SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE (AUTONOMOUS)
(Approved by AICTE, New Delhi, Affiliated to JNTUK, Kakinada)
Accredited by NAAC with 'A+' Grade, Accredited by NBA (UG: Civil, CSE, ECE, EEE, IT & ME)
Recognised as Scientific and Industrial Research Organisation
SRKR MARG, CHINA AMIRAM, BHIMAVARAM – 534204 W.G.Dt., A.P., INDIA
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	B23ADOE01	Java Programming	**CE, ECE, EEE & ME**
	B23ADOE02	Computer Organization and Architecture	
ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	B23AMOE01	Operating Systems	**CE, ECE, EEE & ME**
	B23AMOE02	Computer Organization and Architecture	
	B23AMOE03	AI Tools and Techniques	
CIVIL ENGINEERING	B23CEOE01	Remote Sensing & GIS	**AIDS, AIML,CIC, CSBS, CSE, CSG, CSIT, ECE, EEE, IT & ME**
	B23CEOE02	Intelligent Transport Systems	
COMPUTER SCIENCE & BUSINESS SYSTEMS	B23CBOE01	Database management Systems	**CE, ECE, EEE & ME**
	B23CBOE02	Python Programming	**CE**
COMPUTER SCIENCE & ENGINEERING	B23CSOE01	Computer Organization and Architecture	**CE, ECE, EEE & ME**
	B23CSOE02	Principles of Operating Systems	
CSE(Internet of Things and Cyber Security including Block Chain Technology)	B23CIOE01	Java Programming	**CE, ECE, EEE & ME**
	B23CIOE02	Introduction to IoT	**CE, EEE & ME**
ELECTRONICS & COMMUNICATION ENGINEERING	B23ECOE01	Electronic Devices and Circuits	**AIDS, AIML, CE, CIC, CSBS, CSE, CSG, CSIT, IT & ME**
ELECTRICAL & ELECTRONICS ENGINEERING	B23EEOE01	Renewable Energy Sources	**AIDS, AIML, CE, CIC, CSBS, CSE, CSG, CSIT, ECE& IT**
	B23EEOE02	Principles of Control Systems	**AIDS, AIML, CE, CIC, CSBS, CSE, CSG, CSIT& IT**
INFORMATION TECHNOLOGY	B23ITOE01	Object Oriented Programming through JAVA	**CE, ECE, EEE & ME**
MECHANICAL ENGINEERING	B23MEOE01	Applied Operations Research	**AIDS, CE, CIC, CSBS, CSE, CSG, CSIT, ECE& EEE**
	B23MEOE02	Sustainable Energy Technologies	**AIDS, AIML, CE, CIC, CSBS, CSE, CSG, CSIT, ECE, EEE& IT**
MATHEMATICS AND HUMANITIES	B23BSOE01	Mathematics for Machine Learning	**AIDS, AIML, CE, CIC, CSBS, CSE, CSG, CSIT, ECE, EEE, IT & ME**

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ADOE01	OE	3	--	--	3	30	70	3 Hrs.

JAVA PROGRAMMING

Offered by AIDS

(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: 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	K3
5.	**Analyze** & design the concept of Event Handling and Abstract Window Toolkit	K3

SYLLABUS

UNIT-I (10Hrs)	**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 Threads, Thread States, Thread Priority-Synchronization, Deadlock and Race Situations,

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	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
Textbooks:	
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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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ADOE02	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

COMPUTER ORGANIZATION AND ARCHITECTURE

Offered by AIDS

(Offered to CE, ECE, EEE &ME)

Course Objectives: Students are expected to learn

1.	Principles and the Implementation of Computer Arithmetic
2.	Operation of CPUs including RTL, ALU, Instruction Cycle, and Busses
3.	Functionality of central processing unit and control units
4.	Memory System and I/O Organization

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

S.No	Outcome	Knowledge Level
1.	**Identify** set of digital components, functional components and micro-operations in a basic computer system.	K3
2.	**Demonstrate** various instructions and arithmetic operations	K3
3.	**Illustrate** knowledge of functional components on central processing unit and various control units.	K2
4.	**Determine** different memory components in a computer for better memory organization	K3
5.	**Explain** different ways of communication with I/O devices and standard I/O interface	K2

SYLLABUS

UNIT-I (10 Hrs)	**Introduction:** Basic Logic functions, Logic gates, Boolean functions, Canonical forms, Simplification of Boolean functions (up to 4 variable), Basics of Flipflops, Registers, Decoders and multiplexers. **Basic Structure of Computers**: Computer Types, Functional units, Basic operational concepts, Bus structures. **Register Transfer and Micro operations**: Register Transfer Language, Register Transfer, Bus and Memory Transfers, Arithmetic Micro operations, Logic Micro operations, Shift Micro operations, Arithmetic Logic Shift Unit.
UNIT-II (08 Hrs)	**Basic Computer Organization and Design**: Instruction Codes, Computer Register, Computer Instructions, Instruction Cycle, Memory – Reference Instructions. Input – Output and Interrupt, Complete Computer Description **Computer Arithmetic**: Addition and Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Positive Numbers, Signed-operand Multiplication, Fast

	Multiplication, Integer Division, Floating-Point Numbers and Operations
UNIT-III (10 Hrs)	**Central Processing Unit**: General Register Organization, STACK Organization. Instruction Formats, Addressing Modes, Data Transfer and Manipulation, Execution of a Complete Instruction, Multiple-Bus Organization, **Micro programmed Control**: Control Memory, Address Sequencing, Micro Program example, Hardwired Control and Micro programmed Control.
UNIT-IV (10 Hrs)	**The Memory Organization:** Memory Hierarchy, Main memory, Auxiliary memory, Associate Memory, Cache Memory, and Virtual memory, Memory Management Requirements, Secondary Storage.
UNIT-V (12 Hrs.)	**Input / Output Organization:** Accessing I/O Devices, Interrupts, Processor Examples, modes of transfers, Direct Memory Access, Buses, Interface Circuits, Standard I/O Interfaces.

Text Books:	
1.	Computer System Architecture M. M. Mano: 3rd ed., Prentice Hall of India, New Delhi, 1993
2.	Digital Design, 6th Edition, M. Morris Mano, Pearson Education.
Reference Books:	
1.	Computer Organization, Carl Hamacher, ZvonkoVranesic, SafwatZaky, 5/e, McGraw Hill,2002.
2.	Computer Organization and Architecture, William Stallings, 6/e, Pearson,2006.
3.	Structured Computer Organization, Andrew S. Tanenbaum, 4/e, Pearson,2005.
4.	Fundamentals of Computer Organization and Design, Sivarama P. Dandamudi, Springer, 2006.
e-Resources	
1.	https://nptel.ac.in/courses/106/105/106105163/
2.	http://www.cuc.ucc.ie/CS1101/David%20Tarnoff.pdf

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AMOE01	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

OPERATING SYSTEMS

(Offered by AIML)

(Offered to CE, ECE, EEE &ME)

Course Objectives: This course aims to equip students with the following:

1.	Understand the basic concepts and principles of operating Systems, including process management, memory management, file Systems, and Protection.
2.	Make use of process scheduling algorithms and synchronization techniques to achieve better performance of a computer System.
3.	Illustrate different conditions for deadlock and their possible solutions.

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

S.No	Outcome	Knowledge Level
1.	**Describe** various generations of Operating System and functions of Operating System, System calls	K2
2.	**Apply** various process scheduling algorithms and thread management techniques to optimize System performance.	K3
3.	**Apply** synchronization mechanisms and deadlock handling strategies to ensure efficient concurrent System operation.	K3
4.	**Analyze** the memory management strategies in OS to optimize the practical computing scenarios.	K4
5.	**Summarize** various file allocation methods, fundamental Protection techniques in OS to secure data integrity and accessibility.	K2

SYLLABUS

UNIT-I (10Hrs)	**Operating Systems Overview:** Operating System Functions, Computing Environments, Free and Open-Source Operating Systems, **System Structures:** Operating System Services, User and Operating-System Interface, System Calls, Types of System Calls, System programs, Operating System Design and Implementation, Operating System Structure, Operating System debugging.
UNIT-II (10 Hrs)	**Processes:** Introduction, Process Scheduling, Operations on Processes, Inter-Process Communication. **Threads and Concurrency:** overview of threads**,** Multithreading models, Thread libraries, Threading issues. **CPU Scheduling:** Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling.

UNIT-III (10 Hrs)	**Process Synchronization:** The Critical Section Problem, Peterson's Solution, Mutex Locks, Semaphores, Monitors, Classic problems of Synchronization. **Deadlocks:** System Model, Deadlock characterization, Methods for handling Deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock
UNIT-IV (10 Hrs)	**Memory-Management Strategies:** Introduction Contiguous memory allocation, Paging, Segmentation. **Virtual Memory Management:** Introduction, Demand paging, Page replacement. **Storage Management:** Overview of Mass Storage Structure, Disk Structure, Disk Scheduling.
UNIT-V (10 Hrs)	**File System:** File concept, Access methods, Directory Structure, File system Implementation, File-system structure, File-system Operations, Directory implementation, Allocation method**.** **Protection:** Goals of protection, Principles of protection, Protection Rings, Domain of protection, Access matrix.

Textbooks:	
1.	Operating System Concepts, Silberschatz A, Galvin P B, Gagne G, 10th Edition, Wiley, 2018.
2.	Modern Operating Systems, Tanenbaum A S, 4th Edition, Pearson , 2016.
Reference Books:	
1.	Operating Systems -Internals and Design Principles, Stallings W, 9th edition, Pearson, 2018
2.	Operating Systems: A Concept Based Approach, D.M Dhamdhere, 3rd Edition, McGraw- Hill, 2013
e-Resources	
1.	https://nptel.ac.in/courses/106/106/106106144/
2.	http://peterindia.net/OperatingSystems.html

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AMOE02	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

COMPUTER ORGANIZATION AND ARCHITECTURE

(Offered by AIML)

(Offered to CE, ECE, EEE &ME)

Course Objectives: This course aims to equip students with the following:

1.	Understand how digital computers developed over time and how they perform basic arithmetic operations.
2.	Learn how a basic computer works, including how it processes instructions and controls operations.
3.	Know how control units are designed using microprogramming and how instructions are executed step by step.
4.	Understand how the CPU is organized, including registers, stacks, and how data is handled using different instruction formats and addressing methods.
5.	Learn how memory and input/output devices work, including how data is transferred using techniques like interrupts and DMA.

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

S.No	Outcome	Knowledge Level
1.	Apply concepts of computer evolution, number representations, and arithmetic algorithms.	**K3**
2.	Explain computer organization, instruction cycle, timing, and control.	**K2**
3.	Explain microprogrammed control units and microinstruction sequencing.	**K2**
4.	Explain CPU architecture, instruction formats, and addressing modes.	**K2**
5.	Explain memory hierarchy and I/O methods, including cache and DMA.	**K2**

SYLLABUS

UNIT-I (12Hrs)	**Digital Computers and Arithmetic:** Historical perspective and von Neumann computers, basic number systems and conversions, logic gates, combinational circuits, adders, subtractors, decoders, encoders, multiplexers, flip flops, registers, counters, Fixed and floating-point representation of numbers, Addition and Subtraction algorithms
UNIT-II (8 Hrs)	**Basic Computer Organization and Design:** Instruction Codes, Computer Registers, Computer Instructions, Instruction Cycle, Timing and Control.
UNIT-III (10 Hrs)	**Central Processing Unit:** Introduction, General Register Organization, Stack Organization, Instruction Formats, Addressing Modes, Data Transfer and Manipulation.

	Micro programmed Control: Control Memory, Address Sequencing
UNIT-IV (10 Hrs)	**Memory Organization:** Memory Hierarchy, Auxiliary Memory, Associative Memory, Cache Memory, Virtual memory.
UNIT-V (10 Hrs)	**Input/output Organization:** Peripheral devices, I/O interface, Asynchronous data transfer, Modes of transfer, Priority interrupt, direct memory access and IOP.

Textbooks:	
1.	Digital Design, 4thEdition, M. Morris Mano, Michael D. Ciletti Pearson Prentice-Hall, 2007.
2.	Computer System Architecture, M. Morris Mano, Pearson India, Revised 3rd ed., 2017.
Reference Books:	
1.	Computer Organization and Architecture, William Stallings, 11thEdition, Pearson India, 2022.
2.	Computer Organization, Carl Hamacher, Zvonko Vranesic, Safwat Zaky, 6th Edition, McGraw Hill India, 2022.
3.	Digital Design and Computer Architecture, 2nd Edition, David Money Harris, Sarah L.Harris, 2019.
4.	Computer Organization and Architecture: Themes and Variations, Alan Clements, Cengage Learning, 2014.
e-Resources	
1.	https://nptel.ac.in/courses/106/103/106103068/

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AMOE03	OE	3	--	--	3	30	70	3 Hrs.

ARTIFICIAL INTELLIGENCE TOOLS & TECHNIQUES

(Offered by AIML)

(Offered to CE, ECE, EEE &ME)

Course Objectives: This course aims to equip students with the following:

1.	The student should be made to study the concepts of Artificial Intelligence.
2.	The student should be made to learn the methods of solving problems using Artificial Intelligence.
3.	The student should be made to introduce the concepts of Expert Systems.
4.	To understand the applications of AI, namely game playing, theorem proving, and machine learning.
5.	To learn different knowledge representation techniques

Course Outcomes: After successful completion of the course students will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** state space representation to model and solve AI problems.	**K3**
2.	**Apply** informed and uninformed search strategies to solve AI problems**.**	**K3**
3.	**Apply** predicate logic, semantic networks, frames, and conceptual dependency to represent and manipulate knowledge.	**K3**
4.	**Apply** unification and resolution algorithms to prove the facts represented in propositional and first-order predicate logic.	**K3**
5.	**Summarize** the principles of expert systems and fuzzy logic.	**K2**

SYLLABUS

UNIT-I (10Hrs)	**Introduction: Introduction to AI,** Foundation of AI and history of AI, Domains of AI, State Space Representation of AI Problems (Water Jug Problem, 8 Puzzle Problem, TSP), Problem characteristics of AI, intelligent agents: Agents and Environments, structure of agents.
UNIT-II (10 Hrs)	**Searching:** Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Hill climbing, A*, AO* Algorithm, Means Ends Analysis & Constraint Propagation.
UNIT-III (10 Hrs)	**Representation of Knowledge:** Knowledge representation issues, predicate logic- logic programming, semantic nets- frames and inheritance, Conceptual dependency and Scripts.
UNIT-IV (10 Hrs)	**Logic concepts**: First order Predicate logic, Propositional logic, Conversion of WFF to Clause form, Unification Algorithm, forward chaining, Backward

	chaining, Resolution Algorithm.
UNIT-V (10 Hrs)	**Expert Systems:** Introduction to Expert Systems, Advantages and disadvantages and applications of Expert systems**,** Architecture of expert systems. **Fuzzy Sets & Fuzzy Logic:** Introduction, fuzzy sets, fuzzy set operations & types of membership functions.
Textbooks:	
1.	S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", Second Edition, Pearson Education (2005).
2.	Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", Third Edition, Mc Graw-Hill (2016).
Reference Books:	
1.	David Poole, Alan Mackworth, Randy Goebel," Computational Intelligence: a logical approach", Oxford University Press (1998).
2.	G. Luger, "Artificial Intelligence: Structures and Strategies for complex problem solving", Fifth Edition, Pearson Education (2009).
3.	J. Nilsson, "Artificial Intelligence: A new Synthesis", Elsevier Publishers (2010).
4.	Saroj Kaushik, "Artificial Intelligence", Second Edition, CENGAGE Learning (2011).
e-Resources	
1.	https://ai.google/
2.	https://swayam.gov.in/nd1_noc19_me71/preview

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23CEOE01	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

REMOTE SENSING AND GIS

(Offered by Civil Engineering)

(Offered to AIDS, AIML, CSIT, CSBS, CSD, CSE, CIC, ECE, EEE, IT & ME)

Course Objectives:

1.	Provide a foundational understanding of remote sensing principles, electromagnetic radiation, sensor types, and data acquisition platforms.
2.	Introduce key components of GIS, spatial data models, data input methods, and map projection systems.
3.	Equip students with skills in image interpretation and digital processing techniques for remote sensing data analysis.
4.	Develop competency in spatial data analysis techniques, including overlay operations, elevation models, and network analysis.
5.	Explore real-world applications of RS and GIS in environmental monitoring, urban planning, disaster management, and resource evaluation.

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

S. No	Outcome	Knowledge Level
1.	**Demonstrate** remote sensing principles by identifying system components, interpreting spectra, and selecting sensors and platforms.	K3
2.	**Use** GIS to build spatial models, distinguish raster and vector data, and apply data input methods and projections.	K3
3.	**Apply** image preprocessing, enhancement, and classification techniques (supervised and unsupervised) for digital image interpretation.	K3
4.	**Analyze** spatial data using overlay operations, terrain models (DEM, DSM, DTM), and perform optimum path analysis in networks.	K4
5.	**Evaluate** the use of remote sensing and GIS techniques in land use analysis, urban growth, flood and watershed management, and EIA.	K5

SYLLABUS

UNIT-I (10 Hrs)	**Introduction to Remote Sensing:** Components of remote sensing – Electromagnetic radiation (EMR) and spectrum – Energy interaction with atmosphere and earth surface – Types and characteristics of sensors – Platforms for remote sensing (ground-based, aerial, satellite).
UNIT-II (10 Hrs)	**Introduction to Geographic Information System (GIS):** GIS components – Spatial data models: raster and vector – Raster vs. vector comparison – Data input methods (digitizing, GPS, remote sensing) – Map projections and coordinate systems.
UNIT-III (10 Hrs)	**Image Analysis:** Elements of visual interpretation – Digital image processing: image preprocessing, rectification, enhancement – Image classification techniques: supervised

	and unsupervised.
UNIT-IV (10 Hrs)	**Spatial Data Analysis:** Vector and Raster overlay operations – Digital Elevation Model (DEM), Digital Surface Model (DSM), Digital Terrain Model (DTM) – Applications of elevation models – Network analysis: components, transportation networks, optimum path analysis.
UNIT-V (10 Hrs)	**RS and GIS Applications:** Land use and land cover mapping – Urban growth monitoring – Flood and groundwater management – Watershed management – Environmental Impact Assessment (EIA).

Textbooks	
1.	Remote Sensing and GIS by Basudeb Bhatta, Oxford University Press.
2.	Textbook of Remote Sensing and Geographical Information Systems, 4th edition, by M. Anji Reddy, BS Publications.
Reference Books	
1.	Fundamentals of Remote Sensing by George Joseph and C Jeganathan, University Press (India) Private Limited.
2.	Principles of Geographical Information Systems by Peter A Burrough and Rachel A. Mc. Donnel, Oxford Publications.
3.	Remote Sensing and Image Interpretation, Lillesand, T.M, R.W. Kiefer and J.W. Chipman, 7th Edition (2015), Wiley India Pvt. Ltd., New Delhi
4.	Introduction to Remote Sensing by Campbell, J.B., Taylor & Francis, London.
e-Resources	
1.	https://www.gisresources.com/wp-content/uploads/2013/09/anji-reddy_GIS.pdf
2.	https://www.nateko.lu.se/sites/nateko.lu.se.sv/files/remote_sensing_and_gis_20111212.pdf
3.	https://egyankosh.ac.in/bitstream/123456789/98540/1/Block-1.pdf

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23CEOE02	OE	3	--	--	3	30	70	3 Hrs.

INTELLIGENT TRANSPORTATION SYSTEMS

(Offered by CE)

(Offered to AIDS, AIML, CSIT, CSBS, CSD, CSE, CIC, ECE, EEE, IT & ME)

Course Objectives:

1.	To know the fundamentals of ITS
2.	To explore sensor technologies and Data requirements of ITS
3.	To know ITS functional areas and user services
4.	To discuss various kinds of ITS architecture
5.	To study ITS applications in various fields of transportation engineering

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

S. No	Outcome	Knowledge Level
1.	**Illustrate** the benefits of ITS from various types and Historical Background	K2
2.	**Select** various sensor applications and ITS data collection techniques	K2
3.	**Explain** ITS user services and functional areas.	K2
4.	**Demonstrate** various ITS models, evaluation methods and ITS planning.	K3
5.	**Use** various applications of ITS technology.	K3

SYLLABUS

UNIT-I (10Hrs)	**Fundamentals of ITS:** Definition of ITS, The historical context of ITS from both public policy and market economic perspectives, Types of ITS; Historical Background, Benefits of ITS.
UNIT-II (10 Hrs)	**Sensor technologies and Data requirements of ITS:** Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC); Application of sensors to Traffic management; Traffic flow sensor technologies; Transponders and Communication systems; Data fusion at traffic management centres; Sensor plan and specification requirements; Elements of Vehicle Location and Route Navigation and Guidance concepts; ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), GIS, video data collection.
UNIT-III (10 Hrs)	**ITS functional areas:** Advanced Traffic Management systems (ATMS), Advanced Traveler Information systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control systems (AVCS), Advanced Public Transportation systems (APTS), Advanced Rural Transportation systems (ARTS); ITS User Needs and Services – Travel

	and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.
UNIT-IV (10 Hrs)	**ITS Architecture:** Regional and Project ITS architecture; Concept of operations; ITS Models and Evaluation Methods; Planning and human factor issues for ITS, Case studies on deployment planning and system design and operation; ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS planning.
UNIT-V (10 Hrs)	**ITS applications:** Traffic and incident management systems; ITS and sustainable mobility, travel demand management, Electronic toll collection, ITS and road-pricing. Transportation network operations; commercial vehicle operations and intermodal freight; public transportation applications, ITS and regional strategic transportation planning, including regional architectures: ITS and changing transportation institutions, Automated Highway Systems- Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World, Overview of ITS implementations in developed countries, ITS in developing countries.
Textbooks	
1.	R. Srinivasa Kumar, Intelligent Transportation Systems, University Press (India) Private Ltd., 2022
2.	Pradip Kumar Sarkar, Amit Kumar Jain, Intelligent Transport Systems, PHI Learning Private Limited, Delhi. 2018
Reference Books	
1.	Fundamentals of intelligent transportation system planning by Mashrur A. Chowdhury, Adel W. Sadek.
2.	ITS Hand Book 2000: recommendations for World Road Association (PIRAC) by Kan Paul Chen, John Miles.
3.	Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola, Intelligent Transport Systems: Technologies and Applications, Wiley, 2015
4.	Sussman, J.M., Persecpective on ITS, Artech House Publishers, 2005.
5.	National ITS Architecture Documentation, US Department of Transportation, 2007.
e-Resources	
1.	https://nptel.ac.in/courses/105105204

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Course Code	Category	L	T	P	C	I.M	E.M	Exam
B23CBOE01	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. **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.

UNIT-II (10 Hrs)	**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.

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/

Course code	Category	L	T	P	C	I.M	E.M	Exam
B23CBOE02	**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.
	Learn the use of lists, tuples, dictionaries and sets in Python programs.
	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.
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

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23CSOE01	OE	3	--	--	3	30	70	3 Hrs.

COMPUTER ORGANIZATION AND ARCHITECTURE

(Offered by CSE)

(Offered to CE, ECE, EEE & ME)

Course Objectives:

1.	Understand how digital computers developed over time and how they perform basic arithmetic operations.
2.	Learn how a basic computer works, including how it processes instructions and controls operations.
3.	Know how control units are designed using microprogramming and how instructions are executed step by step.
4.	Understand how the CPU is organized, including registers, stacks, and how data is handled using different instruction formats and addressing methods.
5.	Learn how memory and input/output devices work, including how data is transferred using techniques like interrupts and DMA.

Course Outcomes

S.No	Outcome	Knowledge Level
1.	Apply concepts of computer evolution, number representations, and arithmetic algorithms.	**K3**
2.	Explain computer organization, instruction cycle, timing, and control.	**K2**
3.	Explain microprogrammed control units and microinstruction sequencing.	**K2**
4.	Explain CPU architecture, instruction formats, and addressing modes.	**K2**
5.	Explain memory hierarchy and I/O methods, including cache and DMA.	**K2**

SYLLABUS

UNIT-I (12Hrs)	**Digital Computers and Arithmetic:** Historical perspective and von Neumann computers, basic number systems and conversions, logic gates, combinational circuits, adders, subtractors, decoders, encoders, multiplexers, flip flops, registers, counters, Fixed and floating-point representation of numbers, Addition and Subtraction algorithms
UNIT-II (8 Hrs)	**Basic Computer Organization and Design:** Instruction Codes, Computer Registers, Computer Instructions, Instruction Cycle, Timing and Control.
UNIT-III (10 Hrs)	**Central Processing Unit:** Introduction, General Register Organization, Stack Organization, Instruction Formats, Addressing Modes, Data Transfer and Manipulation.

	Micro programmed Control: Control Memory, Address Sequencing
UNIT-IV (10 Hrs)	**Memory Organization:** Memory Hierarchy, Auxiliary Memory, Associative Memory, Cache Memory, Virtual memory.
UNIT-V (10 Hrs)	**Input/output Organization:** Peripheral devices, I/O interface, Asynchronous data transfer, Modes of transfer, Priority interrupt, direct memory access and IOP.

Textbooks:	
1.	Digital Design, 4thEdition, M. Morris Mano, Michael D. Ciletti Pearson Prentice-Hall, 2007.
2.	Computer System Architecture, M. Morris Mano, Pearson India, Revised 3rd ed., 2017.
Reference Books:	
1.	Computer Organization and Architecture, William Stallings, 11thEdition, Pearson India, 2022.
2.	Computer Organization, Carl Hamacher, Zvonko Vranesic, Safwat Zaky, 6th Edition, McGraw Hill India, 2022.
3.	Digital Design and Computer Architecture, 2nd Edition, David Money Harris, Sarah L.Harris, 2019.
4.	Computer Organization and Architecture: Themes and Variations, Alan Clements, Cengage Learning, 2014.
e-Resources	
1.	https://nptel.ac.in/courses/106/103/106103068/

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23CSOE02	OE	3	--	--	3	30	70	3 Hrs.

PRINCIPLES OF OPERATING SYSTEMS

(Offered by CSE)

(Offered to CE, ECE, EEE & ME)

Course Objectives:

1.	Understand the basic concepts and principles of operating Systems, including process management, memory management, file Systems, and Protection.
2.	Make use of process scheduling algorithms and synchronization techniques to achieve better performance of a computer System.
3.	Illustrate different conditions for deadlock and their possible solutions.

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

S.No	Outcome	Knowledge Level
1.	**Describe** various generations of Operating System and functions of Operating System, System calls	K2
2.	**Apply** various process scheduling algorithms and thread management techniques to optimize System performance.	K3
3.	**Apply** synchronization mechanisms and deadlock handling strategies to ensure efficient concurrent System operation.	K3
4.	**Analyze** the memory management strategies in OS to optimize the practical computing scenarios.	K4
5.	**Summarize** various file allocation methods, fundamental Protection techniques in OS to secure data integrity and accessibility.	K2

SYLLABUS

UNIT-I (10Hrs)	**Operating Systems Overview:** Operating System Functions, Computing Environments, Free and Open-Source Operating Systems, **System Structures:** Operating System Services, User and Operating-System Interface, System Calls, Types of System Calls, System programs, Operating System Design and Implementation, Operating System Structure, Operating System debugging.
UNIT-II (10 Hrs)	**Processes:** Introduction, Process Scheduling, Operations on Processes, Inter-Process Communication. **CPU Scheduling:** Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling.

UNIT-III (10 Hrs)	**Process Synchronization:** The Critical Section Problem, Peterson's Solution, Mutex Locks, Semaphores, Monitors, Classic problems of Synchronization. **Deadlocks:** System Model, Deadlock characterization, Methods for handling Deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock
UNIT-IV (10 Hrs)	**Memory-Management Strategies:** Introduction Contiguous memory allocation, Paging, Segmentation. **Virtual Memory Management:** Introduction, Demand paging, Page replacement. **Storage Management:** Overview of Mass Storage Structure, Disk Structure, Disk Scheduling.
UNIT-V (10 Hrs)	**File System:** File concept, Access methods, Directory Structure, File system Implementation, File-system structure, File-system Operations, Directory implementation, Allocation method**.** **Protection:** Goals of protection, Principles of protection, Protection Rings, Domain of protection, Access matrix.

Textbooks:	
1.	Operating System Concepts, Silberschatz A, Galvin P B, Gagne G, 10th Edition, Wiley, 2018.
2.	Modern Operating Systems, Tanenbaum A S, 4th Edition, Pearson , 2016.
Reference Books:	
1.	Operating Systems -Internals and Design Principles, Stallings W, 9th edition, Pearson, 2018
2.	Operating Systems: A Concept Based Approach, D.M Dhamdhere, 3rd Edition, McGraw- Hill, 2013
e-Resources	
1.	https://nptel.ac.in/courses/106/106/106106144/
2.	http://peterindia.net/OperatingSystems.html

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23CIOE01	OE	3	--	--	3	30	70	3 Hrs.

JAVA PROGRAMMING

(Offered by CIC)

(Offered to CE, ECE, EEE & ME)

Course Objectives: This course aims to equip students with the following:

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 JDBC APIs for program development.

Course Outcomes: At the end of the Course Student will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** Java programming concepts for developing efficient Java applications.	K3
2.	**Apply** Array, ArrayList and String handling for efficient data processing.	K3
3.	**Develop** reusable programs using the concepts of inheritance, interfaces and packages.	K3
4.	**Apply** the concept of Exception handing and multithreading to build an efficient and error free code.	K3
5.	**Develop** a program that manages input & output streams and apply JDBC to interface with database.	K3

SYLLABUS

UNIT-I (10 Hrs)	**Object Oriented Programming:** Basic concepts of OOP, Principles. **Introduction to JAVA:** Structure of JAVA, Features of JAVA, JAVA Tokens, Java Statements, Command Line Arguments, User Input to Programs, Data Types in Java, Declaration of Variables**,** Type Casting, Static Variables and Methods, Operators, Control Statements. **Classes & Objects:** Introduction, Class Declaration and Modifiers, Class Members, Declaration of Class Objects, Method overloading. **Constructors:** Default Constructor, Parameterized Constructor, Copy Constructor and Constructor Overloading, This Keyword.
UNIT-II (10 Hrs)	**Arrays, Array List:** Introduction, Declaration and Initialization of Arrays, Storage of Array in Computer Memory, Accessing Elements of Arrays, Operations on Array Elements, Two-dimensional Arrays, Array List Methods

	String Handling in Java: Introduction, methods in String Class, Methods for comparison of Strings, String Buffer class.
UNIT-III (10 Hrs)	**Inheritance:** Introduction, Types of Inheritances, Single inheritance, Multi-level inheritance, Hierarchical Inheritance, Method Overriding, Super Keyword, Final Keyword, Abstract Classes. **Interfaces:** Introduction, Declaration of Interface, Implementing Interfaces, Extending interfaces, Multiple inheritance, Hybrid Inheritance, Default Methods in Interfaces, Static Methods in Interface. **Packages:** Introduction, Defining Package, Importing Packages, Access Modifiers.
UNIT-IV (10 Hrs)	**Exception Handling:** Introduction, Hierarchy of Standard Exception Classes, Keywords throws and throw, try, catch, and finally Blocks, Multiple Catch Statements, Custom Exceptions, Nested try and catch Blocks. **Multithreaded Programming:** Introduction, Need for Multiple Threads, Thread class, Thread Life Cycle, Extending Thread class, Implementing Runnable interface, Thread Priorities, Inter-thread communication.
UNIT-V (10 Hrs)	**File IO:** Introduction, IO classes and interfaces, Stream classes, Byte Streams, Character Streams. **Java Database Connectivity:** Introduction, Structure of JDBC, JDBC Architecture, Types of JDBC Drivers, JDBC API (java.sql package), Connecting to the Database, JAVA Database connection program for Oracle and MySQL.

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Text Books:	
1.	Core Java Volume I--Fundamentals: 1 (Core Series)11thedition (2020) by Cay Horstmann, Publisher: Pearson
2.	The complete Reference Java, 12th edition (2021), Herbert Schildt, Publisher:TMH.
Reference Books:	
1.	Introduction to java programming, 9th edition(2014) by Y Daniel Liang, Pubisher:Pearson
2.	Murach's Java Programming, 5th edition(2017) Joel Murach , Pubisher:Mike Murach
3.	JAVA one step ahead, 1stedition (2017)Anitha Seth, B.L.Juneja, Oxford.
4.	Java: A Beginner's Guide, Eighth Edition 8th Edition(2018)by Herbert Schildt,Pubisher:McGrawHill Education
5.	Head First Java 3e (2021)(A Brain Friendly Guide) by Kathy Sierra & Bert bates,Pubisher:O′Reilly
6.	Programming With Java:A Primer 6E(2019)By Balagurusamy,Pubisher:TMH.
e-Resources:	
1.	https://nptel.ac.in/courses/106/105/106105191/
2.	https://www.coursera.org/learn/java-introduction

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B23CIOE02	**OE**	**3**	**0**	**0**	**--**	**30**	**70**	**3 Hrs.**

INTRODUCTION TO INTERNET OF THINGS

(Offered by CIC)

(Offered to CE, EEE & ME)

Pre-requisites: Computer Networks

Course Objectives: Students are expected

1.	Understand the fundamental concepts and real-world applications of IoT.
2.	Learn about IoT architecture covering edge, cloud, and application layers.
3.	Gain hands-on skills to build an end-to-end IoT application.
4.	Explore IoT communication protocols, data handling, and sensors.
5.	Research and present advanced topics in IoT through seminars.

Course Out Comes: At the end of the course students will be able to

S. No	OUT COME	Knowledge Level
1.	Explain IoT concepts, architecture, and industry applications.	K2
2.	Identify and describe key IoT components like sensors, edge devices, and gateways.	K3
3.	Apply communication protocols to IoT data transfer and integration.	K3
4.	Analyze and process IoT data using basic analytics and time-series methods.	K4
5.	Design and demonstrate a basic end-to-end IoT project through lab and seminar work.	K4

SYLLABUS

UNIT-I (10 Hrs)	**Introduction to Internet of Things and Use Cases:** Basic concepts of IoT, Differences: Consumer IoT vs Industrial IoT, Fundamental building blocks of IoT, Industry-wise IoT applications: Healthcare, Agriculture, Manufacturing, Smart Homes, etc.
UNIT-II (10 Hrs)	**IoT Architecture & Edge Computing:** IoT reference models and Industrial Internet Reference Architecture (IIRA), Role of Edge Computing in IoT, IoT Gateways and their functions, Data ingestion and processing pipelines, Overview of data stream processing
UNIT-III (10 Hrs)	**Sensors and Industrial Systems:** Introduction to sensors and transducers, Sensor integration with microcontrollers, Introduction to data acquisition systems, Industrial control systems and use cases
UNIT-IV (8 Hrs)	**IoT Networking & Communication:** Mapping OSI model to IoT architecture, Proximity networking: ZigBee, Bluetooth, Serial Comm, Industrial protocols: Modbus, CANbus,

	Communication with cloud: REST APIs, MQTT, TCP/UDP, WebSockets, Message formats: JSON, Protocol Buffers
UNIT-V (8 Hrs)	**IoT Data Processing & Seminar Topics:** Time-series data: characteristics, examples, Time-series databases and analytics, Summarization, sketching, anomaly detection, Handling missing/noisy data. **Seminar Component (Research & Presentation):** Students (in teams) will choose a topic, conduct a literature survey, and present findings. **Suggested Seminar Topics:** IoT Data Visualization, Smart Cities / Smart Grids / Smart Homes / Connected Vehicles, Cloud-based IoT platforms, Low Power Wide Area Networks (LPWAN), IoT Device Management, Embedded OS for IoT, IoT Security (risks, secure communication, privacy).

TEXTBOOK:	
1.	Samuel Greengard, The Internet of Things, MIT Press Essential Knowledge Series.
2.	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things - David Hanes, Gonzalo Salgueiro, Patrick Grossetete Robert Barton, Jerome Henry. 24750 Copyright© 2017 Cisco Systems, Inc. Published by: Cisco Press 800 East 96th Street.
3.	Internet of Things: Architecture and Design Principles by Raj Kamal, McGraw Hill Educati private limited, 2017.
REFERENCE BOOKS:	
1.	Industrial Internet Reference Architecture - http://www.iiconsortium.org/IIRA.htm
2.	World Economic Forum Report on Industrial Internet of Things - https://www.weforum.org/reports/industrial-internet-things
3.	50 Sensor Applications for a Smarter World - http://www.libelium.com/resources/top_50_iot_sensor_applications_ranking/
4.	Visualizing Data-Exploring and Explaining Data with the Processing Environment, By Ben Fry, Publisher: O'Reilly Media
5.	Raspberry Pi Computer Architecture Essentials, by Andrew K Dennis
6.	Getting Started with Arduino, M. Banzi, O Reilly Media
7.	GSMA IoT Security Guidelines & Assessment - https://www.gsma.com/iot/future-iot-networks/iot-security-guidelines/

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ECOE01	OE	3	--	--	3	30	70	3 Hrs

ELECTRONIC DEVICES AND CIRCUITS

(Offered by ECE)

(Offered to AIDS, AIML, CE, CSIT, CSBS, CSD, CSE, CIC, IT & ME)

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 the characteristics of rectifier circuits.
3.	Fundamental operating characteristics of active elements such as BJT, FET and MOSFET.

Course Outcomes

S.No	Outcome	Knowledge Level
1.	**Understand** the basic concepts of semiconductor physics.	K3
2.	**Apply** the knowledge of semiconductor physics to study the characteristics of p-n junction diode and special diodes.	K2
3.	**Analyze** the characteristic parameters of rectifier circuits.	K2
4.	**Apply** the knowledge of semiconductor diodes to study the principle of working and operation of Bipolar Junction Transistor.	K2
5.	**Apply** the knowledge of semiconductor diodes to study the principle of working and operation of Field Effect Transistor and MOSFET	K2

SYLLABUS

UNIT-I (8 Hrs)	**Semi-Conductor Physics:** Intrinsic and extrinsic Semiconductors, Conduction in semiconductors, Charge densities, Diffusion current density, Drift current density, Hall effect.
UNIT-II (8 Hrs)	**Junction Diode Characteristics:** Energy band diagram of PN junction Diode, Open circuited p-n junction, V-I Characteristics p-n junction diode. **Special Semiconductor Devices**: Breakdown mechanisms, Zener Diode, LED, Photodiode, Tunnel Diode**.**
UNIT-III (8 Hrs)	**Rectifiers and Filters:** Basic Rectifier setup**,** Operation of half wave rectifier, full wave rectifier and bridge rectifier, input and output waveforms, derivations of ripple factor and efficiency, Operation of rectifier with Capacitor filter.
UNIT-IV (8 Hrs)	**BJT:** Junction transistor, transistor current components, transistor equation, transistor configurations, transistor as an amplifier, characteristics of transistor in Common Base,

	Common Emitter and Common Collector configurations, Comparison between CE, CB and CC configurations.
UNIT-V (8 Hrs)	**FET:** Classification of FETs, Operation and characteristics of JFET, parameters of JFET, Construction and operation of MOSFET, comparison between JFET and MOSFET.
Textbooks:	
1.	Electronic Devices and Circuit Theory – Robert L.Boylestad and Lowis Nashelsky, Pearson Edition, 2021.
2.	Electronic devices and circuits by S.Salivahanan and N.Sureshkumar, Tata MCGraw Hill edition.
Reference Books:	
1.	Integrated Electronics: Analog and Digital circuits and systems by Jacob Millman and Christos C.Halkias, Tata MCGraw Hill edition.
2.	Electronic Devices and Circuits by Sanjeev Guptha, DhanapatRai 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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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23EEOE01	OE	3	--	--	3	30	70	3 Hrs.

RENEWABLE ENERGY SOURCES

(Offered by EEE)

(Offered to AIDS, AIML, CE, CSIT, CSBS, CSD, CSE, CIC, ECE & IT)

Course Objectives: Students will learn

1.	About the significance of Renewable energy and its current scenario.
2.	To understand the concepts of solar energy and its conversion systems.
3.	About the fundamentals of wind energy and conversion systems. .
4.	About the ocean thermal, wave and tidal energies.
5.	To understand the concepts of geo-thermal energy and fuel cells.

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

S.No	Outcome	Knowledge Level
1.	Explore the importance of Renewable energy resources and world energy scenario.	K3
2.	Apply the principles of solar geometry for heat and electric power generation.	K3
3.	Apply the wind energy basics for wind turbine operation and power generation.	K3
4.	Illustrate the power generation schemes with Ocean thermal, Wave and Tidal Energy	K3
5.	Illustrate the power generation schemes with Geo-thermal and Fuel cells.	K3

SYLLABUS

UNIT-I (10Hrs)	**Introduction to Non-Conventional Energy Sources:** Conventional Energy Resources - Availability and their limitations; Non - Conventional Energy Resources – Classification, Advantages, Limitations; Comparison of Conventional and Non-Conventional Energy Resources; World Energy Scenario; Indian Energy Scenario.
UNIT-II (10 Hrs)	**Solar Energy:** Introduction, solar constant, solar radiation at the earth's surface, solar geometry, solar radiation measurements, estimation of average solar radiation. Solar energy collectors - Physical principles of the conversion of solar radiation into heat, flat plate collectors, concentrating collectors - Parabolic trough and Paraboloid dish collector, Solar electric power generation - principles of solar photo-voltaic cells, conversion efficiency and power output.
UNIT-III (10 Hrs)	**Wind Energy:** Introduction, basic principles of wind energy conversion-nature of wind, power in the wind, maximum power, forces on the blades, lift and drag forces, aerodynamics, types of wind power plants, types of wind turbine, generating systems, application of wind energy,

	site selection considerations.
UNIT-IV (10 Hrs)	**Ocean Energy:** Ocean Thermal Energy conversion - working principle, availability, types, advantages, limitations. Wave Energy - Factors affecting the wave energy, mathematical analysis for potential energy, kinetic energy, Total energy and wave energy conversion devices. Tidal Energy - Basic terminology, types of tidal plants, energy potential estimation from a tidal plant, advantages and limitations.
UNIT-V (10 Hrs)	**Geo-Thermal Energy and Fuel Cells:** Geo-Thermal Energy - Structure of earth's interior, thermal gradient, geo-thermal energy sources, types of geo-thermal power generation, merits & demerits. Fuel Cells - Principle and classification of Fuel cells, types and conversion efficiency.
Textbooks:	
1.	G. D. Rai, "Non-Conventional Energy Sources", 6th edition, Khanna Publishers.
2.	D. P. Kothari, K. C. Singal and Rakesh Ranjan, "Renewable Energy sources and Emerging Technologies", 2nd Edition, PHI Learning Pvt. Limited, 2013.
Reference Books:	
1.	S. P. Sukhatme, "Solar Energy", 3rd edition, Tata McGraw-Hill Education, 1996.
2.	G. N. Tiwari and M. K. Ghosal, "Renewable energy resources", First Edition, Narosa Publishing House, 2004.
e-Resources:	
1.	https://nptel.ac.in/courses/103103206
2.	https://nptel.ac.in/courses/121106014

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23EEOE02	OE	3	--	--	3	30	70	3 Hrs.

PRINCIPLES OF CONTROL SYSTEMS

(Offered by EEE)

(Offered to AIDS, AIML, CE, CSIT, CSBS, CSD, CSE, CIC, ECE & IT)

Course Objectives: Students will learn about

1.	The transfer function modelling & representation of linear systems using block diagrams and signal flow graphs.
2.	The time response of Linear Time Invariant (LTI) systems.
3.	The concept of stability and know different techniques of stability analysis.
4.	The frequency domain analysis using frequency response plots.
5.	The concept of state space modeling and analysis.

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

S.No	Outcome	Knowledge Level
1.	Model electrical systems by applying laws of physics and derive transfer functions from block diagrams & Signal Flow Graphs.	K4
2.	Analyze systems in time domain for transient and steady-state behavior	K4
3.	Analyze the stability of a system by RH criterion and Root locus.	K4
4.	Analyze the behavior of system using frequency response plots.	K4
5.	Model and analyze the LTI system using state space approach.	K4

SYLLABUS

UNIT-I (10Hrs)	**Mathematical Modelling of Control Systems:** Open loop and closed loop systems -Transfer Function models of linear Systems - Modelling of Electrical Systems - Block Diagram representation of Control Systems – Block Diagram Reduction - Signal Flow Graph representation of control systems, Mason's gain formula.
UNIT-II (10 Hrs)	**Time Domain Analysis of Control Systems:** Time Response of First and Second Order Systems with Standard Input Signals - Time Domain Specifications of Second Order Systems - Steady State Error, Steady State Error Constants, Basic Control Actions – Introduction to PI, PD & PID Controllers.
UNIT-III (10 Hrs)	**Stability Analysis of Control Systems:** Concept of Stability, Routh-Hurwitz Criterion, Relative Stability Analysis - The Concept and Construction of Root Loci - Simple problems.

UNIT-IV (10 Hrs)	**Frequency Domain Analysis of Control Systems:** Frequency Response - Bode Plots - Log Magnitude versus Phase Plots, Polar Plots – Frequency Domain specifications – Nyquist stability – Gain Margin & Phase Margin using bode plots.
UNIT-V (10 Hrs)	**State Space Analysis of LTI Systems:** Concept of state, State Variables and State Models - State space models for LTI electrical Systems, Phase variable form - Conversion between Transfer Function models and State space Models - Solution to the State Equation, State Transition Matrix - Concept of Controllability and Observability (simple problems).

Textbooks:	
1.	I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International Publishers (6^{th} Edition).
2.	Kuo, 'Automatic control systems', McGraw Hill India (10^{th} edition)
Reference Books:	
1.	Norman S.Nise,'Control systems Engineering', Wiley publications (7^{th} Edition)
2.	Katsuhiko Ogata, "Modern Control Engineering" PHI (4^{th} Edition).
3.	Richard C. Dorf and Robert H. Bishop, „Modern Control Systems", Addison-Wesley Publishers (8^{th} Edition)
e-Resources:	
1.	https://nptel.ac.in/courses/107106081
2.	https://nptel.ac.in/courses/108106098

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Course Code	Category	L	T	P	C	I.M	E.M	Exam
B23ITOE01	OE	3	--	--	3	30	70	3 Hrs.

OBJECT ORIENTED PROGRAMMING THROUGH JAVA

Offered by IT

(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 inheritance and interfaces to build JAVA programmes	K3
4.	Apply the concept of Exception Handling and Input & Output operations	K4
5.	Analyze JDBC concepts and design basic JDBC applications	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 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
Resources:	
1.	https://nptel.ac.in/courses/106/105/106105191/
2.	https://www.w3schools.com/java/java_data_types.asp

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Course Code	Category	L	T	P	C	I.M	E.M	Exam
B23MEOE01	OE	3	--	--	3	30	70	3 Hrs.

APPLIED OPERATIONS RESEARCH

(Offered by ME)

(Offered to AIDS, CE, CSIT, CSBS, CSD, CSE, CIC, EEE & ECE)

Course Objectives:

1.	Understand Linear Programming
2.	Learn Transportation and Assignment models
3.	Solve Job Sequencing and replacement problems
4.	Understand waiting line and project management problems
5.	Learn dynamic programming and games theory models

Course Outcomes: Upon successful completion of the course, the students will be able to

S.No	Outcome	Knowledge Level
1.	**Demonstrate** Linear Programming models	K3
2.	**Solve** Transportation and Assignment problems	K3
3.	**Demonstrate** job sequencing and replacement Problems	K3
4.	**Solve** Waiting line Models and Project scheduling problems	K3
5.	**Solve** games theory and dynamic programming models	K3

SYLLABUS

UNIT-I (10Hrs)	**Introduction to OR:** Definition of OR, Characteristics and phases of OR, Scope of OR, OR models, Role of computers in OR. **Linear Programming:** Formulation, Graphical Solution, Simplex Method, Artificial Variable Technique-Big-M method.
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 for N-Jobs 2-Machines Problems, N-Jobs 3-Machines Problems, N-Jobs M-Machines Problems, Graphical solution for 2-Jobs and M-Machines Problems.
UNIT-IV	**Network Analysis:** Introduction, Project scheduling by CPM and PERT, Network

(10 Hrs)	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.
UNIT-V (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. **Dynamic Programming:** Introduction, Bellman's principle of optimality, applications of dynamic programming, shortest path problem, linear programming problem

Text Books:	
1.	Operations Research-An Introduction / Hamdy A Taha/Pearson publishers
2.	Operations Research by S.D Sharma / McMillan publishers India Ltd
3.	Operations Research by V. K. Kapoor.
Reference Books:	
1.	Introduction to O.R/Hiller &Libermann/TMH
2.	Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education
3.	Operations Research: Methods & Problems Maurice Saseini, ArhurYaspan& Lawrence Friedman/Wiley
4.	Operations Research/R.Pannerselvam/ PHI Publications.
5.	Operations Research/Wagner/PHI Publications.
Web links	
1.	https://nptel.ac.in/courses/112/106/112106134/
2.	https://nptel.ac.in/courses/110/106/110106062/

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B23MEOE02	OE	3	--	--	3	30	70	3 Hrs.

SUSTAINABLE ENERGY TECHNOLOGIES

(Offered by ME)

(Offered to AIDS, AIML, CE, CSIT, CSBS, CSD, CSE, CIC, ECE, EEE & IT)

Course Objectives:

1.	To demonstrate the importance the impact of solar radiation.
2.	To understand the principles of storage in PV systems
3.	To discuss solar energy storage systems and their applications.
4.	To get knowledge in wind energy and bio-mass
5.	To gain insights in geothermal energy, ocean energy and fuel cells.

Course Outcomes

S.No	Outcome	Knowledge Level
1.	**Demonstrate** the importance of solar radiation.	**K3**
2.	**Use** the principles of storage in PV systems.	**K3**
3.	**Determine** the solar energy storage for various applications.	**K3**
4.	**Apply** the fundamentals of wind energy and biomass energy..	**K3**
5.	**Apply** to learn about fuel cells, ocean energy, and geothermal energy.	**K3**

SYLLABUS

UNIT-I (10Hrs)	**SOLAR RADIATION**: Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data
UNIT-II (10 Hrs)	**STORAGE IN PV SYSTEMS:** Battery Operation, Types of Batteries, Battery Parameters, Application and Selection of Batteries for Solar PV System, Battery Maintenance and Measurements, Battery Installation for PV System.
UNIT-III (10 Hrs)	**SOLAR ENERGY COLLECTION**: Flat plate and concentrating collectors, classification of concentrating collectors, orientation. **SOLAR ENERGY STORAGE AND APPLICATIONS**: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

UNIT-IV (10 Hrs)	**WIND ENERGY**: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement. **BIO-MASS**: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.
UNIT-V (10 Hrs)	**GEOTHERMAL ENERGY:** Origin, Applications, Types of Geothermal Resources, Relative Merits **OCEAN ENERGY:** Ocean Thermal Energy; Wave and Tidal energy conversions,Open Cycle & Closed Cycle OTEC Plants, Environmental Impacts, Challenges **FUEL CELLS:** Introduction, Applications, Classification, Different Types of Fuel Cells Such as Phosphoric Acid Fuel Cell, Alkaline Fuel Cell, PEM Fuel Cell, MC Fuel Cell.
Textbooks:	
1.	Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH
2.	Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 2006
Reference Books:	
1.	Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013
2.	Principles of Solar Engineering - D.YogiGoswami, Frank Krieth& John F Kreider / Taylor &Francis
3.	Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd
4.	Renewable Energy Technologies -Ramesh & Kumar /Narosa
5.	Non-conventional Energy Source- G.D Roy/Standard Publishers
e-Resources	
1.	https://nptel.ac.in/courses/103103206
2.	https://nptel.ac.in/courses/103107157

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Course Code	Category	L	T	P	C	C.I.E	S.E.E	Exam
B23BSOE01	OE	3	--	--	3	30	70	3 Hrs.

MATHEMATICS FOR MACHINE LEARNING

(Offered by M&H)

(Offered to AIDS, AIML, CE, CSIT, CSBS, CSD, CSE, CIC, ECE, EEE, IT & MECH)

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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