menus, Dialogs. **Java Database Connectivity:** Introduction, JDBC Architecture, Establishing JDBC Database Connections.
Text Books:	
1.	JAVA one step ahead, Anitha Seth, B.L.Juneja, Oxford.
2.	The complete Reference Java, 8th edition, Herbert Schildt, TMH.

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Code	Category	L	T	P	C	I.M	E.M	Exam
B20MEOE01	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

OPERATIONS RESEARCH

(Offered by ME)

(Offered to AIDS, CE, CSE, ECE. EEE & IT)

Course Objectives:

1.	To acquaint the students with basic Operation Research concepts, Formulation of LPP and its solution using various methods.
2.	To build capabilities in the students to analyze the various transportation and assignment problems, job sequencing problems, inventory problems, Games theory and Queuing Models.
3.	To familiarize the students with project management techniques i.e., PERT and CPM.

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1.	Describe the basic Operations Research models, formulate and solve Linear Programming problems for industrial and business applications	K4
2.	Build and Solve Transportation and Assignment problems using appropriate methods for different situations.	K4
3.	Determine the optimal solutions for various Job Sequencing and Inventory models for industrial applications.	K4
4.	Analyse and solve various Games theory and Queuing Models in real situations	K4
5.	Design and schedule various project management problems by CPM & PERT.	K4

SYLLABUS

UNIT-I (10Hrs)	**Introduction to OR:** Definition of OR, Characteristics and phases of OR, Scope of OR, OR models, General methods for solving OR models, Role of computers in OR. **Linear Programming:** Formulation, Graphical Solution, Simplex Method, Artificial Variable Technique-Big-M method, Duality.
UNIT-II (10 Hrs)	**Transportation Model:** Balanced and Unbalanced transportation problems-Initial solution by North West Corner Rule, Lowest Cost Method and VAM, Optimality test by MODI method, Degeneracy in TP. **Assignment Model:** Hungarian algorithm, Balanced and Unbalanced Assignment Problems, Travelling Salesman Problems.

UNIT-III (10 Hrs)	**Job Sequencing:** Introduction, Assumptions, Johnson's algorithm forN-Jobs 2-Machines Problems, N-Jobs 3-Machines Problems, N-Jobs M-Machines Problems, Graphical solution for 2-Jobs and M-Machines Problems. **Inventory Models:** Definition ofInventory, Costs associated with Inventory Problems, Classification of Models, EOQ Model with and without Shortages,Inventory Problems with Price Breakups.
UNIT-IV (10 Hrs)	**Game Theory:** Introduction, Basic definitions, Two Person Zero Sum Games, Minimax criterion, Saddle point, Value of game, Solution of games with saddle point, Mixed Strategy Games-Arithmetic method, Dominance principle to reduce size of game, Graphical Method, Algebraic solution to rectangular games. **Queuing Theory:** Structure of Queuing Models, Characteristics of Queuing process, Kendall's notation, Single channel systems-(M/M/1:∞/FIFO) model and (M/M/1:N/FIFO) model.
UNIT-V (10 Hrs)	**Network Analysis:** Introduction, Project scheduling by CPM and PERT, Network diagram representations, Rules to construct Network diagrams, Time estimates in network analysis-EST, EFT, LST, LFT, float/slack and critical path, Time estimates and Probability considerations in PERT,

Text Books:	
1.	Operations Research by S.D Sharma.
2.	Operations Research by V. K. Kapoor.
Reference Books:	
1.	Operations Research - Kanti Swaroop, P.K. Gupta, Man Mohan, SulthanChand&Sons Education.
2.	Operations Research - Hamdy A Taha – Pearson Education.
3.	Operations Research -Panneer Selvan Prentice Hall of India.
4.	Introduction to Operations Research, F.S. Hiller, G.J. Liberman, TMH.
e-Resources:	
1.	https://nptel.ac.in/courses/112/106/112106134/
2.	https://nptel.ac.in/courses/110/106/110106062/

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Code	Category	L	T	P	C	I.M	E.M	Exam
B20MEOE02	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

MECHATRONICS

(Offered by ME)

(Offered to AIDS, CE, CSBS, CSE, ECE. EEE & IT)

Course Objectives:

1.	To equip the students with fundamental knowledge on mechatronic systems.
2.	To familiarize the student with interdisciplinary knowledge of electronics required for application in mechanical engineering.

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1.	**Understand** about various types of sensors, transducers and amplifiers applied in a mechatronic system.	K2
2.	**Identify** the use of signal converters, logic gates and actuation systems required for the design of mechatronic systems.	K2
3.	**Illustrate** mathematical models for physical systems using the fundamental knowledge of control systems.	K3
4.	**Produce** transfer function of first and second order systems with feedback loops.	K3
5.	**Develop** the knowledge on microcontrollers, programmable logic controllers and their applications in mechatronic systems.	K3

SYLLABUS

UNIT-I (10 Hrs)	**Introduction to Mechatronics** **Sensors &Transducers:** Introduction, performance terminology, Classification of sensors: Potentiometer sensor, strain gauged element, Capacity element, LVDT, Optical Encoders, Selection of sensors. **Signal Conditioning**: Introduction signal Conditioning-Operational amplifiers: Inverting amplifier, summing amplifier, Integrating amplifier, Difference amplifier, filtering process.
UNIT-II (10 Hrs)	**Digital signals:** Digital and analog signals - DA and AD converter – Data Acquisition **Digital logic**: Digital logic - Logic gates – Application of logic gates **Pneumatic and hydraulic Actuation Systems**: Direction control valves –process control valve-cylinders**,** Mechanical actuation systems
UNIT-III (10 Hrs)	**Electric Actuation System**: Switching devices: Mechanical switches, solid state switches – solenoids - DC motors, AC motors, stepper motors **Basic System Models**: Modeling of one and two degrees of freedom Mechanical, Electrical, Fluid and thermal systems. Block diagram representations for these systems. Mechanical translational systems, Mechanical rotational systems, Electromechanical

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UNIT-IV (10 Hrs)	**System Transfer functions**: The Transfer function, Laplace transforms, First order systems, Second order systems, systems in series, systems with feedback loops. **Closed loop controllers**: Continuous and discrete processes, control modes, Two step, Proportional, Derivative, Integral, PID controllers
UNIT-V (10 Hrs)	**Microprocessors:** Microprocessor systems, Micro controllers, Applications **PLC**: Introduction, basic structure, I/P, O/P, processing, programming, ladder diagrams, timers, internal relays and counters, data handling, analogue input and output, selection of PLC. **Case studies of Mechatronic Systems**: Pick and place robot, Digital camera, Automotive control

Text Books:	
1.	Mechatronics Electronic control systems in Mechanical and Electrical Engineering by W. Bolton, Pearson Education, 4th Edition,2011
2.	Introduction to Mechatronics – David and Alcaitore Michael B.Histand TMH, 4th Edition, 2006.
Reference Books:	
1.	Mechatronics System Design by Devdas Shetty and Richard A. Kolk, P.W.S. Publishing Company, 2001
e-Resources:	
1.	https://nptel.ac.in/courses/112107298
2.	https://nptel.ac.in/courses/112103174

SRKR ENGINEERING COLLEGE AUTONOMOUS Estd. 1980

Code	Category	L	T	P	C	I.M	E.M	Exam
B20MEOE03	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

ESSENTIALS OF MECHANICAL ENGINEERING

(Offered by ME)

(Offered to AIDS, CE, CSBS, CSE, ECE. EEE & IT)

Course Objectives:

1.	To expose the students to the thrust areas in Mechanical engineering and their relevance by covering the fundamental concepts.
2.	To create awareness on inter dependence of various aspects in Mechanical engineering and its significance leading to development of products, processes and systems.

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** the first& second law of thermodynamics to analyze various thermodynamic systems undergoing different thermodynamic processes.	K3
2.	**Imparting** knowledge on all sub systems of an Automobile such as various types of suspension systems and the concepts of brakes, electrical and electronic ignition systems.	K3
3.	**Apply** the principles of casting for manufacturing mechanical components.	K3
4.	**Analyze** various metal forming and sheet metal operations for manufacturing mechanical components.	K3
5.	**Illustrate** various machining operations on milling, drilling and broaching machines.	K3

SYLLABUS

UNIT-I (10Hrs)	**Thermodynamics:** Laws of Thermodynamics, Significance and Applications of thermodynamics, Entropy, Ideal and real gas equations; Analysis of Carnot cycle, Otto cycle, Diesel cycle.
UNIT-II (10 Hrs)	**Introduction to Automobile:** Automobile Layout, Chassis and body, Power unit- types of automobile engines, engine parts. **Classification:** 'In-line' and 'V' type, Multi-Valve Engines, Super Charging/Turbo charging, Air filters, Fuel Systems. **Petrol Engines:** Carbureted and MPFI, Ignition systems: Conventional and Electronic. **Diesel Engines:** Conventional, CRDI and Dual fuel Engines, Engine Cooling and Lubrication.
UNIT-III (10 Hrs)	**Manufacturing concepts:** Product cycle, Job, batch and mass production, Primary and secondary manufacturing processes. **Metal Casting Process:** Principle of metal casting, Pattern: Materials, Allowances and

	Types, Core boxes, Moulding sands: ingredients, properties, preparation, types, Moulding tools, Sand moulding, Machine moulding, Melting and pouring, Classification of furnaces, Cupola furnace, Casting defects.
UNIT-IV (10 Hrs)	**Metal Forming:** Hot &Cold working, Rolling, Extrusion, Metal spinning, Drawing, Piercing. **Sheet Metal Forming:** Concept of spring back, Materials, Tools, Operations, Embossing, Coining, Stretch forming.
UNIT-V (10 Hrs)	**Machine Tools:** Basic elements, working principle and types of operations, Specifications of Lathe, Functioning of Drilling Machine, Milling machine, Grinding machine.

Textbooks:	
1.	Thermal Engineering by R.K Rajput, Laxmi publications.
2.	Automotive Mechanics (10/e) - William H. Crouse and Donald L. Anglin, Tata McGraw-Hill Publishing Company Limited, ISBN: 0-07-059054-0.
3.	Elements of Workshop Technology Vol-1: Manufacturing Processes by S.K. Hajra Choudhury, K. Hajra Choudhury, Nirjhar Roy, MPP, Pvt. Ltd.
4.	Elements of Workshop Technology Vol-2: Machine Tools by S.K. Hajra Choudhury, A.K. Hajra Choudhury, Nirjhar Roy, MPP, Pvt. Ltd.
Reference Books:	
1.	Engineering Thermodynamics, by P.K. Nag, Tata McGraw-Hill Publications Company.
2.	Automobile Engineering – KK Jain/ RB Asthana, Tata McGraw-Hill Publishing Company Limited, ISBN: 0-07-044529-X.
3.	Manufacturing Technology- Foundry, Forming and Welding by P.N. Rao, Tata Mc Graw- Hill Publishing Company.
4.	Metal cutting and Machine tools by P.N. Rao, Tata McGraw- Hill Publishing Company.
e-Resources:	
1.	https://nptel.ac.in/courses/112105123
2.	https://nptel.ac.in/courses/112107144

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Code	Category	L	T	P	C	I.M	E.M	Exam
B20BSOE01	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

MATHEMATICS FOR MACHINE LEARNING

(Offered by BS)

(Offered to AIDS, CE, CSE, CSBS, ECE. EEE, IT & ME)

Course Objectives: Students are expected to learn

1	Linear combinations, Bases, Dimensions, Vector Space
2	Inner product, Orthogonal Projections and Gram-Schmidt Orthogonalization in Vector spaces
3	Cholesky Decomposition, Eigen decomposition and Diagonalization
4	Singular Value Decomposition, Matrix Approximation, Matrix Phylogeny
5	Gradients of Matrices, Back propagation and Automatic Differentiation.
6	Optimization Using Gradient Descent, Constrained Optimization & Convex Optimization

Course Outcomes: After completion of the course, the student will be able to

S.No	Outcome	Knowledge Level
1	Calculating linear combinations, Dimensions, Vector Spaces	K3
2	Calculating the distance in inner product, Describe Orthogonality, Orthogonal Projection, Apply Gram-Schmidt Orthogonalization	K3
3	Determine Eigen values and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization,	K3
4	Describe Singular value decomposition with certain applications	K3
5	Describe Gradients of Matrices, Useful Identities for Computing Gradients, Back propagation and Automatic Differentiation	K3
6	Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers, Convex Optimization	K3

SYLLABUS

UNIT-I (10 Hrs)	**Linear Algebra:** Systems of Linear Equations, Matrices, Solving Systems of Linear Equations, Vector Spaces, Linear Independence, Basis and Rank, Linear Mappings, Affine Spaces
UNIT-II (10Hrs)	**Analytic Geometry:** Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Gram-Schmidt orthogonalization, Inner Product of Functions, Orthogonal Projections, QR Decomposition, Rotations

UNIT-III (10Hrs)	**Matrix Decompositions:** Determinant and Trace, Eigen values and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation, Matrix Phylogeny
UNIT-IV (10Hrs)	**Vector Calculus :** Differentiation of Univariate Functions, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Back propagation and Automatic Differentiation, Higher-Order Derivatives, Linearization and Multivariate Taylor Series
UNIT-V (12Hrs)	**Probability and Distributions:** Construction of a Probability Space, Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem, Summary Statistics and Independence, Gaussian Distribution, Conjugacy and the Exponential Family, Change of Variables/Inverse Transform **Continuous Optimization:** Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers, Convex Optimization
Text Books:	
1.	"Mathematics for Machine Learning", Marc Peter Deisenroth, A. Aldo Faisal and Cheng Soon Ong, Cambridge University Press.
2.	The Elements of Statistical Learning: Data Mining, Inference, and Prediction, 2nd Edition, Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer 2017.
Reference Books:	
1.	Machine Learning: An Applied Mathematics Introduction, Paul Wilmott, Panda Ohana Publishing 2019.

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