Academic Curricula

Undergraduate Degree Programme

B.Tech. (Hons & Research Program)
Open Elective / Minor Courses
(2022–2023)

For B. Tech. Students Admitted in the Academic Session (2022–2023)

Kalinga Institute of Industrial Technology (KIIT)
Deemed to be University U/S 3 of UGC Act, 1956
Bhubaneswar, Odisha, India

GUIDELINES

Open Electives

Open electives allow students to choose courses from lists of courses offered by all the Schools. It is through these courses that a student can pursue his or her latent interests in specific areas and work towards earning a Minor in an area which is outside his (or her) major engineering branch (if the courses are selected in specific designated areas). These courses are offered in Semester V through Semester VIII:

Semester V:	K-Explore—Practice-based Open Elective I
Semester VI – VIII:	Open Electives II, III, and IV

K-Explore is a 1-Credit Practice-based Open Elective that allows the students to use the scope that the Clubs and the Societies of KIIT University provides to learn the skills of Dance, Music, Photography, etc. and of conducting seminars and conferences through training, practice, and direct involvement.

Minor

The curricula allow a student to earn a Minor in an area outside the core discipline in which he (or she) has registered. For example, a student doing B. Tech in Mechanical Engineering (his/her parent branch) can choose to have a Minor in Computer Science Engineering. To get a Minor, a student must

(i) Get the fourth semester CGPA of 7.0 or more,

(ii) Successfully fulfill the coursework requirement for at least six theory courses and two credit Lab/project courses in an area or discipline other than the one for which he (or she) is registered, and

(iii) Complete at least 20 Credits of coursework in that area.

Thus, if a student has taken threeOpen Electives in one area other than his (or her) own then he (or she) must choose three theory courses and two Lab/project courses in that area in the Fourth year.

If no Lab course is available in that Minor, then the student must choose an additional theory course with at least 2 Credits. Students having no backlogs till the end of Semester 4 and a minimum CGPA of 7.0 will only be allowed to opt for the Minor scheme. Students opting for Minor have to mandatorily attend a minimum of 75% Theory and Lab classes (as the case may be) failing which the Minor option will be withdrawn.

NOTEs

- Students pursuing the 4-year B.Tech. (Hons.) program must opt for three semester-wise Open elective courses, one in each of Semester VI, Semester VII, and Semester VIII.
- Students pursuing the 4-year B.Tech. (Res.) program must opt for one Open elective course in Semester VI.
- Not all courses listed above may be offered in a semester.
- Allocation of courses to the students will be based on a first-come first-serve basis.
- A student with a CGPA of 7.0 after Semester IV must select three additional theory courses and one laboratory course, in Semester VII and Semester VIII to earn a Minor.
- The courses that lead to a particular Minor are marked above with a cross (X).

School of Computer Engineering
Semester-wise Open Elective/Minor Courses

SEMESTER VI/VII/VII			
Course Code	**Open Elective Courses**	**Pre-requisite**	**Minor in Computer Science**
CS30001	Design and Analysis of Algorithms	Nil	
CS30018	Software Engineering Fundamentals	Nil	
CS30020	Essentials of Computer Science	Nil	x
CS30022	Object Oriented Programming	Nil	
CS30024	Fundamentals of Data Structures	Nil	x
CS30011	Computational Intelligence	Nil	
CS40002	Nature Inspired Computing	Nil	

Minor Lab / Project (Students pursuing 4 years B.Tech. Hons or B.Tech. Research program along with Minor program)

Course Code	**Courses**	**Pre-requisite**
CS39008	Computing Laboratory	Nil

School of Civil Engineering
Semester-wise Open Elective/Minor Courses

SEMESTER – VI						
Course Code	**Open Elective Courses**	**Pre-requisite**	**Minor in**			
			Water Resources Management	**Urban Environmental Management**	**Geohazard Mitigation & Management**	**Urban Transportation Management**
CE30072	Fundamentals of Project Management	Nil				
CE30074	Elements of Surface Hydrology	Nil				
CE30076	Environmental Pollution and Control	Nil				
CE30078	Municipal Solid Waste Management	Nil				
CE30052	Surface & Groundwater Hydrology	Nil	x			
CE30054	Water Supply & Quality Management	Nil		x		
CE30056	Geomaterial Characterization	Nil			x	
CE30058	Highway Material Characterization	Nil				x
SEMESTER – VII						
CE40081	Disaster Management	Nil				
CE40083	Coastal Management	Nil				
CE40085	Basic Groundwater Hydrology	Nil				
CE40087	Clean water & Sanitation	Nil				
CE40051	Basic Fluid Mechanics & Hydraulics	Nil	x			
CE40053	Introduction to Remote Sensing & GIS	Nil	x	x		
CE40055	Irrigation Water	Nil	x			

	Management					
CE40057	Urban Waste Management	Nil		x		
CE40059	Urban Storm Water Management	Nil		x		
CE40061	Landslide hazards and protection	Nil			x	
CE40063	Earthquake hazards and mitigation	Nil			x	
CE40065	Geo-hazards Risk Management	Nil			x	
CE40067	Traffic Analysis and Management	Nil				x
CE40069	Railway and Airport Planning	Nil				x
CE40071	Road Safety Analysis	Nil				x
SEMESTER – VIII						
CE40082	Global Warming & Climate Change	Nil				
CE40084	Construction Materials & Specifications	Nil				
CE40086	Natural Resources Management	Nil				
CE40088	Basic Transportation Engineering	Nil				
CE40050	Gender & Legal Aspects in Water Resources Management	Nil	x			
CE40052	Environmental Impact Assessment	Nil	x	x		x
CE40054	Air Pollution Control & Management	Nil		x		
CE40056	Groundwater contamination and remediation	Nil			x	
CE40058	Geotechnical instrumentation and monitoring	Nil			x	

CE40060	Fundamentals of Urban Transportation Planning	Nil				x

Minor Laboratory / Project (Students pursuing 4 years B.Tech. Hons or B.Tech. Research program along with Minor program)

Course Code	**Course**	**Pre-requisite**	**Minor Specialization**			
			Water Resources Management	**Urban Environmental Management**	**Geohazard Mitigation and Management**	**Urban Transportation Management**
CE49001	Water Resources Laboratory	Nil	x			
CE49003	Environmental Quality Laboratory	Nil		x		
CE49005	Geomaterial Laboratory	Nil			x	
CE49007	Highway Material Laboratory	Nil				x

School of Electrical Engineering
Semester-wise Open Elective/Minor Courses

SEMESTER – VI					
Course Code	**Open Elective Courses**	**Pre-requisite**	**Minor in**		
			Electrical Engineering	**Smart Electric Vehicles**	**Industrial IoT**
EE30034	Network Analysis	Nil	x	x	x
EE30016	Renewable Energy Resources	Nil	x	x	
EE30036	Solar Power Technology	Nil			
EE30038	Introduction to Electrical Machines	Nil	x	x	x
EE30040	Energy and Environment	Nil			
EE20007	Analog and Digital Electronics Circuits	Nil	x	x	
EE20005	Measurements and Sensors Technology	Nil	x		
SEMESTER – VII					
EE40031	Fuel Technology	Nil			
EE40033	Energy Audit and Management	Nil	x		
EE20004	Linear Control System	Nil	x	x	x
EE30012	Sensors and Actuators	Nil		x	x
EE40035	Energy Storage Technology	Nil	x	x	
EE30004	Microprocessors and Embedded System	Nil	x		
EE40020	Digital System Design using FPGA	Nil		x	x
EE30022	Special Machines and Control	Nil		x	
EE40044	Hybrid Electric Vehicles	Nil		x	
EE40042	Robotics and Control	Nil			x
EE40047	Cyber security	Nil			x
EE40048	Wireless network systems	Nil			x
SEMESTER – VIII					
EE30007	Power Transmission and Distribution	Nil	x		
EE30001	Power Electronics	Nil	x		

EE30024	Electric Drives and Control	Nil	x		
EE40041	Power System Protection	Nil	x		
EE40046	IoT in Electric Vehicles	Nil		x	
EE40022	Vehicle Charging Technology	Nil		x	
EE40045	Hydrogen and fuel cell technology for Electric and hybrid Vehicle	Nil		x	
EE40049	IoT in Industry	Nil			x
EE40050	Smart Bio-Medical Instruments	Nil			x
EE40051	Bio-Inspired Algorithm	Nil			x
EE40052	IoT Sensors and Protocols	Nil			x

Minor Lab / Project (Students pursuing 4 years B.Tech. Hons or B.Tech. Research program along with Minor program)

Course Code	Course	Pre-requisite	Minor Specialization		
			Electrical Engineering	**Smart Electric Vehicles**	**Industrial IoT**
EE29002	Electrical Machines Laboratory	Nil	x		
EE39001	Power Electronics Laboratory	Nil	x		
EE49001	Power System Protection Lab	Nil	x		
EE49005	Electric Vehicles Laboratory	Nil		x	
EE49003	IoT Laboratory	Nil		x	x
EE49002	Sensors and Control Laboratory	Nil		x	x
EE39007	PLC Laboratory	Nil			x

School of Electronics Engineering
Semester-wise Open Elective/Minor Courses

SEMESTER – VI

Course Code	Open Elective Courses	Pre-requisite	Minor in			
			Minor in Communication and Networking	Minor in VLSI and Embedded System	Minor in Applied Machine Learning	Minor in Cyberphysical Systems
EC30014	Circuits, Signals and Communication	Nil	x	x	x	x
EC30016	Introduction to Sensor Technology	EC10001				x
EC30018	Evolution of Communication Technology	Nil				
EC30020	Electronics and PCB Design	Nil				
EC40001	Optimization Techniques in Engineering	Nil				

SEMESTER – VII

Course Code	Open Elective Courses	Pre-requisite	Minor in			
			Minor in Communication and Networking	Minor in VLSI and Embedded System	Minor in Applied Machine Learning	Minor in Cyberphysical Systems
EC20007	Semiconductor Technology	Nil		x		
EC30011	Digital System Design with Verilog	NIL		x		
EC30013	Optical and Satellite Communication	EC20008	x			
EC30019	Information Theory and Coding	EC20008 / EC30014	x			
EC40023	Consumer Electronics	NIL				
EC40025	Fundamentals of Data Acquisition Systems	NIL				

EC40027	Embedded System Design and Applications	NIL		x	x	x
EC40029	Communication Network Fundamentals	EC20008 / EC30014	x			
EC40031	Principles of Opto-Electronics	NIL				
EC40033	Principle of Modern Communication Systems	NIL				
EM30009	Data Analytics	NIL				x
EM30011	Data Mining	NIL			x	
EM40006	Cybersecurity	NIL				x
EM40008	Bioinformatics	LS10001			x	

SEMESTER – VIII

Course Code	**Open Elective Courses**	**Pre-requisite**	**Minor in**			
			Minor in Communication and Networking	**Minor in VLSI and Embedded System**	**Minor in Applied Machine Learning**	**Minor in Cyberphysical Systems**
EC30010	Mobile Ad Hoc Network	EC20008	x			
EC30021	Industrial IoT	EC30004				x
EC40004	Quantum Communication	NIL		x		
EC40020	Essence of Biomedical Signal Processing	NIL				
EC40022	Imaging Techniques	NIL				
EM30007	Machine learning based Signal Processing	NIL	x	x	x	x
EM40010	Optimization Methods in Machine Learning	NIL			x	

Minor Lab / Project (Students pursuing 4 years B.Tech. Hons or B.Tech. Research program along with Minor program)

Course Code	Course	Pre-requisite	Minor Specialization			
			Minor in Communication and Networking	Minor in VLSI and Embedded System	Minor in Applied Machine Learning	Minor in Cyberphysical Systems
	MI-Lab		X	X	X	X
EC47004	Project		X	X	X	X

School of Mechanical Engineering
Semester-wise Open Elective/Minor Courses

SEMESTER – VI					
Course Code	**Open Elective Courses**	**Pre-requisite**	**Minor in**		
			Mechanical Engineering	**Manufacturing Engineering**	**Industrial Engineering and Management**
ME30050	Kinematics and Dynamics of Machinery	Nil	x		
ME20005	Material Science and Engineering	Nil		x	
ME30016	Supply Chain Management	Nil			x
ME30052	Introduction to Fluid Mechanics and Heat Transfer	Nil			
ME30054	Renewable Energy Sources	Nil			
ME30056	Finite Element Method for Engineers	Nil			
ME30058	Introduction to Composite Materials	Nil			
SEMESTER – VII					
ME40061	Engineering Metrology	Nil		x	
ME30005	Industrial Engineering and Operations Research	Nil	x	x	
ME40077	Manufacturing Processes	Nil	x	x	
ME40063	Quality Engineering	Nil			x
ME40065	Project Management	Nil			x
ME40067	Operations Research	Nil			x
ME40069	Thermodynamics and Hydraulic Devices	Nil	x		
ME40071	Biomechanics	Nil			
ME40073	Fundamentals of Computational Fluid Dynamics	Nil			

ME40075	Automobile Technology	Nil			
SEMESTER – VIII					
ME40062	Work System Design	Nil			x
ME30018	Power Plant Engineering	Nil	x		
ME40064	Mechanical System Design	Nil	x		
ME30015	Additive Manufacturing	Nil		x	
ME40066	Industrial Automation and Robotics	Nil		x	
ME40068	Production, Planning and Control	Nil			x
ME40070	Mechatronic Systems	Nil			
ME40072	Robotics	Nil			
ME40074	Computer Controlled Manufacturing Systems	Nil			

Minor Lab / Project (Students pursuing 4 years B.Tech. Hons or B.Tech. Research program along with Minor program)

Course Code	**Course**	**Pre-requisite**	**Minor Specialization**		
			Mechanical Engineering	**Manufacturing Engineering**	**Industrial Engineering**
ME49011	Thermo fluids Lab	Nil	x		
ME28003	Manufacturing Practices	Nil	x	x	
ME49013	Metrology and Instrumentation Lab	Nil		x	
ME48011	Operations Research Sessional	Nil			x
ME49016	Work System Design Lab	Nil			x

School of Humanities
Semester-wise Open Elective/Minor Courses

SEMESTER – VI			
Course Code	**Open Elective Courses**	**Pre-requisite**	**Minor in Financial Economics (Using Data Analytics)**
HS30150	Foundations of Modern Macroeconomics	Nil	
HS30152	Money and Financial Markets	Nil	x
HS30154	Poverty to Prosperity	Nil	
HS30250	Organizational Change and Development	Nil	
HS30050	Indian Literature in Translation (ILT)	Nil	
HS30052	Climate Change Narratives	Nil	
HS30054	Introduction to Science Fiction	Nil	
SEMESTER – VII			
HS40151	Econometrics for Business Data Analysis	Nil	x
HS40153	Financial Economics	Nil	x
HS40155	Corporate Finance	Nil	x
HS40157	Employment, Employability and Growth	Nil	
SEMESTER – VIII			
HS40156	Public Economics	Nil	x
HS40158	Advanced Econometrics	Nil	x
HS47160	Project	Nil	x
HS40162	Economic Inequality	Nil	

SEMESTER – VI			
Course Code	**Minor Courses**	**Pre-requisite**	**Minor in Sustainable Development**
CE30078	Municipal Solid Waste Management	Nil	
EE30032	Sustainable Energy and Applications	Nil	
HS30154	Poverty to Prosperity	Nil	x
EE30030	Solar Energy Utilization	Nil	
SEMESTER – VII			
CE40087	Clean Water & Sanitation	Nil	x
CE40065	Geo-Hazards Risk Management	Nil	x
EE40013	Wind and Biomass Energy	Nil	x
HS40157	Employment, Employability and Growth	Nil	x
SEMESTER – VIII			
LS30002	Industrial Ecology and Design for Sustainability	Nil	x
EE40018	Waste Management and Energy Recovery	Nil	
HS40162	Economic Inequality	Nil	x

School of Applied Sciences
Semester-wise Open Electiv Courses

Course Code	Courses	Prerequisites
SEMESTER – VI		
MA30002	Advanced Numerical Techniques	Nil
LS30002	Industrial Ecology and Design for Sustainability	Nil
CH30002	Sustainable Energy and Environment	Nil
SEMESTER – VII		
MA40001	Finite Element Analysis	Nil
PH40001	Quantum Computing	Nil
CH40001	Composite Materials and Structures	Nil
SEMESTER – VIII		
CH40002	Solid Waste Management	Nil

School of Management
Semester-wise Open Elective/Minor Courses

Course Code	Courses	Prerequisites
BM30102	Training & Development	Nil
BM30202	Financial Management	Nil
BM30302	Marketing Management	Nil
BM30602	Basics of Management Information System	Nil
BM30702	Entrepreneurship	Nil
BM30802	Production & Operations Management	Nil

School of Rural Management
Semester-wise Open Elective Courses

Course Code	Courses	Prerequisites
RM30152	Sustainable Rural Development	Nil
RM20152	Food Security	Nil

School of Law
Semester-wise Open Elective Courses

Course Code	Courses	Prerequisites
LW30910	Law of Patent	Nil
LW30904	Law of Contract	Nil
LW30908	Intellectual Property Rights Law	Nil
LW30914	Environmental Law	Nil
LW30918	Copyright Law	Nil
LW30920	Information Technology Law	Nil

School of Public Health
Semester-wise Open Elective Course

Course Code	Courses	Prerequisites
PE30002	Health and Wellbeing	Nil

DESIGN AND ANALYSIS OF ALGORITHIMS

Course Code:CS30001
Credit: 3
L-T-P: 3-0-0
Prerequisite: CS21001

COURSE OBJECTIVE

- To understand the importance of algorithm
- To analyze the complexity of an algorithm in terms of time and space complexities
- To understand various problem solving techniques
- To learn about amortized analysis of algorithms
- To design and implement various programming paradigms and its complexity

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Analyze the time and space complexity for any algorithm,

CO2: Compare and contrast different algorithm techniques,

CO3: Apply the design techniques of algorithm in solving real world problems,

CO4: Perform amortize analysis for any algorithm,

CO5: Modify existing algorithms to apply in common engineering design situations,and

CO6: Use NP class of problems to propose approximation algorithms.

COURSE CONTENTS

UNIT I

Introduction
Concepts in algorithm analysis & design motivation, Space and Time Complexity of algorithm, Asymptotic Notations (Big Oh, Omega, Theta), Analysis of time complexity of Insertion Sort by step count method, Solving recurrences using Iterative, Substitution, Recurrence Tree, Master theorem

UNIT II

Divide & Conquer and Greedy Approaches
Divide and Conquer method, Greedy method, Huffman code, Minimum spanning trees, Dijkstra algorithm, Knapsack problem, Job sequencing with deadlines.

UNIT III

Dynamic Programming Approaches

Dynamic Programming, Knapsack problem, Matrix Chain Multiplication, longest common subsequence Multistage graphs, All pair's shortest paths, Optimal binary search trees, Travelling salesman problem.

UNIT IV

Amortization
Randomized Algorithms and Amortized Analysis, Las Vegas and Monte Carlo types, Randomized quick sort andits analysis, Min-Cut algorithm.

UNIT V

NP Problems
NP-Hard and NP-complete problems, Basic concepts, Reducibility, Vertex cover, 3CNF_SAT, clique, Hamiltoniancycle, TSP, Approximation algorithms, Vertex cover, TSP.

Textbook

1. T. Cormen, C. Lieserson, R. Rivest, C. Stein, "Introductions to Algorithms", Third Edition, Prentice-Hall/India, 2009.

Reference Books

1. A. M. Tenenbaum, Y. Langsam, M. J. Augestien, "Data Structures using C", First Edition, Pearson Education, 2007.
2. E. Harowitz, S. Sahni, S. Rajsekaran, "Fundamentals of Computer Algorithms", Universities press.

SOFTWARE ENGINEERING FUNDAMENTALS

Course Code: CS30018
Credit: 3
L-T-P: 3-0-0
Prerequisite: NIL

COURSE OBJECTIVE

- To know software process models
- To understand application of software process models
- To be able to know requirements of the software projects
- To apply the basic project management practices in real life projects.
- To be able to distinguish different testing methodologies

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Elaborate on different software process models,
CO2: Evaluate the requirements of the software projects,
CO3: Apply the basic project management practices in real life projects,
CO4: Translate the baseline requirement specifications into design process,
CO5: Distinguish different testing methodologies,and
CO6: Work ethically in a team on software projects.

COURSE CONTENTS

Unit I

Software Process Models:

Software product, Software crisis, Handling complexity through Abstraction and Decomposition, Overview of software development activities. Process Models: Classical waterfall model, Iterative waterfall model, Prototyping model, Evolutionary model, Spiral model, RAD model. Agile models: Extreme programming and Scrum. Software Requirement Engineering

Unit II

Software Requirement Engineering:

Requirement Gathering and analysis, Functional and non functional requirements, Software Requirement Specification(SRS) , IEEE 830 guidelines, Decision tables and trees.

Unit III

Software Project Management:

Responsibilities of a Software project manager, Project planning, Metrics for project size estimation, Project estimation techniques, Empirical estimation techniques, COCOMO models, Scheduling, Organization & team structure, Staffing, Risk management, Software configuration management.

Unit IV

Structural Analysis & Design:

Overview of design process: High level and detailed design, Cohesion & coupling, Modularity and layering, Function–Oriented software design: Structural Analysis, Structural Design (DFD and Structured Chart), Object Oriented Analysis & Design, Command language, menu and iconic interfaces.

Unit V

Testing Strategies:

Coding, Code Review, Documentation, Testing:, Unit testing, Black-box Testing, White-box testing, Cyclomatic complexity measure, Coverage analysis, Debugging, Integration testing, System testing, Regression testing.

Textbooks

1. Fundamentals of Software Engineering, Rajib Mall , PHI, Latest edition.

Reference books

1. Software Engineering: A Practitioner’s Approach, Roger S. Pressman, Eighth edition, MGH.
2. Software Engineering, Ian Sommerville, Tenth Edition, Pearson Education.

ESSENTIALS OF COMPUTER SCIENCE

Course Code: CS30020
Credit: 3
L-T-P: 3-0-0
Prerequisite: NIL

COURSE OBJECTIVE

- To make the student understand the basic building blocks of a computing system
- To make the student understand the flow of Concept- Program-Input-Processing-Output
- To introduce low level language, translators, operating system

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Trace the fundamentals of digital logic design,
CO2: Classify programming languages,
CO3: Explore the use of compiler,
CO4: Generate low level code for simple programs,
CO5: Understand functionality of an operating systems,and
CO6: Design simple arithmetic and memory units.

COURSE CONTENT

UNIT I

Concept, Program, Input, Processing – Output

Demo of simple high level language program to low level machine level language program, Tracing their execution from high level to circuit level/ gate level, Overview of the Hardware Description Language (HDL), Designing a set of elementary logic gates from primitive NAND gates. Design of binary adders, Culminating in the construction of a simple ALU (Arithmetic–Logic Unit) using logic gates, Design of memory hierarchy from elementary flip–flop gates to registers and RAM units of arbitrary sizes using logic gates.

NIT II

Introduction to Low Level Language

Introducing an instruction set in both binary and assembly (symbolic) versions, Writing some low-level assembly programs, Other details of computer architecture, Basic language translation techniques: parsing, symbol table,macro, assembly

UNIT III

Introduction to Virtual Machine

The role of virtual machines in modern software architectures like Java and .NET, Introduction of a typical VM language, Focusing on stack–based arithmetic, Logical and memory access operations, VM abstraction and implementation, Focusing on stack-based flow-of-control and subroutine call-and-return techniques.

UNIT IV

Introduction to Compilers

Context-free grammars and recursive parsing algorithms, Building a syntax analyzer (tokenizer and parser), The syntax analyzer to generate XML code reflecting the structure of the translated program, Code generation, Low- level handling of arrays and objects.

UNIT V

Introduction to OS

Discussion of OS/hardware and OS/software design trade–offs, and time/space efficiency considerations, Design and implementation of OS, memory management, string processing, I/O handling algorithms.

Textbook

1. Noam Nisan, Shimon Schocken, "The Elements of Computing System: Building a Modern Computer fromFirst Principles", MIT Press, 2005.

OBJECT ORIENTED PROGRAMMING

Course Code: CS30022
Credit: 3
L-T-P: 3-0-0
Prerequisite: C Programming

COURSE OBJECTIVE

- To understand the difference between structure-oriented and object-oriented programming
- To know various object-oriented features
- To know exception handling and generic programming
- To test and debug solutions in C++

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Compare the features between structure-oriented and object-oriented programming,
CO2: Develop object-oriented programming language like C++ and associated libraries to develop object-oriented programs,

CO3: Apply various object-oriented features like class, object, inheritance, data abstraction, encapsulation polymorphism to solve various computing problems,
CO4: Design application using operator-overloading, contracture and destructor,
CO5: Apply exception handling and use built-in classes from STL,and
CO6: Implement, test and debug solutions in C++.

COURSE CONTENTS

UNIT I

Introduction to Object Oriented Programming

Object oriented programming concepts: Objects, Classes, Encapsulation and abstraction, Inheritance, Polymorphism, Dynamic binding, Message passing; C++ Programming basics: Character set, Keyword, Constant, Variable, Data types, Operator & expression, Control structure (branching & looping), typecasting, Array & strings, Streams based I/O, Type conversions and casting, Name space, Scope resolution operator (::); Function: Parameter passing (i) by value, (ii) by address, (iii) by reference, Inline function, Function overloading, Default arguments.

UNIT II

Class and Object

Class and Object: Defining class with functions and data members, Creating & deleting objects by using new and delete operators respectively, Array of Objects, Objects as function argument, Static Data members and member functions, Function with default arguments, Function overloading; Constructor and Destructors: Definition of constructors and its uses, Types of constructors: Default constructor, Parameterized constructor, Copy constructor, Constructor with dynamic allocation, Dynamic Constructors, Constructor Overloading, Destructors.

UNIT III

Inheritance

Concept of inheritance: Defining derived and base classes, Class hierarchies, public, private, and protected derivations; Types of Inheritance: Single Inheritance, Multilevel Inheritance, Multiple Inheritance, Hierarchical Inheritance, Hybrid Inheritance, Virtual base class: Function overriding, Constructors/Destructors in derived classes: Constructors invocation and data members initialization in derived classes, Member classes: classes within classes.

UNIT IV

Polymorphism

Operator overloading: Overloading unary operators, Binary operators, overloading binary operators using friend function and member function, Rules for overloading operators; Polymorphism: Introduction to pointers: Pointers to objects, Pointer to derived class object, This pointer, Compile time polymorphism: Review of Function Overloading and Operator overloading; Run time polymorphism: Virtual functions, Pure virtual functions, Abstract class, Virtual constructors and destructors

UNIT V

Exception Handling, Templates, Files and Streams

Exception Handling: Basics of Exception Handling, Exception Handling Mechanism: The keyword try, Throw and catch. Templates: Need of template, Class Templates: Definition, Class Template with multiple parameters, Function Templates: Definition, Function Template with multiple parameters. Files and

Streams: Introduction to file handling: text file Vs. binary file, Hierarchy of file stream classes: Functions of File Stream classes, Steps to process a File in a program. Different functions used in file, File modes(Sequential and random), File pointers and their Manipulations, Error handling during file operation

Textbooks

1. Object Oriented Programming with C++, Reema Thareja, OXFORD University Press, Revised First Edition, 2018.
2. Object Oriented Programming with C++, E.Balaguruswamy, McGraw Hill Education; Seventh edition 2017.

Reference Books

1. C++ completes reference, Herbert Schildt, MGH, 10th Edition, 2002
2. C++ How to Program, Deitel and Deitel, Pearson Education, 10th Edition, 2011.
3. Programming in C++ Ashok N Kamthane, Pearson Education, 2nd Edition, 2003

FUNDAMENTALS OF DATA STRUCTURES

Course Code: CS30024
Credit: 3
L-T-P: 3-0-0
Prerequisite: NIL

COURSE OBJECTIVE

- To find the Time Complexity and Space Complexity for algorithm
- To understand the various techniques of sorting and searching
- To design and implement arrays, stacks, queues, and linked lists
- To understand the complex data structures such as trees and graphs
- To solve real life problems

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Use the concepts of data structure, data type and abstract data type to develop solutions for engineering problems,
CO2: Develop programs to implement linear data structures such as stacks, queues, linked lists, etc,
CO3: Apply the concept of trees and graph data structures in real world scenarios,
CO4: Comprehend the implementation of sorting and searching algorithms,

CO5: Compare Time Complexity and Space Complexity for algorithm,and
CO6: Effectively choose the data structure that efficiently models the information in a problem.

COURSE CONTENTS

UNIT I

Introduction

Development of Algorithms, Notations and analysis, Storage structures for arrays, Sparse matrices, Stacks andQueues: Representations and applications.

UNIT II

Linked List, Stacks, and Queues

Linked Lists, Linked stacks and queues, Operations on polynomials, Doubly linked lists, Circularly linked lists, Dynamic storage management, Garbage collection and compaction.

UNIT III

Trees

Tree representation, Binary Trees, Binary search trees, Tree traversal, Expression manipulation, Symbol table construction, Heightbalanced trees, AVL trees.

UNIT IV

Graphs

Graphs, Representation of graphs, BFS, DFS, Topological sort, String representation and manipulations, Patternmatching.

Textbooks

1. J. P. Tremblay, P. G. Sorenson, "An Introduction to Data Structures with Applications", Second Edition,Tata McGraw Hill, 1981.
2. M. Tenenbaum, Augestien, "Data Structures using C", Third Edition, Pearson Education, 2007.
3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Third Edition, Pearson Publishers, 2006.

Reference Book

1. Sartaj Sahni, "Data Structures, Algorithms and Applications in C++", Universities Press (I) Pvt. Ltd., 2008.

COMPUTATIONAL INTELLIGENCE

Course Code: CS30011
Credit: 3
L-T-P: 3-0-0
Prerequisite: NIL

COURSE OBJECTIVE

- To understand the basic concepts and characteristics of soft computing
- To understand and analyse fuzzy rules, fuzzy reasoning and various fuzzy inference systems
- To be able to know derivative free optimization and apply genetic algorithms to optimizationproblems
- To apply neural networks to variousclassification problems.
- To know some hybrid models such as adaptive Neuro-fuzzy inference systems

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Identify the basic concepts and characteristics of soft computing and also its associated Methodologies,
CO2: Apply various set theoretic operations in fuzzy sets,
CO3: Analyze fuzzy rules, fuzzy reasoning and various fuzzy inference systems,
CO4: Choose derivative free optimization and apply genetic algorithms to optimization problems,
CO5: Assess concepts of artificial neural networks and apply neural networks to various classification problems,and
CO6: Analyze some hybrid models such as adaptive neuro-fuzzy inference systems.

COURSE CONTENTS

UNIT I
Introduction
Introduction, Soft Computing constituents and Conventional AI, Neuro-Fuzzy and Soft Computing characteristics

UNIT II
Artificial Neural Networks
Introduction to ANN, Perceptrons and MLP, Adaline and Madaline, Back-propagation Multilayer Perceptrons (BPMLP), Radial Basis Function Networks (RBF), Kohonen Self-Organizing Networks, Learning Vector Quantization, Hebbian Learning, Hopfield networks

UNIT III

Fuzzy Set Theory

Fuzzy sets, Basic Definition and Terminology, Set-theoretic Operations, Member Function Formulation and Parameterization, More on Union, Intersection and Complement, Extension Principle and Fuzzy Relations, Fuzzy If-Then Rules, Fuzzy Reasoning, Fuzzy Inference Systems, Mamdani Fuzzy Models, Sugeno Fuzzy Models, Tsukamoto Fuzzy Models, Adaptive Neuro-Fuzzy Inference Systems(ANFIS), ANFIS Architecture, Hybrid Learning Algorithm

UNIT IV

Particle Swarm Optimization

PSO Model, Global Best, Local Best, Velocity Update Equations, Position Update Equations, Velocity Clamping, Inertia Weight, Constriction Coefficients, Synchronous and Asynchronous Updates, Binary PSO.

UNIT V

Differential Evolution

DE as modified GA, generation of population, operators and their implementation.

UNIT VI

Ant Colony Optimization

Basic Concepts, Ant System, Application.

UNIT VII

Artificial Bee Colony

Historical Development, Types of Bees and Their Role in the Optimization Process.

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Textbook

1. Neuro-Fuzzy and Soft Computing, Jang, Sun, Mizutani, PearsonEducation

Reference Books

1. Swarm Intelligence Algorithms: A Tutorial, Adam Slowik, Ed: CRC Press, 2020
2. Neural Networks: A Comprehensive Foundation, Simon Haykin, Pearson Education
3. Genetic Algorithms, David E. Goldberg, Pearson Publication, 2003

NATURE INSPIRED COMPUTING

Course Code: CS40002
Credit: 3
L-T-P: 3-0-0
Prerequisite: NIL

COURSE OBJECTIVE

- To gain knowledge on present and future computing paradigm changes with examples found in the real world
- To design of various computing models using cellular automata, biological and quantum computing.
- To be able to explain the application of NIC for solving real world problem.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Identify the needs for present and future computing paradigm changes with examples found in the real world,
CO2: Formulate and implement the nature-inspired computing (NIC) approaches in the contexts of problem-solving and modelling,
CO3: Design of various computing model and use of cellular automata, biological and quantum computing,
CO4: Explain the application of NIC for solving real world problem,
CO5: Describe the nature and characteristics of case study problems or applications,and
CO6: Recommend new NIC methods and their general applicability to solve the critical problems

COURSE CONTENTS

UNIT I
Introduction to NIC Computers
Computing paradigms inspired by nature, Cellular automata, biological computers, quantum computers, neural networks and molecular computing.

UNIT II
Nature Inspired Computing for Problem-Solvin
Artificial neural networks, Artificial immune systems, Swarm intelligence; Evolutionary algorithms, Ant colony optimization, Particle swarm optimization; Diffusion search

UNIT III

Nature Inspired Computing for Modeling

Artificial life like forms and behaviour, Creative evolutionary art, Foraging and satisfying, Autonomous self-organizing systems, Competition and cooperation, Collective/crowd behaviour, Social trend and consensus.

UNIT IV

Immunocomputing

Introduction, Immune System, Physiology and main components, Pattern Recognition and Binding , Immune Network Theory, Danger Theory, Evaluation Interaction, Immune Algorithms , Introduction, Genetic algorithms, Bone Marrow Models , Forest's Algorithm**,** Artificial Immune Networks

UNIT V

Computing With New Natural Materials

DNA Computing: Motivation, DNA Molecule , Adleman's experiment , Test tube programming language, Universal DNA Computers , PAM Model, Splicing Systems, Lipton's Solution to SAT Problem , Scope of DNA Computing , From Classical to DNA Computing

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Textbook

1. D. Floreano and C. Mattiussi, Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies, MIT Press, 2008.

Reference Books

1. L. Nunes de Castro, Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications. Chapman and Hall/CRC, Boca Raton, Florida, 2006.
2. Floreano D. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, Cambridge, MA, 2008.
3. Albert Y.Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006.

FUNDAMENTALS OF PROJECT MANAGEMENT

Course Code: **CE30072**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to understand and appreciate the importance of concepts of project management. The students would be able to investigate complex business problems and propose project-based solutions

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Appreciate the importance of various aspects of project management,
CO 2: Apply knowledge of various domains of the project to address specific management needs,
CO 3: Understand the concepts related to time management of the project,
CO 4: Learn the aspects related to the optimization of project time and cost,
CO 5: Understand the facts concerning resource management, and
CO 6: Learn about the various concepts related to cost management and engineering economy.

COURSE DETAILS

Introduction to project management
Introduction to project management, Purpose of project management, Process of project management, Objectives of project management, Elements of a network diagram, Rules of a network diagram, Constraints of a network diagram, Errors in a network diagram.

Performance domains of the project
Different performance domains of the project – Stakeholders, Team, Development approach and life cycle, Planning, Project work, Delivery, Measurement, Uncertainty.

Time management of the project
Critical path method (CPM) – Critical path analysis, Activity times and floats, Project evaluation review technique (PERT) – Three times estimates, Beta-distribution curve, Critical path analysis for PERT network, Probability of completion of the project, Differences between CPM and PERT.

Optimization of time and cost of the project
Various costs associated with the project, Variation of various costs of the project concerning the time of completion, Cost slope, Optimization of the mathematical model of network.

Resources management of the project
Resource allocation, Resource smoothening, Resource levelling.

Finance management of the project
Principles of engineering economy, Interest and interest formulae, Comparison of alternatives, Minimum cost point analysis, Breakeven point analysis, Depreciation, Depletion.

Textbooks

1. A Guide to The Project Management Body of Knowledge (Pmbok® Guide), Project Management Institute, 7th Edition, 2021, ISBN 9781628256642.
2. U.K. Shrivastav, Construction Planning and Management, Galgotia Publications Pvt. Ltd, 3rd Edition, 2005, Reprint 2015, ISBN-978-81-7515-246-5.

Reference Books

1. C.F. Gray and E.W. Larson, Project Management, the Managerial Process, McGraw-Hill, 6th Edition, 2017, ISBN-13 - 978-9339212032.
2. K.N. Jha, Construction Project Management, Pearson Education, 2nd Edition, 2015, ISBN-10 – 9332542015.

ELEMENTS OF SURFACE HYDROLOGY

Course Code: **CE30074**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To learn and use the knowledge of hydrology through understanding different components of hydrological cycle and use different techniques to develop and implements hydrological analysis.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Estimate the water balance of a catchment,
CO 2: Perform consistency of rainfall data and estimate missing & mean rainfall,
CO3: Perform frequency analysis of point rainfall and estimate evaporation,
CO 4: Determine infiltration capacity, fit infiltration model and estimate infiltration indices,
CO 5: Find out run off from catchment using different methods; properties, and
CO 6: Analyze hydrographs, and develop & derive different durations of unit hydrographs.

COURSE DETAILS

Hydrologic cycle
Components & Description, Catchment, Water-Budget Equation and Applications in Engineering.

Precipitation
Forms and weather systems for precipitation, measurement, preparation and presentation of rainfall data, Mean precipitation over an area, DAD curves, Frequency of point rainfall, IDF Curve.

Abstractions
Different types of abstractions, Evaporation, Evaporimeters, Transpiration, Evapo-transpiration, Interception and Depression storage, Infiltration-process, measurement, Modelinginfiltration capacity.

Runoff
Catchment characteristics, Runoff estimation methods, NRCS-CN method for estimation of runoff, Drought, Classification of Drought.

Hydrograph
Factors affecting runoff hydrograph, Components, Base flow, Baseflow Separation, Effective rainfall, Unit Hydrograph, Definition, Development, Unit Hydrographs of Different Durations, Superposition Method, S-Curve technique.

Textbook

1. Engineering Hydrology by K. Subramanya, Tata Mc-Graw Hill, 5th Edition, 2019.

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Reference Books

1. V.T. Chow, D.R. Maidment and L.W. Mays, Applied Hydrology, Tata Mc. Graw Hill, 1st Ed., First Indian Reprint 2010.

2. L.W. Mays, Water Resources Engineering, Wiley Publication, 2nd Edition, First Indian Reprint 2001.

ENVIRONMENTAL POLLUTION AND CONTROL

Course Code: CE30076
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course is designed to enable the students to know the sources, characteristics and effects of air and noise pollution, their effects on environment and human health and the methods of controlling the same.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the importance of global bio-geochemical cycles,
CO 2: Characterize physical, chemical and biological parameters responsible for water pollution,
CO 3: Understand the various water and wastewater treatment processes,
CO 4: Learn about the parameters responsible for air pollution and their control processes,
CO 5: Learn about the parameters responsible for noise pollution and their control processes, and
CO 6: Learn about the parameters responsible for Soil pollution and their control processes.

COURSE DETAILS

Global biogeochemical cycles
Carbon Cycle, Nitrogen Cycle, Oxygen Cycle, Phosphorus Cycle and Sulfur Cycle.

Water chemistry
Physical, chemical and biological properties of water and their significances.

Water and wastewater treatment processes
Water treatment - schematic diagram, intake structure, aeration, sedimentation, coagulation, flocculation, filtration, disinfection.
Wastewater treatment - schematic diagram, Primary Treatment: screen, grit chamber, primary, sedimentation tank, Secondary Treatment: suspended growth system – activated sludge process, attached growth system – trickling filter, rotating biological contactor, Tertiary Treatment – Nutrient removal.

Air pollution
Types of air pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.

Noise Pollution
Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

Soil Pollution
Types of soil pollutants, Processes of soil pollution, Effect of soil pollution on human beings, plants and animals, Control measures for soil pollution.

Textbook

1. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.

Reference Book

1. T.D. Reynolds & P.A. Richards, Unit Operations and Processes in Environmental Engineering, PWS Publishing Company, CENGAGE Learning, 2nd Edition, 2009.

MUNICIPAL SOLID WASTE MANAGEMENT

Course Code: **CE30078**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to understand different types of solid waste, learn about the different waste management rules, characterize wastes and select proper methods for collection, transportation and treatment and size waste containment systems for disposable wastes.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Appreciate the importance of municipal solid waste management hierarchy in the context of environmental pollution,
CO 2: Learn about the different waste management rules,
CO 3: Characterize waste based on physical and chemical properties,
CO 4: Understand methods of waste sampling, segregation and collection,
CO 5: Recognize proper biochemical and thermal technologies for conversion of waste to wealth, and
CO 6: Size engineered landfills for disposable wastes.

COURSE DETAILS

Introduction to Municipal Solid Waste Management
Introduction, different types of municipal solid waste, Waste Management hierarchy – prevention, reduce, reuse, recycle, energy recovery and disposal.

Waste Management Rules
Solid waste management rules 2016, Plastic waste management rules 2016, Construction & demolition waste management rules 2016, Electronic waste management rules 2016, Biomedical Waste Management rules 2016, Hazardous & other wastes (management and transboundary movement) rules, 2016.

Sampling and characterization of solid waste
Waste composition, sampling, characterization based on physical and chemical properties.

Collection and transportation of solid wastes
Basic waste collection system, Collection methods – Hauled Container System (HCS), Stationary Collection System (SCS), Transfer and Transport, Transfer stations.

Biochemical conversion technologies
Aerobic stabilization - composting, important design considerations, stages of composting, factors affecting composting process, different composting techniques.
Anaerobic stabilization - Anaerobic digestion, Stages and operational parameters of anaerobic digestion, Different types of digesters.

Thermal conversion Technologies
Fundamentals of thermal processing, Incinerable waste, Refuse derived fuel, Process description of combustion, gasification and pyrolysis, co-processing of hazardous waste.

Engineered landfills
Selection criteria of landfill site, Principles of landfill design, essential components of landfill, different types of landfill, Landfill planning and design. Leachate control, gas collection system.

Textbooks

1. CPHEEO, Manual on Municipal Solid Waste, Ministry of Urban Development, GoI, New Delhi, 2016.
2. Sunil Kumar, Municipal Solid Waste Management in Developing Countries, CRC press Reference -178 -42B/W illustrations, 2016, ISBN 978498737746-CAT# K26553.

Reference Books

1. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
2. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.

SURFACE & GROUNDWATER HYDROLOGY

Course Code: **CE30052**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To learn and use the knowledge to analyze hydrological cycle, precipitation, abstractions, runoff, groundwater hydrology, well hydraulics and recharging of groundwater.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Estimate water balance, optimal rain gauge network, consistency of rainfall data,
CO 2: Determine the mean rainfall and probability of rainfall events,
CO 3: Estimate infiltration capacity, infiltration indices and apply infiltration models,
CO 4: Compute runoff from the catchments,
CO 5: Understand groundwater concept as well as properties, and

CO 6: Analyze well hydraulics, open wells and recharge of aquifers.

COURSE DETAILS

Surface Water Hydrology
Hydrologic cycle
Water-Budget Equation and Applications in Engineering.

Precipitation
Forms and weather systems of precipitation, Measurement, preparation and presentation of rainfall data, Mean precipitation over an area, Frequency of point rainfall.

Abstractions
Different types of abstractions, Evaporation, Evaporimeters, Transpiration, Evapo-transpiration, Interception and Depression storage, Infiltration-process, measurement, Modelinginfiltration capacity.

Runoff
Catchment characteristics, Runoff estimation methods, NRCCS-CN method.

Ground Water Hydrology
Introduction, Forms of sub surface water, Saturated formation, Aquifer properties - Porosity, Specific yield, Darcy's law, Coefficient of permeability and Stratification.

Well Hydraulics
Steady flow into a well - Confined flow and Unconfined flow, Open wells, Recharge and Artificial Recharge Methods.

Textbook

1. K. Subramanya, Engineering Hydrology, Tata McGraw Hill, 5th Edition, 2019.

Reference Books

1. V.T. Chow, D.R. Maidment and L.W. Mays, Applied Hydrology, Tata McGraw Hill, 1st Edition, 1st Indian Reprint, 2010.
2. L.W. Mays, Water Resources Engineering, Wiley Publication, 2nd Edition, 1st Indian Reprint, 2001.
3. D.K. Todd and L.W. Mays, Groundwater Hydrology, John Wiley and Sons, 3rd Edition, 2011.
4. H.M. Raghunath, Ground Water, New Age International Publishers, 3rd Edition, Dec 2007.

WATER SUPPLY & QUALTY MANAGEMENT

Course Code: **CE30054**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to understand the basic of water supply system, characterize water based on physical, chemical and biological parameters and select the specific treatment units required in a water treatment plant.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Estimate the water demand for a particular area,
CO 2: Select a pump for transportation of water at a particular head and discharge,
CO 3: Size service reservoirs for Storage and supplying of treated water to individual households,
CO 4: Size water distribution network pipe for supplying water to individual households,
CO 5: Identify the physical, chemical and biological parameters of water, and
CO 6: Select the different components of a water treatment plant.

COURSE DETAILS

Basics of Water Supply System
General requirement of water supply, sources of water supply, Estimation of water demand, Pumps for transportation of water, selection of pumps, Types of Service Reservoirs, Estimation of capacity of Service Reservoirs, Types of Water distribution system, designing of water distribution system.

Water Quality Parameters
Physical, chemical, and biological characteristics of water as per IS 10500: 2012.

Basics of Water Treatment
Introduction to water treatment system, schematic of water treatment plant for ground water and surface water, Aeration, coagulation, softening: lime-soda process and ion exchange process, flocculation, sedimentation, filtration, disinfection - chlorination and ozonation.

Textbooks

1. S.K. Garg, Environmental Engineering (Vol. I) Water Supply Engineering, Khanna Publishers, 36th Edition, 2022, ISBN-13: 978-81-7409-120-8.
2. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
3. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.

Reference Books

1. L.D. Benefield, J. F. Judkins and B.L. Weand, Process chemistry for water and wastewater treatment, Prentice - Hall Series, 1st Edition, 1981.
2. M.L. Davis & D.A. Cornwell, Introduction to Environmental Engineering, 4th Edition, Tata McGraw Hill, 2010.
3. T.D. Reynolds & P.A. Richards, Unit Operations and Processes in Environmental Engineering, PWS Publishing Company, CENGAGE Learning, 2nd Edition, 2009.
4. CPHEEO, Manual on water supply and Treatment, Ministry of Urban Development, GoI, New Delhi, 2009.
5. Metcalf & Eddy, Inc., Wastewater Engineering: Treatment and Reuse, Tata McGraw- Hill, 5th Edition, New Delhi, 2013.

GEOMATERIAL CHARACTERIZATION

Course Code: **CE30056**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to introduce the characterization of geomaterials. This course will help the students to characterize the geomaterials based on the geology, morphology, mineralogy. This course will introduce the concept of geotechnical characterization and various problems related to it.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the origin of soil and rock,
CO 2: Classify rock and soil,
CO 3: Make the geotechnical and mineralogical characterization of soil and rock,
CO 4: Calculate the index properties and can perform grain size analysis,
CO 5: Characterize the geomaterial based on morphology, physical and chemical properties, and
CO 6: Characterize the geomaterials based on field data.

COURSE DETAILS

Origin of rock and soil
Rock cycle and the origin of soil, geological classification of rocks, basic terminology, index properties of rock and soil, unit weight, porosity, permeability.

Classification of rock and soil
Classification of rock for engineering properties, soil classification and grain size analysis.

Geomaterial characterization-I of soil
Need for geomaterial characterization, geotechnical characterization-void ratio and porosity, compaction, consolidation and compressibility, hydraulic conductivity, shear strength, Mineralogical characterization-X-ray diffraction (XRD).

Geomaterial characterization-II of rock
Morphological characterization- Scanning electron microscopy (SEM), Physical characterization-Gradational analysis, Chemical characterization- X-ray fluorescence (XRF), Case studies based geomaterial characterization.

Textbooks

1. K.R. Arora, Soil Mechanics and Foundation Engineering, Standard Publisher Dist, New Delhi, 7th Reprint Edition, 2019, ISBN- 978-8180141126.
2. B.P. Verma, Engineering Geology and Rock Mechanics, Khanna Publishers, New Delhi, 4th Edition 2017, ISBN-978-9387394155.

Reference Book

1. K.R Saxena and V.S. Sharma, In-situ Characterization of Rocks, A A Balkema Publishers; 1st Edition, 2002, ISBN-978-9058092373.

HIGHWAY MATERIAL CHARACTERISATION

Course Code: **CE30058**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To introduce the technologies in pavement engineering materials and to make the students conversant with characterization of various conventional and alternative road construction materials.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the types and materials used in various types of pavements,
CO 2: Know the basic soil properties related to pavement applications,
CO 3: Identify properties of aggregate and bituminous binders used in pavement,
CO 4: Evaluate bituminous mixes for non-stabilized and stabilized roads,
CO 5: Learn about cement concrete, semi rigid, non-conventional and new pavement materials, and
CO 6: Know about various alternative pavement materials.

COURSE DETAILS

Introduction
Types of pavements, pavement layers, pavement materials in various layers.

Soil
Classification of soil, Identification, and strength tests- Atterberg limits, compaction tests, California Bearing Ratio (CBR), Unconfined Compressive Strength (UCS), Modulus of subgrade reaction, Resilient Modulus, Permeability, Free Swelling Index (FSI), Soil stabilization techniques.

Aggregates
Origin and Classification, physical, mechanical and durability properties, sampling techniques, aggregate texture and skid resistance, Polish Stone Value, Alkali-aaggregate reactivity.

Bitumen
Bitumen sources and manufacturing, Bitumen constituents and its properties, Structure and Rheology, tests on bitumen-emulsions & cutback, modified bitumen and its types, goals of modification, properties of modified bitumen, separation test, long-term and shorter aging of bitumen, Elastic recovery test of modified bitumen.

Cement
Origin, composition, Types of cement, physical properties of cement consistencyy, setting times, soundness and strength of cement, flow test, alternative Pavement Materials - Recycled Concrete aggregates, Reclaimed asphalt pavement materials, use of industrial and agricultural wastes for pavement construction, chemical and mineral admixtures.

Textbook

1. P. Chakraborty and A. Das, Principles of Transportation Engineering, PHI Publication, 2nd Edition, 2017, ISBN: 978-8120353459.

Reference Books

1. G. V. Rao, Principles of Transportation and Highway Engineering, Tata Mc. Graw Hill, 1st edition 1995. ISBN: 978-0074623633.
2. S. K. Khanna and CEG Justo, A. Veeraragavan, Highway Engineering, Nem Chand & Bros., Roorkee, India, 10th Edition, ISBN:9788185240930.
3. Relevant IRC, ASTM and AASHTO codes and specifications.

DISASTER MANAGEMENT

Course Code: CE40081
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course shall inculcate deep knowledge about various types of disasters like Flood, Cyclone, and Earthquake. It shall help students to learn about the causes that lead to disaster and understand the quantitative analysis of losses caused by disaster. It shall also help students to learn about the methodology and techniques used in disaster management.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand foundations of hazards, disasters and associated natural/social phenomena,
CO 2: Familiar with disaster management theory (cycle, phases),
CO 3: Learn about the technological innovations in Disaster Risk Reduction (DRR),
CO 4: Know about humanitarian assistance before and after disaster,
CO 5: Know various methods of community involvement as an essential part of successful DRR, and
CO 6: Gain experience on conducting independent DM study including data search, analysis, and presentation of disaster case study.

COURSE DETAILS

Introduction to Disaster Management
Hazards and Disasters, Introduction, Types of Disasters, Major disasters in history, Developing appropriate technology for disaster mitigation, Role of management teams, Importance of awareness alertness and preparedness camp.

Earthquake
Causes of earthquake, Plate tectonics, Seismic zoning map, Characteristics of strong, ground motions& attenuation damage assessment.

Tsunami
Formation of Tsunami, Warning systems for Tsunami, Prevention measures before Tsunami, After-effects of Tsunami.

Flood
Hydrograph - concept and uses, Flood and its estimation, Flood early warning system, Flood protection measures, After-effects of floods and disaster mitigation strategies.

Cyclones
Introduction to cyclone, wind speed, eye of the storm, formation of cyclone and anticyclones, types of cyclones and nomenclature, cyclone warning system, prevention measures for cyclones, after-effects of cyclones.

Textbook

1. R. Subramanian, Disaster Management, Vikas Publishing House, 2018, ISBN-13: 978-9352718702.

Reference Books

1. K Subramanya, Engineering Hydrology, McGraw Hill, 5th Edition (20 September 2020), ISBN-13: 978-9390177509.
2. Neelam Sharma, Earthquake Resistant Building Construction, S.K. Kataria & Sons; Reprint 2013 Edition (1 January 2013), ISBN-13: 978-9350142042.
3. NDRF report on "SOP for Capacity Building of State Disaster Response force".
4. NDRF report on "SOP for Effective Coordination and Cooperation During Disaster Response".

COASTAL MANAGEMENT

Course Code: **CE40083**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course deals with the needs to create balance knowledge between coastal zone development and protection of natural resources. The goals are to "preserve, protect, develop, enhance, and restore" the coastal resources wherever possible.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn about estuaries, wetlands, lagoons, and of the uses of and stresses on the coastal zone,
CO 2: Study the classification, characteristics, and theories of waves, tides and currents,
CO 3: Learn about coastal erosion, sea level change, and coastal structures,
CO 4: Study seawater intrusion, desalination, and anthropogenic impacts on wetlands, mangroves and coral reefs,
CO 5: Learn about coastal zone management and the applications of remote sensing and geographical information systems in coastal zone management, and
CO 6: Understand social impact assessment and other developmental activities.

COURSE DETAILS

Introduction
Origin of coasts, wind, waves, ocean currents, tides, wave theories (basics), wave forces.

Coastal process
wave shoaling, wave refraction, wave diffraction, wave reflection, wave breaking, types of breakers, Wave run-up, beach profile, beach process.

Coastal erosion & protection
Erosion process, causes for erosion, littoral drift, protection works using seawall, Groins, Jetties, off-shore breakwaters, artificial beach nourishment, new technologies of shore protection.

Coastal Zone Management
Coastal Zone Management and Remote Sensing & GIS Applications, Concepts and Development, Database for Coastal Zone Management.

Remote Sensing Data for CZM, GIS
Concepts and Models Used in Coastal Zone.

Environmental impact assessment
Concept of coastal eco-systems, coastal pollution and its implications, Environmental Impact Assessment (EIA), Evaluation and Methodology, Social Impact Assessment and other developmental activities.

Textbooks

1. Herbich, Hand Book of Coastal and Ocean Engineering, Gulf publishing Company, 1st Edition, 2000, ISBN:9780071508230, 0071508236.
2. Beatley, Brower, and Schwab, An Introduction to Coastal Zone Management, Island Press, 2nd Edition, 2002, ISBN: 9781559639156, 1559639156.

Reference Books

1. Bartlett and Smith, GIS for Coastal Zone Management, United Kingdom: CRC Press LLC, 2019, ISBN: 9780367393977, 0367393972.
2. Sundar and Sannasiraj, Coastal Engineering: Theory And Practice, World Scientific Publishing Company, 2019, ISBN:9789813275928, 9813275928.
3. Brunn, Port Engineering, 4th ed. (Vol 1 & 2), Gulf Publishing Company, 1981.

BASIC GROUNDWATER HYDROLOGY

Course Code: **CE40085**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To learn and use the knowledge of groundwater hydrology and understand the formations, well hydraulics, groundwater pollution and artificial recharge

COURSE OUTCOMES

At the end of the course, the student will be able to

CO 1: Analyze different formations and estimate hydraulic conductivity,
CO 2: Analyze well hydraulics for steady and unsteady flow in aquifer,
CO 3: Explain the construction of shallow and deep wells,
CO 4: Analyze pollution and quality of groundwater,
CO 5: Identify modern methods of groundwater exploration, and
CO 6: Describe various methods of artificial recharge of groundwater.

COURSE DETAILS

Occurrence and Movement of Ground Water
Origin & age of ground water, rock properties affecting groundwater, zones of aeration & saturation, aquifers and their characteristics/classification, groundwater basins & springs, Darcy's Law, permeability & its determination, Dupuit assumptions, heterogeneity &anisotropy, Ground water flow rates & flow directions, general flow equations through porous media.

Well Hydraulics
steady/ unsteady, uniform/ radial flow to a well in a confined/ unconfined /leaky aquifer, well flow near aquifer boundaries/ for special conditions, partially penetrating/horizontal wells & multiple well systems, well completion/ development/ protection/ rehabilitation/ testing for yield.

Pollution and Quality Analysis of Ground Water
Municipal / industrial / agricultural / miscellaneous sources & causes of pollution, attenuation / underground distribution / potential evaluation of pollution, physical /chemical /biological analysis of ground water quality, criteria & measures of ground water quality, ground water salinity & samples.

Artificial Ground Water Recharge
Concept & methods of artificial ground water recharge, recharge mounds & induced recharge, wastewater recharge for reuse, water spreading.

Textbook

1. D.K. Todd and L.F. Mays, Groundwater Hydrology, John Wiley and sons.

Reference Books

1. S.P. Garg, Groundwater and Tube Wells, Oxford and IBH Publishing Co., New Delhi.
2. V.T. Chow, Handbook of Applied Hydrology, McGraw-Hill Publishing Company, New York.
3. H.M. Raghunath, Ground Water, New Age International Publishers; 3rd Edition, 2007.

CLEAN WATER & SANITATION

Course Code: **CE40087**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to understand and appreciate the importance of clean water and sanitation with special reference to Sustainable Development Goal 6.0, and learn the various treatment strategies to provide safe and affordable drinking water to all and treated wastewater for safe recycling or reuse.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Appreciate the importance of water as recognized in Sustainable Development Goal 6.0,
CO 2: Recognize the parameters responsible for pollution of water,
CO 3: Understand the physical, chemical and biological parameters of water,
CO 4: Learn about the various strategies used for safe and affordable drinking water,
CO 5: Understand the physical, chemical and biological parameters of wastewater, and
CO 6: Learn about the various sanitation systems and adopt strategies used for improving the wastewater treatment and safe recycling or reuse.

COURSE DETAILS

Introduction to Clean Water and Sanitation
Introduction to Sustainable Development Goal 6.0, Current scenario in accessibility to safe and affordable drinking water and the future needs, Need for reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, treatment and recycling or reusing of treated wastewater.

Drinking water quality as per Indian & International standards
Physical, chemical and biological characteristics of water as per IS 10500: 2012 and WHO 2017.

Treatment strategies for drinking water
Introduction to water treatment system, schematic of water treatment plant for ground water and surface water, Aeration, coagulation, softening: lime-soda process and ion exchange process, flocculation, sedimentation, filtration, disinfection - chlorination and ozonation.

Wastewater characteristics and discharge standards
Physical, chemical and biological characteristics of wastewater, Discharge standards as per The Environment (Protection) Rules, 1986 and USEPA.

Introduction to Sanitation Systems and Treatment strategies of Wastewater for recycling or safe reuse
Sanitation systems - Introduction to wastewater, Class of water based on designated-best-use, different types of wastewaters, Conservancy system of sanitation, water carried sewerage system
Treatment strategies - (1) Treatment options for sewered areas – primary, secondary and tertiary treatment units: description and applications. (2) Treatment options for non-sewered areas - oxidation ponds, Septic tank, Imhoff tank.

Textbooks

1. S.K. Garg, Environmental Engineering (Vol. I) Water Supply Engineering, Khanna Publishers, 36th Edition, 2022, ISBN-13: 978-81-7409-120-8.
2. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
3. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.

Reference Books

1. IS: 10500 – 2012 Indian Standard Drinking Water — Specification.
2. The Environment (Protection) Rules 1986, General Standards for Discharge of Environmental Pollutants Part-A: Effluents, Schedule VI.

BASIC FLUID MECHANICS & HYDRAULICS

Course Code: **CE40051**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To learn and use the concept of fluid and its various aspects like static, kinematics, dynamic behavior; concept of free surface flow, specific energy, critical depth, uniform flow and most efficient open channel section, computation of GVF profiles.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Ascertain different fluid properties, velocity, shear force,
CO 2: Apply the basic equations of fluid statics to determine pressure, forces on planar and curved surfaces submerged in a static fluid,
CO 3: Determine the buoyant force, develop and apply the concept of fluid kinematics,
CO 4: Use the Euler‘s and Bernoulli‘s equations and its application in venturimeter, orificemeter, and analyze the momentum principles,
CO 5: Analyze specific energy, critical depth and transitions, uniform flow computation, and
CO 6: Solve problems on dynamics of gradually varied flow.

COURSE DETAILS

Introduction
Properties of Fluids, Newton's law of viscosity, Newtonian & Non-Newtonian Fluids.

Fluid-Statics
Fluid Pressure, Pascal‘s Law, Manometers, Pressure on Plane Surface, Buoyancy and Floatation of Bodies, Stability of Floating Bodies, Metacentre.

Fluid Kinematics
Types of fluid Flows, Continuity Equation, Rotational and Irrotational Motion.

Fluid Dynamics
Bernoulli‘s Energy Equation, Application of Bernoulli‘s Energy Equation in Venturimeter and Orifice Meter.

Free Surface Flow
Introduction, Types of channels, Classification of flows.

Energy Principles
Energy equation, specific energy, critical depth, transitions.

Uniform flow
Chezy's equation, Manning's formula, hydraulically efficient channel section.

Gradually Varied Flow
Governing equation, types of flow profiles, computation of gradually varied profile using standard step method.

Textbooks

1. R.K. Bansal, A Textbook of Fluid Mechanics & Hydraulic Machines. Laxmi Publications (P) Ltd., 10th Edition.
2. K. Subramanya, Flow in Open Channels, McGraw Hill, 5th Edition, 2019.

INTRODUCTION TO REMOTE SENSING & GIS

Course Code: **CE40053**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course will enable the students to understand and apply the principles of remote sensing and GIS in various fields of Civil Engineering.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the concept, principle and application of remote sensing,
CO 2: Know the various types of platforms and sensors used in remote sensing,
CO 3: Interpret satellite images,
CO 4: Explain the fundamental operations of GIS,
CO 5: Manage GIS data files, and
CO 6: Analyze the spatial and attribute data.

COURSE DETAILS

Introduction to Remote Sensing system
Data acquisition and processing, Applications, Multi concept in remote sensing.

Physical Basis of Remote Sensing
EMR nature, definition, nomenclature and radiation laws. Interaction in atmosphere-nature, its effects in various Wave-length regions, atmospheric windows; Interaction at ground surface soils Geometric basis of interaction.

Platform and Sensors
Terrestrial, aerial and space platforms, Orbital characteristics of space platforms, sun-and geo-synchronous; Sensor systems-radiometers, opto-mechanical and push broom sensor.

Resolution

Spectral, spatial, radiometric and temporal; IFOV, FOV, GRE; geometric characteristics of scanners, V/H and S/N ratio; Data products from various air and space borne sensors-aerial photographs, LiDAR, Landsat, SPOT, IRS, ERS, IKONOS etc.

Image Interpretation
Elements of interpretation; digital image processing and interpretation, Field verification.

Geographical Information systems
Components of GIS-data acquisition, spatial and attribute data, pre-processing, storage and management; data structures raster and vector data.

GIS analysis functions
Errors and corrections; data presentation and generation of thematic maps.

Textbooks

1. Basudev Bhatta, Remote Sensing and GIS, by Oxford, 2013.
2. M. Chandra and S. K. Ghosh, Remote Sensing and GIS, Narosa Pub, 2007.
3. S.K. Duggal, Surveying Volume -II, 3rd Edition, Tata McGraw Hill- 2011.

Reference Books

1. I. Heywood, S. Cornelius and S. Carver, An Introduction to GIS, 2nd Edition, Pearson Education, 2002.
2. George Joseph, Fundamentals of Remote Sensing, Universities Press, 2nd Edition, 2011.

IRRIGATION WATER MANAGEMENT

Course Code: **CE40055**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To learn and apply the various concepts of management of irrigation water including soil water-plant relationship, crop water requirement, irrigation methods, efficiency and scheduling and participatory irrigation management

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn about irrigation and also explain the various aspects of soil water,
CO 2: Describe the relationship between soil, plant and water,
CO 3: Compute the water requirement of various crops,
CO 4: Understand about the various irrigation methods and compute irrigation efficiency,
CO 5: Schedule irrigation, and
CO 6: Understand about the participatory irrigation management.

COURSE DETAILS

Introduction
Importance and harmful effects of irrigation, sources of water to crop plants.

Issues in Water Management
Multiple use of water – Issues in Inter-sectoral Water Allocation - domestic, irrigation, industrial sectors - modernization techniques – Rehabilitation – Command Area Development - Water delivery systems.

Soil water relationship
Basic soil physical properties, Forms, occurrence and classification of soil water, Soil water constants, Energy concept of soil water, Forces acting on soil water, Soil water potential, Infiltration, permeability, movement of water in soils and methods of soil water measurement.

Soil Water-Plant relationship
Water absorption and conduction by plant, Transpiration, Soil water availability, soil water extraction pattern of plants.

Crop water requirement
Evapotranspiration, effective rainfall, percolation loss, Irrigation requirement, duty of water.

Irrigation methods
Classification of Irrigation methods, Surface, Subsurface, Sprinkler and Drip irrigation and methods of water measurement.

Irrigation efficiency and scheduling
Irrigation efficiency, time of irrigation, Criteria for scheduling of irrigation, depth, frequency and interval of irrigation.

Participatory irrigation management
Sociology – Basic concepts – Perspectives- Social Stratification – Irrigation as a Socio technical Process - Participatory concepts– Objectives of participatory approach. Farmers participation –need and benefits – Comparisons of cost and benefit -Sustained system performance - Kinds of participation – Context of participation, factors in the environment – WUA - Constraints in organizing FA – Role of Community Organizer – Case Studies.

Textbook

1. D.K. Majumdar, Irrigation Water Management, Principles and Practice, PHI Learning Private Limited, 2014.

Reference Book

1. Robert Chambers, Managing Canal Irrigation, Cambridge University Press, 1989.

URBAN WASTE MANAGEMENT

Course Code: **CE40057**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to understand different types of solid waste, different waste management rules, characterize wastes and select proper methods for collection, transportation and treatment and size waste containment systems for disposable wastes.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Appreciate the importance of various types of liquid and solid waste in urban context,
CO 2: Identify the physical, chemical and biological parameters of wastewater,
CO 3: Understand the various strategies used for treatment of wastewater,
CO 4: Learn about the different solid waste management rules,
CO 5: Characterize solid wastes based on physical and chemical properties, and
CO 6: Identify proper technologies for conversion of solid wastes to wealth.

COURSE DETAILS

Introduction to Urban Waste Management
Introduction to different types of liquid and solid waste.

Wastewater Management
Introduction to wastewater, Class of water based on designated-best-use, different types of wastewaters, Physical, chemical and biological characteristics of wastewater.
Treatment and Reuse strategies for different types of wastewaters, Treatment options for sewered areas – primary, secondary and tertiary treatment units: description and applications.
Treatment options for non-sewered areas - oxidation ponds, Septic tank, Imhoff tank.

Sampling and characterization of solid waste
Waste composition, sampling, characterization based on physical and chemical properties.

Collection and transportation of solid wastes
Basic waste collection system, Collection methods – Hauled Container System (HCS), Stationary Collection System (SCS), Transfer and Transport, Transfer stations, Economic comparison of transport alternatives.

Biochemical conversion technologies for Organic Fraction of Municipal Solid Waste (OFMSW)
Aerobic stabilization
composting, important design considerations, stages of composting, factors affecting composting process, oxygen requirement for compete aerobic stabilization, composting techniques.
Anaerobic stabilization
Anaerobic digestion, Stages and operational parameters of anaerobic digestion, Process technologies, categories of anaerobic digestion, different types of digesters, design of digester, Estimation of biogas production.

Thermal conversion Technologies
Fundamentals of thermal processing, Incinerable waste, Refuse derived fuel, Process description of combustion, gasification and pyrolysis.

Engineered landfills
Selection criteria of landfill site, Principles of landfill design, essential components of landfill, different types of landfills, Landfill planning and design. Leachate control, gas collection system.

Hazardous waste management

Different types of hazardous wastes, properties of hazardous wastes, labelling requirement, waste management hierarchy, co-processing of hazardous waste, recycling and reusing opportunities.

Textbooks

1. CPHEEO, Manual on Municipal Solid Waste, Ministry of Urban Development, GoI, New Delhi, 2016.
2. Sunil Kumar, Municipal Solid Waste Management in Developing Countries, CRC press Reference -178 -42B/W illustrations, 2016, ISBN 978498737746-CAT# K26553.

Reference Books

1. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
2. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.

URBAN STORMWATER MANAGEMENT

Course Code: **CE40059**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course will introduce students to the concepts, theories, and design methodologies for green stormwater infrastructure specifically aimed at managing urban storm water.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the basics of water and wastewater management,
CO 2: Demonstrate a functional knowledge base of the challenges and opportunities presented by urban stormwater management,
CO 3: Estimate storm water quantity using various methods,
CO 4: Plan and size different storage facilities for stormwater,
CO 5: Explore a variety of urban stormwater management Best Management Practices, and
CO 6: Size, and grade different urban storm water infrastructure.

COURSE DETAILS

Introduction – Historical Development
Basics of Water and wastewater management in urban areas: water cycle, water sources, water treatment and supply system, wastewater generation, collection and treatment approaches. Different types of wastewaters – domestic, industrial and storm water and their management, Importance of storm water management.

Estimation of Urban Storm water
Estimation of urban storm water quantity, catchment characteristics, process parameters, hydrological losses in developing, watersheds, design period, calculation of runoff and peak flow. Rational method, NRCS curve number method.

Stormwater Storage Facilities
Planning for local disposal by infiltration and percolation, roof top storage, detention ponds, storage at sewer treatment plants. Estimating the storage volumes – sizing of infiltration and percolation basins, detention facilities.

Stormwater Management
Best Management Practices (BMPs) including urban design considerations, treatment sizing and capacity, water quality benefits, maintenance, and costs. urban storm water infrastructure features - green roofs, rain gardens, bioswales, and storm water treatment wetlands.

Textbooks

1. Hormoz Pazwash, Urban storm water management, CRC Press, 2nd Edition, 2016, ISBN: 978-1-4822-9896-3.
2. Benedict, Mark A. and McMahon, Edward T. Green Infrastructure: Linking Landscapes and Communities. Washington: Island Press, 2006.
3. CPHEEO, Manual on Storm Water Drainage Systems, Ministry of Urban Development, GoI, New Delhi, 2019.
4. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
5. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.

Reference Books

1. Metcalf & Eddy, Inc., Wastewater Engineering: Treatment and Reuse, Tata McGraw- Hill, 5th Edition, New Delhi, 2013
2. Sarté, S.B. Sustainable Infrastructure: The Guide to Green Engineering and Design. Hoboken, NJ: Wiley Press, 2010.

LANDSLIDE HAZARDS AND PROTECTION

Course Code: **CE40061**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course aims to introduce to students on landslide phenomena and their risk evaluation. This course will help the students understand the cause of landslides, the mechanism of landslides, the prediction of landslides, and the risk assessment.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know the causes of landslides and their prediction,
CO 2: Learn various types of landslides,
CO 3: Investigate and identify Landslides,

CO 4: Learn different stability methods for rock and soil,
CO 5: Understand the concept on stabilization of soil slope as well as rock slope, and
CO 6: Understand landslide risk evaluation process and management.

COURSE DETAILS

Landslide phenomenon
Types and causes of slope failures, significance of landslide, landslide classification and processes, the impact of landslide.

Investigation of landslide phenomena
Mechanism of landslides, factor of safety, organization of investigation process, slope instability recognition and subsurface exploration, prediction of landslides.

Strength and stability analysis
Concept of instability, stability factors, soil and rock strength properties, soil slope stability analysis, rock slope stability analysis.

Landslide mitigation
Important consideration in slope design, stabilization of soil slope, stabilization of rock slope.

Landslide risk evaluation
Landslide risk perception, associated risk management, landslide protection, different case studies.

Textbooks

1. Thomas Glade, Malcolm Anderson, Michael J. Crozier, Landslide hazard and risk, John Willey and Sons Ltd., 2005.
2. John F. Shroder, Tim Davies, Landslide hazards, risk and disasters, Elsevier, 2015.

Reference Books

1. T.W. Lambe and R V Whitman, Soil Mechanics, John Wiley & Sons, 1979.
2. A. Keith Turner, Robert L. Schuster, Landslide investigation and mitigation.

EARTHQUAKE HAZARDS AND MITIGATION

Course Code: **CE40063**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to offer a methodical presentation of essentials of earthquake engineering, based on understandable mathematics and mechanics with an emphasis on engineering application. This course will help the student to understand seismic ground motions and loading on structures due to earthquake shaking. This course will also help the student to understand how the mitigation measures are taken to increase the seismic resistance of structures.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the causes and consequences of earthquake,
CO 2: Identify different types of waves generated due to earthquake,
CO 3: Understand the measurement of earthquake magnitude and intensities and different parameter of ground motions,
CO 4: Determine the liquefaction potential of a site,
CO 5: Understand seismic hazard and risk assessment, and
CO 6: Understand different type of earthquake mitigation measures.

COURSE DETAILS

Introduction to earthquake
Historical Earthquake Events. Consequences of Earthquakes. Causes of Earthquakes. Tectonic Plate Boundaries and Fault Zones, Relation of Plate Boundaries with Earthquake Occurrences.

Ground motion characterization
Definition of Earthquake Locations. Body waves, Surface Waves, Guided Waves, Measuring Seismic Motions Using Seismogram, Torsional Seismic Motions. Earthquake energy.

Magnitude and Intensity
Earthquake Magnitude. Intensity Categories, Peak Ground Motions, Peak Ground Motions and Its Relationship with Magnitude and Intensity. Contribution of Body and Surface Waveto Ground Motions. Attenuation Relationship and Uncertainties. Approximation of Ground Motion Duration.

Liquefaction
Definition of liquefaction. Mechanism of liquefaction, Factors affecting liquefaction. Evaluation of liquefaction potential. Evaluation of the effects of liquefaction.

Seismic Hazard and Risk Assessment
Identification and evaluation of earthquake source. Hazards due to earthquakes. Introduction to deterministic and probabilistic seismic hazard analysis. Seismic Hazard Map.

Earthquake Mitigation Measures
Mitigation of Tsunami Hazard, Mitigation Measures of Soil Liquefaction: Soil compaction, Grouting and chemical stabilization, Application of surcharge, Drainage using coarse Materials. General Principles of Earthquake-Resistance Design.

Textbook

1. Steven Lawrence Kramer, Geotechnical Earthquake Engineering, Pearson Education India, 1st Edition, 2003, ISBN-13: 978-8131707180.

Reference Book

1. Junbo Jia, Modern Earthquake Engineering, Springer-Verlag Berlin and Heidelberg GmbH & Co. KG, 1st Edition, 2017, ISBN-13: 978-3642318535.

GEO-HAZARDS RISK MANAGEMENT

Course Code: **CE40065**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to introduce various geohazards. This course will help the students to understand the various engineering and scientific concept behind the geohazards. This course primarily focused on geohazards like earthquake, lands slides and groundwater contamination. It will make students familiar with the various causes and mitigation of various geohazards.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn various types geohazards,
CO 2: Understand the characterization of geomaterial,
CO 3: Understand the various causes of landslides and methods of slope protection,
CO 4: Understand earthquake hazards and mitigation,
CO 5: Learn groundwater contamination and remediation, and
CO 6: Learn about various instrumentation and monitoring system for geohazards.

COURSE DETAILS

Introduction
Introduction to various geological hazards like earthquake, landslides, tsunami, volcanic eruption, flood, drought, and meteorite impact.

Geomaterial characterization
Formation of rock, type of rock, weathering process, geological cycle, geological features of rock, joints in rock, classification of rock, basic geotechnical properties of soil and rocks.

Landslide hazards and protection
Introduction, causes of landslides, landslides type and predictability, factor effecting landslides, mechanism of landslides, methods of slope protection, mitigation measures.

Earthquake hazards and mitigation
Historical data on earthquake, Introduction to the seismology, tectonic plates movement, types of waves, quantification of earthquake, site response, liquification assessment and its remediation, concept of earthquake resistance building design, Micro-zonation and earthquake risk assessment. Strengthening of earthquake damage structures.

Groundwater contamination and remediation
Origin of Groundwater Contamination, Classification of Groundwater Contamination, Transport Mechanism, GE for Contaminant Transport in Saturated Porous Media, remedial measures for contaminated ground water.

Instrumentation and monitoring
Field and laboratory pore water pressure measurement, embedment gauge, inclinometer, settlement monitoring, surface extensometer, Terrestrial, deflectometer, earthquake measuring instrument, surface movement monitoring using field instrument and GPS system.

Textbook

1. F.G. Bell, Geological hazards their assessment, avoidance and mitigation, E & FN Spon London, 1st Edition, 1999, ISBN:0-419-16970-9.

Reference Books

1. B.A. Bolt, W.L. Horn, G.A. Macdonald and R.F. Scott, Geological hazards, Springer-Verlag, New York, 2nd Edition, 1977, ISBN: 978-0-387-90254-8.
2. S.L. Kramer, Geotechnical earthquake engineering, Prentice Hall, 3rd Edition, 2009, ISBN: 9788131707180, 8131707180.

TRAFFIC ANALYSIS AND MANAGEMENT

Course Code: **CE40067**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To introduce the advances in traffic engineering analysis and design and to make the students conversant with relevant field applications.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Describe the main characteristics of traffic flow,
CO 2: Represent traffic phenomena using different methods and tools,
CO 3: Recognize how traffic congestion starts and propagates,
CO 4: Select and apply appropriate methods and techniques for analyzing traffic-related problems,
CO 5: Interpret and elaborate different type of traffic data, and
CO 6: Learn the elements of design of various traffic facilities.

COURSE DETAILS

Introduction
Elements of traffic engineering, road users, vehicles, highways and control devices.

Fundamentals of Traffic flow
Road user and vehicle characteristics, Speed flow and density concepts, Microscopic and macroscopic parameters of traffic flow, fundamental relationships between speed flow and density, Traffic studies, PCU, peak hour factor, accident study and analysis.

Traffic Operation and Control
Delay concepts, Highway capacity and level of service of different traffic facilities, Traffic control and regulation devices, Signal design by Webster's method, Types of intersections and channelization, Introduction to Intelligent Transportation System.

Management Techniques
Traffic calming devices, Traffic signs, Congestion, and road user pricing; priority movements; traffic regulations and control systems; use of intelligent systems.

Textbooks

1. S.K. Khanna, M.G. Arora and S.S. Jain, Airport Planning and Design, Nem Chand & Bros., Roorkee, India, 6th Edition, 2012, ISBN: 81-85240-68-10.

2. L.R Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, India, 9th Edition, 1999, ISBN: 978-81-7409-220-5.

Reference Books

1. C.J. Khisty & B. K. Lall, Transportation Engg: An introduction, Pearson Education, 3rd Edition, 2017, ISBN: 978-9332569706.
2. P. Chakraborty and A. Das, Principles of Transportation Engineering, PHI Publication, 2nd Edition, 2017, ISBN: 978-8120353459.

RAILWAY AND AIRPORT PLANNING

Course Code: CE40069
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course helps students to understand about the technical aspects of railway, and airport engineering. The students are made familiar with the design of railway tracks, the concepts of gauges and elements of design. In airport engineering, the students learn the factors affecting site selection of airports, the design of runways, and taxiway.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn the basics of Airport and Railway Engineering,
CO 2: Know the function of various components of permanent way,
CO 3: Understand the geometric design of railway track,
CO 4: Know the layout and planning of airport,
CO 5: Understand the elements of geometric design of airport, and
CO 6: Know the design of runway and taxiway.

COURSE DETAILS

Introduction to Railway Engineering

Role of Indian Railways in National Development – Railways for Urban Transportation – LRT & MRTS - Engineering Surveys for track alignment (Conventional and modern methods), Permanent way components – Cross section of Permanent Way – Function of various components like rails, sleepers and ballast, Gauge – Creep of rails – Theories related to creep – Sleeper density.

Geometric Design of Railway Track

Gradients – Grade compensation – Cant and negative super elevation – Cant deficiency – Degree of curve, Points and Crossing, Rail joints & welding of joints, Railway station & yards, Signalising & interlocking.

Airport Planning

Air transport characteristics, airport classification, airport planning: objectives, components, layout characteristics, and socio-economic characteristics of the catchment area, criteria for airport site selection and ICAO stipulations, typical airport layouts, Parking and circulation area.

Airport Design: Runway Design: Orientation, Wind Rose Diagram, Runway length, Problems on basic and Actual Length, Geometric design of runways, Configuration and Pavement Design Principles,

Elements of Taxiway Design, Airport Zones, Passenger Facilities and Services, Runway and Taxiway Markings and lighting.

Textbooks

1. S Chandra and M.M. Agarwal, Railway Engineering, Oxford University Press India, 2nd Edition, 2013, ISBN: 9780198083535.
2. S.K. Khanna, M.G. Arora and S.S. Jain, Airport Planning and Design, Nem Chand & Bros., Roorkee, India, 6th Edition, 2012, ISBN: 81-85240-68-10.

Reference Books

1. S.C. Saxena and S.P. Arora, A Textbook of Railway Engineering, Dhanpat Rai Publishing Co Pvt Ltd, 2015, ISBN: 9789383182923.
2. R.M. Horonjeff and F.X. Mckelvey, Planning and Design of Airports, McGraw-Hill Education, New York, 5th Edition, 2010, ISBN: 9780071446419.
3. R.L. de Neufville and A.R. Odoni, Airport Systems - Planning, Design and Management, McGraw-Hill Education, New York, 2nd Edition, 2013, ISBN:978-0071770583.

ROAD SAFETY ANALYSIS

Course Code: **CE40071**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To introduce the concepts of traffic safety on highways and to make students familiar with related analytical methods and remedial measures.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know the scenario of road crashes in India and deaths accompanied,
CO 2: Understand the steps of crash investigation,
CO 3: Learn various statistical techniques to model road crashes,
CO 4: Know various traffic management techniques to improve road safety,
CO 5: Understand the process of road safety auditing, and
CO 6: Know about various Indian and world guidelines and codes targeting improvement of road safety.

COURSE DETAILS

Introduction
Road traffic accidents scenario in India, characteristics of accidents, accident vs. crash, effect of human factors, planning for road network, land use and road environment for safety, designing for road safety — links and junctions, road safety improvement strategies.

Crash investigation and analysis
Steps in treatment of crash locations, diagnosing crash problem and solutions, accident report form, storing of data, using and interpreting crash data, identifying and prioritizing hazardous locations, condition and collision diagrams; Vulnerable road users: crashes related to pedestrian and bicyclists, their safety, provision for disabled.

Statistical analysis of accidents
Descriptive statistics, confidence interval, hypothesis testing, models related to accident frequency, accident severity.

Before -after methods in crash analysis
Before and after study, before and after study with control sites, comparative parallel study, before, during and after study.

Traffic management system
Traffic flow improvements, expressway patrol, public transit, ridesharing, mobility rest areas, park-and-ride lots, bus bays, signage, markings; ITS applications - vehicular navigation, crash avoidance system, incident management, traffic management centre, highway side communication.

Road safety audits
Procedure, aims and objectives, roles and responsibility, history of road safety audit, design standards, tasks, various stages of safety audits; common identifiable problems, structuring of report, identifying common problems.

Textbook

1. L.R Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, India, 9th Edition, 1999, ISBN: 978-81-7409-220-5.

Reference Books

1. American Association of State Highway and Transportation Officials (AASHTO), Highway Safety Manual, AASHTO, 1st Edition, 2010, ISBN: 978-1560514770.
2. Relevant AASHTO/ IRC and other Codes and Specifications.

GLOBAL WARMING AND CLIMATE CHANGE

Course Code: **CE40082**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course deals with various environmental issues and their adverse effects on ecosystem. It also includes basics of atmosphere, atmospheric stability assessment, pollution dispersion and the radiative effects of air pollutants (gases and particulate matter). In addition to that it covers greenhouse gases, global warming phenomenon, causes and effects of global warming, climate change consequences and mitigation measures.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the sources of air pollutants and understand the effects of air pollutants on health and environment,
CO 2: Classify the air pollutants and understand their impacts on global warming,
CO 3: Understand the meteorological parameters and their effect on dispersion of air pollutants into the atmosphere,
CO 4: Acquire knowledge on fundamentals of climate change due to global warming,

CO 5: Understand the issues of climate change, and
CO 6: Understand the social and economic impacts of climate change.

COURSE DETAILS

Atmosphere and Air Pollutants
Structure of the atmosphere, Natural and anthropogenic sources of pollution, Atmospheric sources, Effects of air pollution on human health, vegetation and animals, building materials and structures, atmosphere, soil and water bodies, Gaseous and particulate matter, Primary pollutants, Secondary pollutants, Criteria pollutants, Hazardous pollutants, greenhouse gases.

Meteorological parameters and Air Pollution
Lapse rates, atmospheric stability, plume behaviour, boundary layer, mixing height, stack height and Plume rise.

Climate Science & Fundamentals of Climate Change
Weather, Climate and Climate Change – An Introduction, Basic Elements of Global Climate, Solar Radiation & Energy Balance, Inter-Year Climate Change.

Anthropogenic Global Warming & Climate Change
Anthropogenic Character of Global warming, Intergovernmental Panel on Climate Change, UNFCCC 1992 & International Conferences on Climate Change, Major UN Climate Change Conferences till date.

Social and Economic Impacts of Climate Change
Elements of Economics of Climate Change, Carbon Trading, Urban Climate Change, Climate Change & Human Migration.

Textbook

1. M.K. Ghosh Roy, Global Warming and Climate Change, Medtech, 1st Edition, 2023, ISBN: 9789384007737.

Reference Books

1. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
2. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, 2017, ISBN-13: 978-9351340263.
3. Gopal Bhargava, Global Warming and Climate Changes Transparency and Accountability (Vol. 3), Gyan Publishing House 2004.

CONSTRUCTION MATERIALS AND SPECIFICATIONS

Course Code: **CE40084**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to understand the various type of construction materials such as bricks, cement, concrete, bitumen, geosynthetic along with non-structural materials used for construction purpose and their specifications.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know and understand the necessities of specifications of the materials with respect to quality and quantity for a construction work,
CO 2: Know the engineering specifications containing detailed description of all workmanship and materials for a complete project in accordance with plan and drawings,
CO 3: Know the specifications regarding the quality of workmanship to be achieved during construction,
CO 4: Manage creative teams and project processes effectively and efficiently,
CO 5: Understand the specification and applications of geosynthetic materials, and
CO 6: Know the specification of materials used for thermal insulation, acoustic, water proofing and flooring.

COURSE DETAILS

Bricks
Classification, Methods of brick manufacture, Testing of bricks.

Cement and concrete
Classification, Chemical composition, Cement manufacturing process, Tests on cement. Composition of concrete, W/C ratio, Nominal mix design, pozzolanic concrete, Light weight and high density concrete, Tests on concrete.

Aggregates
Fine and coarse aggregates, Gradation of sand, Tests on aggregates.

Bitumen
Manufacturing of Bitumen, Tests on bitumen, Grades of bitumen.

Geosynthetics
Geo textiles, geogrids, geonets, geomembrane, geosynthetic clay liner, geocells, geo composites, Pre-fabricated vertical drains, Applications of geosynthetic materials.

Reinforcement and Structural Steel
Steel manufacturing process, Types of reinforcement steel and application, Grades of structural steel, Various types of standard sections.

Non-structural materials
Thermal insulation and acoustic absorption materials, Water proofing materials, Flooring materials.

Textbooks

1. M.L. Gambhir, Neha Jamwal, Building Material, 1st Edition, TMH Education, New Delhi, 2017.
2. P.C. Verghese, Building Material, PHI Learning (P) Ltd., New Delhi, 2005.

Reference Books

1. S.K. Sharma, A Textbook of Building Construction, Revised Edition, S. Chand Publication.
2. S.S. Bhavikatti, Building Material, 1st Edition, Vikas Publication.
3. B.C. Punmia, Jain and Jain, Building Construction, Jain and Jain, 10th Edition, Laxmi Publication, New Delhi.
4. P.C. Verghese, Building Material, PHI Learning (P) Ltd., New Delhi, 2005.
5. S.C. Rangwala, Engineering Materials, Charotar Publishing House, 2011.

NATURAL RESOURCES MANAGEMENT

Course code: **CE40086**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To learn and use the knowledge for planning, management, utilization and sustainability of natural resources.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand ecological footprint & interrelationship among different natural resources,
CO 2: Identify basic management issues related to forest and land,
CO 3: Prepare strategies related to water and minerals,
CO 4: Prepare approaches for NRM,
CO 5: Implement PRA concept, and
CO 6: Identify technology and methods for NRM.

COURSE DETAILS

Introduction to Natural Resource Bases
Concept of resource, carrying capacity, ecological foot print and sustainability; Natural resources of different geographical regions of India; Factors influencing resource availability, distribution and uses; Interrelationships among different types of natural resources; Concern on productivity issues.

Resource Management Paradigms
Evolution of resource management paradigms, resource extraction, access and control system, Basic management issues, associated with key natural resources viz. Forest, Land, Water, and Minerals.

Approaches in Resource Management
Ecological approach; economic approach; ethnological approach; implications of the approaches; participatory rural appraisal (PRA); role of indigenous knowledge in Natural Resources Management (NRM).

Technologies for NRM
Farmers' field-based technologies and tools for NRM; Case studies from few agro-ecological zones of India; Various crop models, land-use models, nutrient models; Multi-criteria-decision analysis (MCDA); Precision farming technologies (PFT); Information Communication Technologies (ICT) for NRM.

Textbooks

1. E.P. Odum, Fundamentals of Ecology: W.B. Saunders Co. USA, 574p (Indian Edition), 2005.
2. D.R. Lynch, Sustainable Natural Resource Management: For Scientists and Engineers, Publisher: Cambridge University Press, 2009.

References Books

1. M.C. Dash, Concepts of Environmental Management for Sustainable Development Publisher: I K International Publishing House Pvt. Ltd., 2013.

BASIC TRANSPORTATION ENGINEERING

Course Code: CE40088
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course is designed to enable the students to understand and appreciate the importance of transportation engineering and learn the various modes of transportation. The students shall learn the basic technicalities of highway engineering, railway engineering, airport, tunnel, dock, and harbor engineering.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand highway system,
CO 2: Learn about the different materials used in highway construction,
CO 3: Know about the other modes of transportation engineering,
CO 4: Gain basic knowledge about railway system,
CO 5: Understand airport system, and
CO 6: Understand docks & harbours system.

COURSE DETAILS

Highway Engineering
Introduction to Transportation Systems, Road Development in India, Highway Engineering – Classification of Roads, Highway Planning - Road cross section - camber, gradient, Super elevation - Sight distance - Horizontal and Vertical curve, Highway Materials- Soil & Soil properties, Bitumen and bituminous mixes – sources, composition, characterization, various forms - Tests on bitumen- Aggregate test, mix design - Types of pavement – pavement construction and maintenance, Traffic engineering- various studies, Level of Service, Intersections, Road signs, markings & signals, Highway Parking.

Railway Engineering
Introduction, Development & Administration of Indian Railway, Railway surveying, Rolling Stock & track resistances, Tractive power & Tractive resistances, Permanent way, Railway gauges, Sleepers, Ballast, Track design, Stations & yards, Station Equipment, Signalling, High speed Trains, Train Accidents-Causes & Prevention.

Airport Engineering
Administration, Advantages & Disadvantages of Air transport, Aircraft Characteristics, Airport Obstructions, Typical layout of Airports – Component parts – Objectives of components – Runways – Taxiways – Aprons – Landing, Helicopters, Air traffic control, Airport Marking & Lightning.

Tunnel Engineering
Introduction-Advantages, disadvantages, economics & selection, Classification of tunnels, Design of shape & size of tunnels, Components of Tunnel, Methods of tunneling, Precautions, Tunnel Lining & drainage.

Docks & Harbor Engineering
Introduction, Classification & Requirements of ports, harbor, docks, Maintenance of ports & harbours, advantages of docks, Transit shed & warehouse, Tides, wind & waves, Different components of docks, Navigational aids, Breakwater.

Textbook

1. S.P. Chandola, A Textbook of Transportation Engineering, S. Chand (G/L) & Company, 1st Edition, 2001, Revised 2016, ISBN-13: 978-8121920728.

Reference Books

1. V.N. Vazirani & S. P. Chandola, Transportation Engineering Vol. I, Khanna Publishers, 5th Edition (1 January 1998), ISBN-13: 978-9387394292.
2. Amit Gupta & B.L. Gupta, Roads, Railways, Bridges, Tunnels & Harbour Dock, Standard Publishers Distributors (1 January 2009), ISBN-13 : 978-8180140099.
3. Rangwala, Highway Engineering, Charotar Publishing House Pvt. Ltd., 10th edition (1 January 2015), ISBN-13: 978-9385039096.
4. S. C. Saxena and S. P. Arora, A Textbook of Railway Engineering, Dhanpat Rai Publications, New Delhi, (1 January 2010), ISBN-13: 978-8189928834.
5. Norman J. Ashford, Saleh Mumayiz, Paul H. Wright, Airport Engineering: Planning, Design, and Development of 21st Century Airports, Wiley, 4th Edition.
6. Rangwala, Railway Engineering, Charotar Publishing House Pvt. Ltd, 27th Edition, ISBN-13: 978-9385039249.
7. H.P. Oza & G.H. Oza, Dock & Harbour Engineering, Charotar Publishing House Pvt Ltd, 7th Edition, ISBN-13: 978-9380358789.

GENDER & LEGAL ASPECTS IN WATER RESOURCES MANAGMENT

Course Code: **CE40050**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To learn various legal provisions in managing water resources and to understand the gender aspects in the water resources management

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the basics of water law, in the context of historical development and evolving, recognition of issues related to human and ecological needs of water,
CO 2: Understand how the policies, laws and judicial approaches tackle the recent water issues,
CO 3: Help formulate recommendations/responses that could resolve/avoid disputes,
CO 4: Emphasize water as a finite common property resource that must be used in public interest,
CO 5: Understand the legal perspective of Water Resources Management, and
CO 6: Undertake critical analysis of water conflict.

COURSE DETAILS

Gender Approach to Water Management
Drinking and Domestic Water - Sanitation and Hygiene -Gender Policies in Water Management - Country Experiences.

Historical Background and Current Challenges on Legal Aspects
Policy, Law, Bill, Act, Rules, Notifications – Nature of Rights: Natural Rights -Doctrine of Equality – Doctrine of Equitable Apportionment – Public Trust Doctrine -Challenges in Water Management – Physical and Technical Challenges – Social and Economic Challenges - Role of Law in Water Management, Conceptions of Water: Commodity, Service, Human Right Water Legislation in India.

Pre-Constitutional Water Laws
Constitutional Provisions: Article 14, Article 21, Directive Principles of State Policy, Fundamental Duties, Article 262 – Legislative Process: Legislative, Judicial, Executive – Natural Justice – Delegation of Powers - Tribunals – Post-Constitutional Water Laws –National-Level Enactments - Protection of Water Sources – Groundwater – Drinking and Domestic Water Supply, – Industrial Use – Water Pollution.

Water Governance
Policies And Legal Frameworks: Water Governance and Water Policy – Legal Framework of Water – Substance of National Water Laws – Other key issues – Changing incentives through Regulation - National Water Policy – National-Level Commissions – Irrigation Management Transfer Policies and Activities.

Legal Changes in Water Allocation
Water Conflicts in India: Water conflicts and Tribunals - Contending Water Uses – Equity, Access and Allocation - Water Quality Conflicts - Sand Mining - Micro-level Conflicts, Dams and Displacement – Privatization – Case Studies.

Reference Books

1. Singh, Chhatrapati ―Water Rights in India, Edition Chhatrapati Singh. Water Law in India: The Indian Law Institute, New Delhi,1992.
2. Law for Water Management – A Guide to Concepts and Effective Approaches‖, Ed: Jessica Vapnek, Brace Aylward, Christie Popp and Jamie Bartram, FAO, Rawat Publications, New Delhi, 2011.
3. Water Conflicts in India – A Million Revolts in the Making‖ , Ed: K. J. Joy, Biksham Gujja, Subas Paranjape, Vinod Goud, Shruti Vispute, Routledge, New Delhi, 2008.
4. Groundwater Management and Ownership‟, Report of the Expert Group, New Delhi: Government of India, Planning Commission, http: // planning commission.nic.in / reports / genrep / rep_grndwat.pdf, 2007.
5. Irrigation Management Transfer in India – Policies and Performance, Brewer, J., S. Kolavalli, A. H. Kalru, G. Naik, S, Ramnarayan, K.V. Raju and R. Sakthivadivel, Oxford and IBH Publishing Company, New Delhi,1999.

6. The Politics of Irrigation Reform – Contested Policy Formulation and Implementation in Asia, Africa and Latin America‖, Mollinga, Peter P., and Alex Bolding, Ashgate, England.
7. Commentaries on The Indian Easements Act, 1882 and Licences‖, Row, Sanjiva, 5th Edition, Delhi Law House, New Delhi, 2006.
8. The Politics of Water – A Survey, Edition Kai Wegerich and Jeroen Warner, Taylor and Francis Group, London, 2010.

ENVIRONMENTAL IMPACT ASSESSMENT

Course Code: **CE40052**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course will enable the students to define and classify Environmental Impacts, understand the environmental Impact assessment procedure, and explain the EIA methodology.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain key concepts in environmental impact assessment & Management,
CO 2: Understand the importance of various rules & regulation in EIA,
CO 3: Evaluate the Impact on various environments and role of stake holders in EIA,
CO 4: Apply various techniques in Impact Assessment studies,
CO 5: Identify most suitable tool for assessment process and make suggestions for solutions, and
CO 6: Evaluate a project using EIA with one or more management tools.

COURSE DETAILS

Introduction to EIA
Ecology and the environment. Ecosystem and its characteristics, Structure of Ecosystem; Food chains, Food webs and Tropic levels, Energy and energy flows; Elemental cycles, Concept of Succession; Role of succession in restoration and recovery of ecosystem, Ecosystem disturbances and their causes; natural causes and anthropogenic causes, Ecosystem and Ecological Footprints, Definition and concepts of EIA, ethics and environment, EIA for civil engineers, Types of EIA: Rapid; Comprehensive; Strategic; Sectoral; Regional - Rationale and scope of each type.

Evolution of EIA
Evolution of EIA worldwide; Evolution of EIA in India, EIA Regulations in India Overview of Indian laws – Constitutional Provisions (Water, Air, Forest, Hazardous etc), Overview of- EPA 1986 & EIA Notification 2006, Environmental Risk Assessment, Environmental management: Principles, problems and strategies; Review of political, ecological and remedial actions, Environmental audit: Definitions and concepts, partial audit, compliance audit, Overview of methodologies and regulations, Environmental management systems in local government, Sustainable development – Definitions, Charter and Global Conventions; Future scenarios.

Assessment Techniques
Components of the Environment: Water Standards pertaining to water quality, Components of the Environment: Air & Noise- Standards pertaining to Air & Noise quality, Components of the Environment: Soil- Soil quality, Landuse Criteria, Components of the Environment: Biosphere (Macro, Micro)- Introduction to Hazard Exposure levels for biota, Components of the Environment: Socioeconomic,

Components of the Environment: Cultural and Aesthetics, Role of Public Participation in EIA, Role of Public Participation in EIA, Role of stakeholders.

EIA Methodologies

Initial Environmental Examination; Screening, Scoping Analysis of alternatives, Mitigation- Definition, options for mitigation of impact on water, air and land, water, energy, flora and fauna, Environmental Impact Statement- Document planning - collection and organization of relevant information, Environmental Assessment- Base line, Construction Phase, Post Construction/ Operational phase scenario, Impact Assessment Methodologies: Checklists- Simple, Descriptive, Scaling Checklist.

Textbooks

1. L.W. Canter, Environmental Impact Assessment, 2nd Ed., McGraw-Hill, 1997.
2. Y. Anjaneyalu, ValliManickam, Environmental Impact Assessment Methodologies, 2nd Ed., BS Publications, 2007.
3. B.M. Noble, Introduction to Environmental Impact Assessment: A Guide to Principles and Practice. Oxford University Press, USA, 2005.

Reference Books

1. G. Burke, B. R. Singh and L. Theodore, Handbook of Environmental Management and Technology, 2nd Ed., John Wiley & Sons, 2000.

2. R. Therivel, John Glasson, Andrew Chadwick, Introduction to Environmental Impact Assessment (Natural and Built Environment), Routledge, 2005.

AIR POLLUTION CONTROL & MANAGEMENT

Course Code: CE40054
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil
COURSE OBJECTIVE

The course is designed to enable the students to know the sources, characteristics and effects of air pollution, their effects on environment and human health and the methods of controlling the same.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the structure of atmosphere and identify the sources of air pollutants,
CO 2: Classify the air pollutants and understand the effects of air pollutants on health and environment,
CO 3: Understand the meteorological parameters and their effect on dispersion of air pollutants into the atmosphere,
CO 4: Learn about air quality standards and determine the air quality index,
CO 5: Adopt suitable measures for controlling particulate air pollutants, and
CO 6: Adopt suitable measures for controlling gaseous air pollutants.

COURSE DETAILS

Introduction to Air Pollution

Structure of the atmosphere, Natural and anthropogenic sources of pollution, Atmospheric sources.

Air Pollutants and their effects

Gaseous and particulate matter, Primary pollutants, Secondary pollutants, Criteria pollutants, Hazardous pollutants, greenhouse gases, Effects of air pollution on human health, vegetation and animals, building materials and structures, atmosphere, soil and water bodies.

Meteorological parameters and Air Pollution
Lapse rates, atmospheric stability, plume behaviour, boundary layer, mixing height, stack height and Plume rise.

Air Quality Standards
Air Quality Index (AQI), Air Quality Standards, Air Pollution Legislations and Regulations

Control of Air Pollutants
- **Particulate pollutants -** Control of particulate air pollutants using gravitational settling chambers, cyclone separators, wet collectors, fabric filters (Bag-house filter), electrostatic precipitators (ESP).
- **Gaseous Pollutants -** Control of gaseous contaminants: absorption, adsorption, condensation and combustion; Control of sulfur oxides, nitrogen oxides, carbon monoxide, and hydrocarbons.

Textbooks

1. Daniel Vallero, Fundamentals of Air Pollution, Academic Press, 5th Edition, 2014, ISBN: 978-0-12-401733-7
2. Wark, K., Warner, C.F., and Davis, W.T., Air Pollution: Its Origin and Control, Addison-Wesley Longman. 1998.
3. Boubel, R.W., Fox, D.L., Turner, D.B., Stern, A.C., Fundamentals of Air Pollution, Academic Press. 2005.
4. Gurjar, B.R., Molina, L., Ojha, C.S.P. (Eds.), Air Pollution: Health and Environmental Impacts, CRC Press. 2010.

Reference Books

1. Karl B. Schnelle, Jr. and Charles A. Brown, Air Pollution Control Technology Handbook, CRC Press, 1st Edition, 2001.
2. Jeremy Colls, Air Pollution, SPON Press, 2nd Edition, 2003.
3. Seinfeld, J.H. and Pandis, S.N., Atmospheric Chemistry and Physics, John Wiley, 2006.

GROUNDWATER CONTAMINATION AND REMEDIATION

Course Code: **CE40056**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course will provide learners with an in-depth understanding of modern geo-environmental engineering abilities, allowing them to solve environmental concerns and sustainable approaches associated to groundwater development. It will also help to identify, formulate and solve complex problems associated with groundwater. Learners will gain knowledge on the practical aspects related to various characteristics of interaction of containment, its biogeochemistry, transport process of contaminants on the subsurface, and methods of groundwater remediation.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the fundamentals, importance, and scope of geo-environmental engineering,
CO 2: Understand the importance, occurrence, and assessment of groundwater engineering,
CO 3: Understand the groundwater movement in porous media under different conditions and its significance in determining groundwater-contaminant interaction,
CO 4: Identify the contaminant transport mechanisms in groundwater and understanding the contaminants interaction along with the biogeochemistry of groundwater,
CO 5: Identify the various remediation techniques for contaminated groundwater, and
CO 6: Perform the Economic assessment of groundwater remediation.

COURSE DETAILS

Fundamentals of Geo-environmental Engineering
Introduction to fundamentals, importance, and scope of geo-environmental engineering. Soil properties based on its formation (or type of weathering process). Sources, type, and impact of ground contamination on geo-environment.

Groundwater-Contaminant Interaction
Introduction to groundwater and its significance; study of groundwater known as hydrogeology; water-contaminants interaction; forces of interaction between groundwater-contaminant interaction, theories of ion exchange, contaminant transport mechanism and retention.

Groundwater Remediation
Site characterization; risk assessment of groundwater. Different in-situ and ex-situ remedial approaches for groundwater.

Economic Assessment of Groundwater Remediation
Cost analysis of various remedial measures of groundwater.

Textbooks

1. H.D. Sharma and Krishna R. Reddy, Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies HandBook, Wiley Publication, 2004.
2. James E. Landmeyer, Introduction to Phytoremediation of Contaminated Groundwater, Historical Foundation, Hydrologic Control, and Contaminant Remediation, Springer. 2011.

Reference Books

1. Rowe R.K., Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publications, London, 2000.
2. Yong, R. N., Geoenvironmental Engineering, Contaminated Soils, Pollutant Fate, and Mitigation, CRC Press, New York, 2001.
3. Sharma H.D. and Reddy K.R., Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, John Wiley & Sons, Inc., USA, 2004.
4. Landmeyer, J.E., Introduction to phytoremediation of contaminated groundwater, historical foundation, hydrologic control, and contaminant remediation. Springer Science & Business Media, 2011.

GEOTECHNICAL INSTRUMENTATION AND MONITORING

Course Code: **CE40058**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course aims to introduce various geotechnical instrumentation used to monitor geohazards. This course will help the students to understand how to plan and install monitoring systems at potential geohazard sites. It will make students familiar with the various field instrument and data acquisition systems generally used in geohazards sites.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand how to plan a monitoring program and learn the method of monitoring,
CO 2: Learn about various groundwater monitoring systems and stress measurement equipment,
CO 3: Learn about various deformation measurement equipment,
CO 4: Learn about earthquake measuring instruments and tsunami observation,
CO 5: Understand field equipment and GPS system, and
CO 6: Understand IoT for disaster management.

COURSE DETAILS

Introduction, Planning monitoring program, benefit of using geotechnical instrumentation, systematic approach to planning monitoring program, Monitoring methods, measurement uncertainty, instrumentation transducer and data acquisition, Measurement of groundwater pressure, observation well, piezometer, types of piezometer, arrangement of piezometers, installation of piezometer, Measurement of total stress in soil, types & method, embedment earth pressure cell, contact earth pressure cell, Measurement of stress change in rock, categories, inclusion of gages, Measurement of deformation: surveying method, extensometer, tiltmeters, inclinometers, transverse deformation gauge, Earthquake measuring instrument, Surface movement monitoring using field instrument and GPS system, Tsunami observation, Wireless sensor networks and IoT in disaster management.

Textbook

1. Geotechnical Instrumentation for monitoring field performance by J. Dunnicliff & G. E. Green John Wiley & Son, 1st Edition, 2007. 978-0471005469.

Reference Book

1. Geological disaster monitoring based on sensor networks by T.S. Durrani, W. Wang and S.M. Forbes, Springer Nature Hazards, 2365-0664.

FUNDAMENTALS OF URBAN TRANSPORTATION PLANNING

Course Code: **CE40060**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course shall help students to deal with the different types of rapid transit system and public transportation systems, various planning strategies which are employed for the selection of schedule for any public transit system, and various mathematical models for urban transportation planning.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Justify the need for urban transportation system planning,
CO 2: Undertake transport surveys followed by a report,
CO 3: Plan the process of trip generation and distribution,
CO 4: Justify the need of a modal split,
CO 5: Prepare the transportation plans for urban mass rapid transit systems, and
CO 6: Prepare an optimal bus schedule according to demand of the locality.

COURSE DETAILS

Introduction
Transport and socio-economic activities, freight transportation system, future development of transportation system: BRTS, MRTS, ITS. Urban structure: urban activity system, urban movement hierarchies. Goods movement: broad classes of urban goods movement demand, classification of urban goods movement, methodology of approach to analysis of goods movement, modeling demands for urban goods transport.

Classification of roads
Arterial roads, secondary or sub-arterial roads, local road, other road: bypass road, outer and inner ring road, express way, freeway types of urban or road systems.

Urban transportation planning
Trip generation analysis, introduction, types of trip, methods of trip generation, trip production statistical analysis, category analysis or cross classification.

Mode choice and modal split
modelling, influencing factors, socioeconomic characteristic of the trip makers, characteristics of the trip, characteristics of the transportation system. factor affecting modal split, modal split in transportation planning process: trip end type modal split modal, Rip interchange modal split modal. trip interchange modal split modal, binary choice model, logit model.

Trip distribution
methods of trip distribution, uniform constant factor method, average factor method, Fractar method, Furness method, growth factor model, Gravity model, etc.

Route assignment

Objective of traffic assignment, principle of traffic assignment, assignment technique, all-or-nothing assignment, multiple route assignment, capacity restrain assignment, application of route assignment, Optimal Bus Scheduling.

Textbooks

1. L.R Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, India, 9th Edition, 1999, ISBN: 978-81-7409-220-5.
2. C.S. Papacostas and P. D. Prevedouros, Transportation Engineering and Planning, Pearson,3rd Edition, 2015, ISBN: 9789332555150.

Reference Books

1. C.J. Khisty & B. K. Lall, Transportation Engg: An introduction, Pearson Education, 3rd Edition, 2017, ISBN: 978-9332569706.
2. P. Chakraborty and A. Das, Principles of Transportation Engineering, PHI Publication, 2nd Edition, 2017, ISBN: 978-8120353459.

WATER RESOURCES LABORATORY

Course Code: **CE49001**
Credit: **2**
L-T-P: **0-0-4**
Prerequisite: **Nil**

COURSE OBJECTIVE

To learn different principles of flow, flow measuring devices, various losses in pipes and perform statistical analysis of hydrological time series, uses of GPS and GIS in water resources domain.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Determine the metacentric height of floating body & different regimes of flow using Reynold's apparatus,
CO 2: Verify Bernoulli's theorem and determine coefficient of discharge of venturimeter, orificemeter and notches,
CO 3: Estimate major and minor losses through pipes,
CO 4: Perform different statistical analysis of hydrological time series using excel,
CO 5: Use GPS system and GIS principles for area delineation, and
CO 6: Perform spatial interpolation of hydrological data.

COURSE DETAILS

Part-I: Hydraulics & WR Lab: (2 hours per week)

- Determine the metacentric height of floating body
- Determination of different regimes of flow by Reynold's apparatus
- Verification of Bernoulli's theorem
- Determination of Coefficient of Discharge (C_d) of Venturi meter

- Determination of Coefficient of discharge (C_d) of Orifice meter
- Determination of hydraulic coefficients (C_c, C_v, C_d) of Circular Orifice
- Determination of Coefficient of Discharge (C_d) of Triangular Notch
- Determination of Coefficient of Discharge (C_d) of Rectangular Notch
- Determination of Darcy's friction factor for different pipes
- Determination of Minor losses in pipes

Part-II: Water Resources Computational Lab: (2 hours per week)

- Excel based hydrological data Analysis-I (Basic Statistics)
- Excel based hydrological data Analysis-II (Probability Analysis)
- Excel based hydrological data Analysis-III (DAD curve preparation)
- Excel based hydrological data Analysis-IV (IDF curve preparation)
- Infiltration Analysis & Model Fitting-I (Experiment based infiltration capacity)
- Infiltration Analysis & Model Fitting-II (Fitting different infiltration models)
- Use of GPS system for area delineation
- GIS based delineation of catchment-I
- GIS based delineation of catchment-II
- Spatial Interpolation of hydrological data using GIS

Reference Books

1. Hydraulics and Water resources Engineering Laboratory Manual, School of Civil Engineering, KIIT Deemed to be University, Bhubaneswar
2. R.K. Bansal, A Textbook of Fluid Mechanics & Hydraulic Machines, Laxmi Publications (P) Ltd., 10^{th} Edition.
3. P.A. Burrough and R.A. McDonnell, Principles of Geographical Information Systems, Oxford University Press, UK.
4. M.F. Goodchild, P.A. Longley, D.J. Maguire and D.W. Rhind, Geographic Information Systems and Science, John Wiley & Sons Ltd., England.
5. Satheesh Gopi, Global Positioning System: Principles and Applications by, McGraw Hill Education.

ENVIRONMENTAL QUALITY LABORATORY

Course Code: **CE49003**
Credit: **2**
L-T-P: **0-0-4**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to determine the physical, chemical and biological characteristics of water and wastewater. and assess the noise pollution.

COURSE OUTCOMES

After successfully completing the course, the students will be able to
CO 1: Determine pH and turbidity of a water sample,
CO 2: Determine alkalinity, hardness and chlorides present in a water sample,
CO 3: Determine optimum dosage of coagulant based on the solids present in a water sample,
CO 4: Determine dissolved oxygen present in a water sample,
CO 5: Determine BOD present in a water sample, and
CO 6: Assess the noise pollution through measurement of sound pressure level.

COURSE DETAILS

- Determination of pH of water sample
- Determination of turbidity of water sample
- Determination of Total Alkalinity of water sample
- Determination of Total Hardness of water sample
- Determination of concentration of chlorides in water sample
- Determination of Total Suspended Solids, Total Dissolved Solids and Total Solids present in water sample
- Determination of Optimum coagulant dosage based on the solids present
- Determination of dissolved oxygen in water sample
- Determination of BOD in water sample
- Measurement of sound pressure levels using Sound Level Meter

Textbooks

1. IS: 3025 – 2019, Methods of sampling and test (Physical and Chemical) for water and wastewater.
2. IS: 10500 – 2012 Indian Standard Drinking Water — Specification.
3. S.K. Garg, Environmental Engineering (Vol. I) Water Supply Engineering, Khanna Publishers, 36th Edition, 2022, ISBN-13: 978-81-7409-120-8.

Reference Book

1. C.N. Sawyer and Perry L. McCarty, Chemistry for Environmental Engineering, 5th Edition, McGraw-Hill Education, 2002, ISBN-10: 0072480661.

GEOMATERIAL LABORATORY

Course Code: **CE49005**
Credit: **2**
L-T-P: **0-0-4**
Prerequisite: **Nil**

COURSE OBJECTIVE

This laboratory encompasses basic tests to ascertain soil and rock properties like Atterberg limits, in-situ density, specific gravity, water absorption, porosity, permeability, determination of soil's consolidation parameters, determination moisture content and dry density relationship and shear strength parameters of soil using direct shear, uunconfined shear, vane shear, unconfine compression strength of rock and triaxial shear method.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the types of soil and rock,
CO 2: Determine the change in properties of soil with the water content,
CO 3: Learn various laboratory test procedures normally used in geotechnical engineering for soil and rock,
CO 4: Determine index and shear strength properties of soils,
CO 5: Determine hydraulic properties of soils and
CO 6: Determine compaction and consolidation properties of soils.

COURSE DETAILS

- Introduction to different types of soil, rock, soil-water interaction, various soil properties and their test methods.
- Determination of Specific Gravity of soil and rock by pycnometer test.
- Grain size Analysis (Dry and Wet sieving method).
- Determination of Atterberg Limit.
- Determination of Dry Density of Soils in place by the core-cutter and sand replacement method.
- Determination of Permeability of soil (falling head or constant head method).
- Determination of basic properties of rock (water absorption, density, porosity etc.).
- Determination of compaction property of soil.
- Unconfine compression test of rock core.
- Determination of shear parameters by direct shear test.
- Determination of shear parameters by unconfined compression test.
- Determination of shear parameters by triaxial (unconsolidated undrained) shear test.
- Determination of consolidation parameters of soil.

Textbook

1. B.C. Punmia, Ashok K. Jain & Arun Kumar Jain, Soil Mechanics & Foundation Engineering, Laxmi Publication, New Delhi, 17th Edition, 2017.

Reference Books

1. Geotechnical Engineering Laboratory Manual, School of Civil Engineering, KIIT (DU).
2. IS: 2720 (Part 2) (1973). Methods of test for soils: Laboratory determination of Water Content.
3. IS: 2720 (Part 3) (1980). Methods of test for soils: Laboratory determination of Specific Gravity.
4. IS: 2720 (Part 4) (1985). Methods of test for soils: Grain size Analysis.
5. IS: 2720 (Part 5) (1985). Methods of test for soils: Laboratory determination of Liquid Limit and
    a. Plastic Limit.
6. IS: 2720 (Part 29) (1975). Methods of test for soils: Determination of Dry Density of Soils in place by the core-cutter method.
7. IS: 2720 (Part 28) (1974). Methods of test for soils: Determination of Dry Density of Soils in-place by the sand-replacement method.
8. IS: 2720 (PART-17) (1986). Methods of test for soils: Determination of Permeability of soil.
9. IS: 2720 (PART-14) (1983). Methods of test for soils: Determination of relative density of soil.
10. IS:2720 (PART-7) (1980). Methods of test for soils: Determination of compaction property of soil.
11. IS: 2720 (PART-13) (1986). Methods of test for soils: Determination of shear parameters by direct shear test.
12. IS: 2720 (PART-13) (1991). Methods of test for soils: Determination of shear parameters by unconfined compression test.
13. IS: 2720 (PART-11) (1993). Methods of test for soils: Determination of shear parameters by triaxial shear test.

14. IS: 2720 (PART-30) (1980). Methods of test for soils: Determination of shear parameters by direct shear method.
15. IS: 2720 (PART-15) (1965). Methods of test for soils: Determination of consolidation property of soil.

HIGHWAY MATERIAL LABORATORY

Course Code: **CE49007**
Credit: **2**
L-T-P: **0-0-4**
Prerequisite: **Nil**

COURSE OBJECTIVE

This laboratory course is designed for students to perform experiments on materials used for designing of highway infrastructures. Students are taught to test the characteristics and behaviour of pavement materials based on their properties. The students also learn the required quality of pavement materials for various types of roads, traffic conditions and environmental conditions. They also learn standard procedure for the selection of materials for the design of pavement according to the IS codes.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the field applications of Transportation Engineering,
CO 2: Describe various parameters and standards for the selection of pavement materials,
CO 3: Know the usage of test equipment/machines to determine engineering properties of pavement materials,
CO 4: Write formal technical report & convey engineering message efficiently,
CO 5: Understand the codes and specifications required for the tests to be conducted, and
CO 6: Perform the experiments to test properties of aggregates, soil, and bitumen.

COURSE DETAILS

- Learning of IRC codes for design of various transportation facilities and Indo-HCM Manual for LOS estimation of various traffic facilities.
- Determination of grain size distribution of coarse and fine aggregate.
- Determination of specific gravity and water absorption of coarse aggregate.
- Determination of flakiness index and elongation index of coarse aggregate.
- Determination of aggregate impact value.
- Determination of aggregate crushing value.
- Determination of Los Angeles abrasion value of aggregates.
- Determination of penetration value of bitumen.
- Determination of softening point value of bitumen.
- Determination of ductility value of bitumen.
- Determination of CBR value of soil.

Reference Books

1. Transportation Engineering Laboratory Manual, School of Civil Engineering, KIIT Deemed to be University, 2022.
2. S.K. Khanna and CEG Justo, A. Veeraragavan, Highway Engineering, Nem Chand & Bros., Roorkee, India, 10th Edition, ISBN:9788185240930.

3. P. Chakraborty and A. Das, Principles of Transportation Engineering, PHI Publication, 2nd Edition, 2017, ISBN: 978-8120353459.
4. S.K. Khanna, C. E. G. Justo and A. Veeraragavan, Highway Materials and Pavement Testing, Nem Chand & Bros, 5th Edition, 2013, ISBN: 978-81-85240-58-9.

NETWORK ANALYSIS

Course Code : EE30034
Credit : 3
L-T-P : 3-0-0
Prerequisites : NIL

COURSE OBJECTIVE

To familiarize the basic theorems to analyzing electrical circuits, explain the concept of coupling in electric circuits and analyze the transient response of circuits with dc and ac input. Understand the concept of two port network and able to design filters.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Analyze different electrical circuits using network theorems,
CO2: Understand the magnetic couple circuits,
CO3: Apply the transients in DC/AC circuits,
CO4: Evaluate different parameters of two port networks,
CO5: Know the concept of network topology,and
CO6: Design different passive filters.

COURSE CONTENT

Network Theorems

Independent and dependent source**,** Source transformation, Maximum Power Transfer theorem (Both AC and DC Network), Reciprocity Theorem, Millman's Theorem and Tellegen's Theorem, Analysis of circuit with one nonlinear network.Thevenin's, Norton's and superposition theorem for AC circuits.

Magnetic coupled circuits

Self and Mutual Inductance, Dot convention for coupled circuits and coefficient of coupling, Single Tuned coupled circuit.Double Tuned coupled circuits.

Transient Response

Duality of circuits, Transient response for R-L, R-C and R-L-C circuits with both DC and AC excitation in time domain and Laplace transformation method.Analyze RLC transient behavior using MATLAB/P-Spice/Multisim.

Two-Port Networks

Network Configurations, Open Circuit, Short circuit, transmission and hybrid parameters, Condition of symmetry and reciprocity in two port network, Interconnection of two port networks (Series, Parallel &Cascade).Inter-relationship between parameters of two port network, Image parameters.

Network Topology

Concepts of Network graph, Tree, Co-Tree, Links and Twigs, Formation of incidence matrix [A] and loop matrix [B] Formation of Fundamental Cut-Set Matrix [QF], Tie-Set Matrix.Relation between branch voltage and current, loop current network topology analysis.

Filter Design

Passive filters, Design of low pass, high pass, band pass, and band elimination filter.Application of different electric filters, Concept of Active filter.

Textbooks

1. Network Analysisby M. E. Van Valkenburg, Pearson Education, 3rd Edition, 2006.
2. Networks and systems by D.Roy Choudhury, New Age Publication, 2nd Edition, June 2013.

Reference Books

1. Circuits and Networks Analysis and Synthesis (Second Edition) A Sudhakar ShyammohanS Palli, Tata McGraw-Hill, 2011.
2. Basic Circuit Analysis(Second Edition), John O'Malley, Schaum'sOutlines, Tata McGraw-Hill, 2010(Reprint).
3. Fundamentals of Electric Circuits, Charles K. Alexander, Matthew N.O. Sadiku, McGraw Hill Education; 5 edition (1 July 2013).

RENEWABLE ENERGY RESOURCES

Course Code : EE30016
Credit : 3
L-T-P : 3-0-0
Prerequisite :Nil

COURSE OBJECTIVE

To facilitate the students to achieve a clear conceptual understanding of technical aspects of Renewable Sources of Energy.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the need of renewable energy sources for future requirements,
CO 2: Demonstrate on various solar thermal system applications,
CO 3: Apply the concept of solar PV for maximizing the energy efficiency,
CO 4: Describe the process of extraction of power from wind energy and biomass energy,
CO 5: Analyze the scope of Geothermal and Ocean energy,and
CO 6: Reflect the concept of principle of operation of fuel cell and its applications.

COURSE CONTENT

Fundamentals of Energy
Energy Consumption and standard of living, Classification of Energy Resources, Importance of Non-Conventional Energy Sources, Common Forms of Energy, Advantages and Disadvantages of Conventional energy Sources, Environmental aspects of energy, Environment–economy-energy and sustainable development, Energy densities of fuels, Energy scenario in world and India.

Basics of Solar Energy, Solar Thermal and Photovoltaic Systems

Basics of Solar Energy: Extraterrestrial and Terrestrial Radiations, Depletion of Solar Radiation, Solar Time, Solar Radiations Measurement.

Solar Thermal Systems: Solar Collectors: Classification, Performance indices, Working of Flat plate collector and Evacuated Tube collector, various other types of Collectors, Solar Passive Space – Heating and Cooling Systems, Solar thermal energy applications in Water Heater, Cookers, Furnaces, Green House, Dryer and Distillation**.**

Solar Photovoltaic Systems: Solar Cell Fundamentals, P-N Junction, Generation of electron hole pair, Photoconduction, Solar Cell Characteristics, Effect of variation of isolation and temperature, Energy payback period, Solar Cell Classification, Solar Cell, Module, Panel and Array Construction, Cell mismatch and Effect of shadowing. Maximizing the Solar PV Output and Load Matching, Maximum Power Point Tracker (Perturb and Observance method and Incremental conductance method).

Wind and Biomass energy
Wind Energy: Origin of Winds, Nature of Winds, Wind Turbine Siting, Major Application of Wind Power, Power extraction from wind, Wind Turbine Types and Their Construction, Speed control strategies for wind turbine, Power versus wind speed Characteristics, Wind Energy Conversion Systems (WECS), Environmental aspects of wind energy, Wind energy programme in India.

Biomass Energy: Usable Forms of Biomass, their Composition and Fuel Properties, Biomass Resources, Energy Farming, Biomass Conversion Technologies, Urban Waste to Energy Conversion, Biomass Gasification, Biomass Liquefaction, Biomass to Ethanol Production.

Geothermal and Ocean energy, Fuel cells

Geothermal Energy: Applications, Origin, and Distribution of Geothermal Energy, Types of Geothermal Resources, Environmental aspects of Geothermal energy, Geothermal Energy in India

Ocean Energy: Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Environmental impact, Tidal Energy: Energy from tides, Tidal energy conversion scheme: single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy.

Wave energy: Power from wave, wave energy conversion devices, advantages and disadvantages of wave energy, Environmental impact

Fuel cells:Principle of working of various types of fuel cells and their working, performance and limitations, MHD (Magneto hydro dynamics) generation principles, advantages and disadvantages.

Textbooks

1. B. H. Khan, "Non – Conventional Energy Resources" Tata Mc Graw Hill, 2nd edition 2009.
2. N. K. Bansal, Manfred Kleemann, Michael Meliss, "Renewable energy sources and conversion technology", Tata Mc Graw Hill, 1990.

Reference Books

1. Kothari D.P., "Renewable energy resources and emerging technologies", Prentice Hall of India Pvt. Ltd, 2006.
2. Rai G.D, "Non-Conventional Energy Sources", Khanna Publishers, 4th Edition 2000.
3. Ashok V. Desai, "Nonconventional Energy", New Age International Publishers Ltd, Reprint 2003.

SOLAR POWER TECHNOLOGY

Course Code : EE30036
Credit : 3
L-T-P : 3-0-0
Prerequisites : NIL

COURSE OBJECTIVE

The objective of solar power technology is to harness the energy from the sun and convert it into usable electrical power. Solar power technology aims to provide a sustainable and renewable energy source that can replace traditional fossil fuel-based energy generation methods.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Understand the historical development of solar energy utilization and approaches to harnessing solar energy,
CO2: Know the semiconductor physics of solar cell,
CO3: familier with different converters for grid integration,
CO4: Apply the MPPT technique to extract maximum solar power,
CO5: Understand various solar thermal systems and its applications,and
CO6: Analyze the balance of system components for efficient and optimal performance of solar thermal installation.

COURSE CONTENT

Introduction

Basics of solar energy, Brief History of solar energy utilization, various approaches of utilizing solar energy, Blackbody radiation, Relation between radiation field energy density and radiation spectrum, Planck's formula in energy unit, Maximum spectral density, Planck's formula in wavelength unit, Wien displacement law, Stefan Boltzmann law, Photoelectric effect, Einstein's theory of photons, Einstein's derivation of the black-body formula.

Solar Cells

Formation of a p-n junction, Space charge and internal field, Quasi - Fermi levels, The Shockley diode equation - Structure of a solar cell, The solar cell equation, Fill factor and maximum power, Various electron, hole-pair recombination mechanisms, Crystalline silicon solar cells, Thin film solar cells, organic solar cells**.**

Solar Photovoltaic System

Solar PV modules from solar cells, Balance of solar PV system, Inverters (DC/DC, DC/AC), Power conditioning, Maximum power point operation Balance of System (BOS) for PV module installation, Concentrated solar power (CSP) systems.Standalone PV system design, Grid-connected PV system.

Solar thermal systems

Solar Collectors, Solar Water Heater, Solar Passive Space – Heating and Cooling Systems, Solar Refrigeration and Air Conditioning Systems, Solar Cookers, Solar Furnaces, Solar Green House, Solar Dryer, Solar Distillation. Solar Thermo-Mechanical Systems, Balance of System Components.

Textbooks

1. Solar Photovoltaics, fundamentals Technoloies and Applications, by Chetan Singh Solanki, PHI, 2nd edition 2012
2. Jui Sheng Hsieh, Solar Energy Engineering, Prentice-Hall, 2007.

Reference Books

1. Micheal Boxwell , Solar Electricity Handbook, Green Stream publishing (2010).
2. Rai G.D, Non-Conventional Energy Sources, Khanna Publishers, 4th Edition 2000.
3. Kothari D.P., Renewable energy resources and emerging technologies, Prentice Hall of India Pvt. Ltd,2006.

INTRODUCTION TO ELECTRICAL MACHINES

Course Code : EE30038
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OBJECTIVE

The objective of this course to enable the efficient and effective conversion of one form of energy into another form by using various DC and AC machine.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Know the principle of electromechanical Energy conversion system,
CO2: Understand the principle of operation and characteristics of DC generator,
CO3: Analuze the performace of DC motor through its characteristics,
CO4: Analyze the performace of transformer by equivalent circuit,
CO5: Know the oprtaion principle, torques and starting of 3 phase induction motor,and
CO6: Understand the construction, operating principle and application of Synchronous Machine.

COURSE CONTENT

Electromechanical Energy Conversion

Principle, Singly Excited Magnetic System and Doubly Excited Magnetic system, Physical concept of torque production, Electromagnetic torque and Reluctance torque.

DC Machines

DC Generator: EMF equation of dc generator, methods of excitation, armature reaction, interpoles and compensating winding, commutation, characteristics of separately excited and self excited dc generator, losses, condition for maximum efficiency. DC Motor: Working principle, voltage equation, condition for maximum power, characteristics, operating characteristics of dc motor, torque developed, speed control methods.

Transformers

Single Phase Transformer: Working principle, types, EMF equation, Transformer on no load and full load, vector diagram, exact and approximate equivalent circuit, O.C and S.C.test on transformer, Voltage regulation of transformer, losses and efficiency, condition for maximum efficiency, Auto transformer, 3 Phase transformers: connections (Y-Y, Y-Δ, Δ- Δ, Δ-Y).

3 Phase Induction Motor

Types, rotating magnetic field, principle of operation, slip, frequency of rotor current, rotor emf, rotor current, vector diagram and equivalent circuit, expression for torque, conditions for maximum torque, torque slip characteristics, starting torque in squirrel cage and slip ring motors, effect of change in supply voltage on torque, slip and speed , relation between full load torque and maximum torque, Power stages in induction motor, starting methods for 3 phase induction motor.

Synchronous Machine

Alternator: Basic principle, pitch factor, distribution factor, emf equation, alternator on load, voltage regulation: Synchronous impedance method. Synchronous motor: Basic principle.

Textbooks

1. Electrical Machines, Ashfaq Hussain, Dhanpat Rai, Delhi, 2nd Edition, 2008.
2. Electrical Machinery, P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.

Reference Books

1. Principles of Electrical power systems by J. B. Gupta
2. Text book of Electrical Machine by K R Sidhapura and D B Raval, Vikash, 1st edition, 2013.

ENERGY AND ENVIRONMENT

Course Code : EE30040
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OBJECTIVE

To understand the fundamentals of energy sources, energy use, energy efficiency, and resulting environmental implications of various energy supplies. To introduce various aspects of environmental pollution and its control. To understand the causes and remedies related to social issues like global warming, ozone layer depletion, climate change etc. To introduce various acts related to prevention and control of pollution of water and air, forest protection act, wild life protection act etc.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Understand energy scenario, energy sources, and their utilization,
CO2: Understand various methods of energy storage, energy management, and economic analysis,
CO3: Analyse the awareness about the environment and ecosystem,
CO4: Understand the environmental pollution along with social issues and acts ,and
CO5: Analyze the social issues on the environment and its protection.
CO6: Analyze the source of environment pollutions and its remedies

COURSE CONTENT

Basic Introduction to Energy

Energy and power, forms of energy, primary energy sources, energy flows, world energy production and consumption, Key energy trends in India: Demand, Electricity, Access to modern energy, Energy production and trade, Factors affecting India's energy development: Economy and demographics Policy and institutional framework, Energy prices and affordability, Social and environmental aspects, Investment.

Energy Storage Systems

Thermal energy storage methods, Energy saving, Thermal energy storage systems Energy Management: Principles of Energy Management, Energy demand estimation, Energy pricing Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries.

Environment

Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance, Need for public awareness. Ecosystem: Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession.

Environmental Pollution

Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards, Solid waste Management, Disaster management Role of an individual in prevention of pollution, Pollution case studies.

Social Issues and the Environment

Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation. Group assignments: Assignments related to e-waste management; Municipal solid waste management; Air pollution control systems; Water treatment systems; Wastewater treatment plants; Solar heating systems; Solar power plants; Thermal hermal power plants; Hydroelectric power plants; Biofuels; Environmental status assessments; Energy status assessments etc.

Textbooks

1. Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education University grant commission and Bharathi Vidyapeeth Institute of environment education and Research, Pune
2. Energy Management Audit & Conservation- for Module 2 Barun Kumar De Vrinda Publication

2nd Edition 2010

Reference Books

1. Energy Management Hand book Turner, W. C., Doty, S. and Truner, W. C Fairmont Press 7th Edition 2009
2. Energy Management Murphy, W. R Elsevier 2007
3. Energy Management Principles Smith, C. B Pergamum 2007
4. Environment pollution control Engineering C S Rao New Age International reprint 2015, 2nd edition
5. Environmental studies Benny Joseph Tata McGraw Hill 2nd edition.

ANALOG AND DIGITAL ELECTRONICS CIRCUIT

Course Code : EE20007
Credit :3
L-T-P :3-0-0
Prerequisite : Basic Electronics (EC10001)

COURSE OBJECTIVES

The course gives an introduction to analysis of elementary analog and digital circuits. This course is intended to develop an understanding power amplifiers, tuned amplifiers and behavior of noise in an amplifier and their applications. It also provides the basic knowledge of digital logic levels to understand digital electronics circuits including Boolean algebra, logic gates, combinational logic, sequential logic concepts and their applications.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Understand different applications of P-N Junction diode,
CO2: Develop biasing circuits for BJT,
CO3: Apply Field Effect Transistor as an amplifier,
CO4: Analyze different power Amplifier circuit and different application of OP-AMP circuit,
CO5: Identify and understand various digital circuits,and
CO6: Design basic combinational and sequential circuits.

COURSE CONTENT

Diode applications

Limiters, clippers, clampers, Zener diode applications: Voltage stabilizers.

Bipolar junction transistor

Analysis of transistor amplifier in CE configuration using BJT small signal model.

Field Effect Transistors

JFET structure and characteristics, MOS structure and characteristics, MOS as a switch CMOS as an inverter.

Power Amplifier and Feedback circuit

Types of amplifier and their equivalent circuit (VA, CA, Trans conductance and Trans resistance amplifier), Class A, B amplifier, Concept and types of feedback topology, Analysis of practical feedback amplifiers, Barkhausen criterion, RC and LC phase shift oscillator(qualitative description), output frequency of the oscillator.

Operational Amplifier

OP-AMP as differentiator and integrator circuit, OP-AMP as comparator, square wave generator using OP-AMP, Schmitt trigger, 555 timer.

Introduction to Digital Circuits

Logic Gates preview

Boolean Algebra:Logic operations**,** Axioms and Laws of Boolean Algebra, Duality, Reducing Boolean Expressions, Boolean Functions and their representation, Expansion of a Boolean Expression in SOP form and POS form.

Minimization of Switching Functions: Introduction, Two-variable K-Map, Three-variable K-Map, Four Variable K-Map, Don't care Combinations.

Combinational Logic Design

Introduction, Adders, Subtractors, Encoders, Decoders,Priority Encoder, Multiplexer, Demultiplexer.

Sequential Logic Design

Flip Flops: Latches and Flip Flops, Race Around Condition, Master Slave (Pulse-Triggered) Flip Flops, Flip Flop Excitation tables, Shift Registers and Counters

ADC and DAC

Introduction, Digital to Analog converter (Weighted Resistor type and R-2R ladder type), Analog to Digital converter (Flash type, Counter type and Successive approximation type).

Textbooks

1. Integrated Electronics- Analog and Digital Circuits and Systems, J. Millman&Halkias, C.D. Parikh, Mc-Graw Hill India, 2nd Edition, 2013 (10th Reprint).
2. Op-Amps and Linear Integrated Circuits - Ramakant A. Gayakward , Pearson, 4th Edition, May 2015.
3. Digital Logic and Computer Design – M. Morris Mano – PHI, 2011
4. Fundamentals of Digital Logic – Anand Kumar - PHI, 4th Edition, 2017

Reference Books

1. Digital Principles and Applications – Malvino & Leach –TMH, 7th edition, 2011
2. Digital Fundamentals – T. L. Floyd & Jain – Pearson Education, 10th edition, 2011
3. Microelectronics circuits- A. S. Sedra and K. C. Smith- 5th Edition, 2011 - Oxford University Press.
4. Linear Integrated Circuits - D. Roy Choudhury and Shail B. Jain- 5th Edition- New Age International Publishers, 2018.
5. Foundations Of Analog and Digital Electronic Circuits:-Anant Agarwal, Elsevier India (2013)

MEASUREMENT AND SENSOR TECHNOLOGY

Course Code : EE20005
Credit :3
L-T-P :3-0-0
Prerequisite : Basic Electronics (EC10001)

COURSE OBJECTIVES

To introduce the students the principle of measurement, theory of instruments andSensors, in depth knowledge in physical principles applied in sensing, measurement and acomprehensive understanding on how measurement systems are designed, calibrated, characterized, and analyzed.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Illustrate the basics of electrical measuring instruments and their purposes,
CO2: Determine the unknown parameter using different bridges,
CO3: Understand the recent advancements in electronic and biomedical instruments,
CO4: Perform the measurement of strain, pressure and motion using sensors,
CO5: Utilize heat and temperature sensors in different applications,and
CO6: Know about different industrial measurement systems.

COURSE CONTENT

Introduction to Electrical Measurement

Moving Iron type instrument, extension of range, Electrodynamometer type meter, Induction type wattmeter, VAR meter, Induction type energy meter, Electrodynamometer type power factor meter, Current transformers: Ratio and phase angle errors, phasor diagrams, uses.

DC and AC Bridge

General equation of bridge balance, Wheatstone bridge, Kelvin's double bridge. Maxwell's inductance, Anderson's bridge, Schering bridge, Errors.

Electronic and Biomedical Instruments

Electronic voltmeter: Block diagram, principle of operation, CRO: Block Diagram, Sweep Generator, use of CRO for measurement of frequency, phase, amplitude and rise time. Digital Frequency meter, Digital Multi-meter,Digital Energy Meter. Biomedical Instruments: ECG, Blood Pressure, Sonography.

Strain, Pressure and Motion Sensors

Resistance strain gauge, piezoelectric pressure gauge, characteristics. Capacitor plate sensor, inductive sensor, LDVT Accelerometer systems, rotation sensors, piezoelectric devices, Rotary encoders, Tachometers.

Heat and Temperature Sensors

Bimetallic strip, Bourdon temperature gauge, thermocouples, Resistance thermometers, thermostats, PTC thermistors, bolometer, Pyroelectric detector.

Industrial Sensors

Proximity detectors- inductive and capacitive, Ultrasonic photo beam detectors, Reed switch, magnet and Hall–effect units, Doppler detectors, liquid level detectors, flow sensors, smoke sensors.

Text books

1. A Course in Electrical and Electronics Measurement and Instrumentation by A. K. Sawhney, 10^{th}edition, Dhanpat Rai, 1994.
2. Ian R Sinclair, "Sensors and transducers", Third Edition, Newness Publishers, 2001.

Reference Books

1. Electronics Instruments and Measurements – David A. Bell – PHI, 2012.
2. Electronic Instrumentation and Measurement Techniques, By William David Cooper, PHI, 2010.
3. Jack P Holman, "Experimental Methods for Engineers", Seventh Edition, McGraw Hill, USA, 2001.
4. Robert G Seippel, "Transducers, Sensors and detectors", Reston Publishing Company, USA, 1983

FUEL TECHNOLOGY

Course Code : EE40031
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OBJECTIVE

To know the various types of fuel i.e. solid, liquid and gaseous fuels and their refining process along with applications

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Know the different types of fuel,
CO2: Illustrate the preparation, combustion techniques of solid fuel,
CO3: Demonstrate the refining process, products, handling and storage of liquid fuel,
CO4: Analyze the different types of gaseous fuel,
CO5: Describe the cleaning, purification of solid, liquid and gaseous fuel,and
CO6: Know the applications of all types of fuel.

COURSE CONTENT

Introduction

Types of fuels, solid, liquid and gaseous fuels, History of solid liquid and gaseous fuels, production, present scenario and consumption pattern of fuels, fundamental definitions, properties and various measurements, properties of solid liquid fuels and their measurement techniques.

Solid Fuels

Coal origin, its classification, composition, and properties. Coal mining,preparation, and washing. Combustion of coal and coke making, different types of coalcombustion techniques, coal tar distillation, coal liquefaction: direct and Indirectliquefaction, coal gasification, oxidation and hydrogenation. Efficient useofsolidfuels,Applications.

Liquid Fuels

Origin and classification of petroleum, refining, properties & testing ofpetroleum products, various petroleum products, petroleum refining in India, liquidfuels from other sources, storage and handling of liquid fuels, Applications.

Gaseous Fuels

Types of gaseous fuels: natural gases, methane from coal mines,manufactured gases, producer gas, water gas, biogas, refinery gas, LPG, hydrogen,acetylene, other fuel gases. Cleaning, purification and quality enhancement of gaseousfuels, Applications.

Text books

1. Irvin Glassman, “Combustion” 2nd ed., Academic Press.
2. John Griswold, “Fuels Combustion and Furnaces” Mc-Graw Hill Book Company Inc.
3. S.P. Sharma & Chander Mohan, “Fuels and Combustion”, Tata McGraw Hill Publishing Co. Ltd.

Reference Books

1. Gupta O.P, “Elements of Fuels, Furnacesand Refractories”, 3rd ed., Khanna Publishers.
2. Dr. Samir Sarkar, “Fuels and Combustion”, 2nd ed., Orient Longman

ENERGY AUDIT AND MANAGEMENT

Course Code : EE40033
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OBJECTIVE

To determine ways to reduce energy consumption per unit of product output or to lower operating costs and minimize waste and environmental effects without affecting production & quality .

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Understand about energy scenario nationwide and worldwide,
CO2: Identify various energy conservation techniques for demand side and supply side Management,
CO3: Analyze power, load profiles andvarious tariff system,
CO4: Analyze different types of furnace technology,
CO5: Design various heating system and conduct energy performance assessment,and
CO6: Perform detail energy audit analysis and prepare audit report.

COURSE CONTENT

General Energy scenario

Energy consumption – world energy reserves – prices – Types of energy sources, Definition, Energy audit-need, Types of energy audit, Energy management (audit) approach energy policies, Energy security, Demand side Management, Supply side management, Energy cconservation and its importance, Energy strategy for the future, Energy conservation Act-2001 and its features. Energy and environment: Air pollution, Industrial safety.

Electrical system

Electricity tariff, Load management, types of power: firm power, dump power, secondary power, load curve, load distribution curve, Power factor improvement, Electrical losses and efficiency, Light source, Choice of lighting. Industrial energy use – Energy index – Cost index, Representation of energy consumption: Pie charts – Sankey diagrams – Load Profile.

Energy Utilization and conversion system

Classification of furnace, controlled atmosphere in furnace, efficiency of energy in furnace, Heat – Heat content – Rate of heat transfer – Heat transfer coefficient – Conduction – Convention and radiation. Thermal insulation & its importance – space heating – HVAC system – Heating of Buildings – District heating – Factors & affecting the choice of district heating. Energy performance assessment of compressor, HVAC system and Lighting system

Energy Management and Audit

Data collection and data analysis methodologies, understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments, Payback period, CUSUM analysis, energy audit-reporting format.

Text books

1. Abbi, Y.P. and Jain, S., Handbook on Energy Audit and Environment Management, Teri Bookstore (2006).
2. W.R. Murphy and G. McKay, "Energy management", Butterworth & Co Publishers, Oxford, UK, 2001.

Reference Books

1. A Workbook for Energy Management in building by: Tarik Al-Shemmeri, Wiley-Blackwell.
2. Energy audit: Thermal power, combined cycle, and co-generation plants, by: Y.PAbbi, TERI, 2011.
3. Diwan, P., Energy Conservation, Pentagon Press (2008).
4. Younger, W., Handbook of Energy Audits, CRC Press (2008)

LINEAR CONTROL SYSTEM

Course Code : EE20004
Credit : 3
L-T-P : 3-0-0
Prerequisite : Electric Circuit Analysis (EE21001)

COURSE OBJECTIVE

To understand the control system model of physical systems, and to employ time domain and frequency domain analysis to determine the system stability, the steady state and transient response, also to realize the response of multi input and multi output system.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Illustrate different terminology of control system,
CO2: Develop the mathematical model of physical systems,
CO3: Analyze the time domain response of different systems,
CO4: Evaluate the stability of a system by classical methods,
CO5: Analyze frequency domain response of different linear dynamic system,and
CO6: Understand the state space modeling and different types of compensators.

COURSE CONTENT

Introduction

Basic concept of control system: open loop and closed loop control system, differential equations and transfer function, Effect of feedback on gain, stability, sensitivity and noise of the system, order and type of the system.

Modeling of physical system

Mathematical modeling of mechanical system and electrical system, Analogous system, Translational and rotational mechanical system, Transfer function by block diagram reduction technique, Developing block diagram from a mathematical model, Signal flow graph terminology, construction & procedure, Transfer function from signal flow graph using Mason's gain formula, Time delay control system.

Time domain analysis

Time response of first order system, Response to the unit step input, unit ramp input, Time response of second order system for unit step input, Time response specification, steady state error & design specification, Error constant of second order system, Minimization of Errors through P, PI and PID controllers.

Concept of stability

The concept of stability, necessary condition for stability, Routh- Hurwitz stability criterion, Relative-stabilityanalysis.

Root Locus Technique

Root locus concept, construction of root locus, construction rules, Determination of gain from root locus.

Frequency domain analysis

Introduction, Polar plots, Bode plots, Nyquist stability criterion, Stability analysis.

Compensators

Realization of basic compensators, Cascade compensation and Feedback compensation.

State Space

Concept of state, State variable, State model, State space model for LTI system, Computation of State transition matrix.

Text books

1. Control System Engineering by Noran S Nise, John Wiley Publication, 6th Edition, 2012.
2. Modern Control Engineering by K. Ogata PHI publication, 5th Edition, 2010.

Reference Books

1. Control Systems Engineering by R. Anandnatarajan and P. Ramesh Babu, SCITECH,4th edition, 2016.
2. Control Systems: Theory and applications by Smarajit Ghosh, Pearson. Publication 2012
3. Automatic control system by Hasan Saeed, 6th revised edition 2008, S.K. Kataria and Sons.
4. Modern Control Engineering. By D. Roy Choudhury PHI publication, 5th Edition,2009.
5. Automatic Control Systems by Benjamin C. Kuo, Prentice-Hall,7th Edition,2009.
6. Control System Engg, by I. J. Nagrath and M Gopal ,New age international publication, 4th Edition,2011.
7. Control System by D N Manik, Cengage Learning India Pvt, 2012.
8. Automatic control systems by Prof. B.S. Manke and S. N. Verma , Khanna publication, 2012

SENSORS AND ACTUATORS

Course Code :EE30012
Credit : 3
L-T-P : 3-0-0
Prerequisite : Measurement and Sensor Technology (EE20005)

COURSE OBJECTIVE

This course helps the students to have an exposure to sensors and its importance in the real world. Student will be able to understand basics of sensors, actuators and their operating principle and also have knowledge about simulation and characterization of different sensors.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Understand components of sensor and its selection criteria,
CO2: Select suitable sensors for measuring displacement and velocity,
CO3: Apply suitable sensor for force, weight and pressure measurement,
CO4: Choose suitable sensor for measurement of temperature, level and flow,
CO5: Know about different actuators and Electrical actuating systems,and

CO6: Use micro sensor and micro actuators in different applications.

COURSE CONTENT

Introduction

Definition of sensor and transducer, classification, characteristics. Selection criteria of transducers. Smartsensor: Blockdiagram, features.

Displacement and velocity Measurement

Linear and rotary displacement sensors: Potentiometer, capacitive, inductive. Positionmeasurement: OpticalEncoder, proximitysensors.

Velocity measurement: Tachometer types, Stroboscope, Encoder
Measurement of Force, Weight and Pressure

Force and weight measurement : Strain gauge, load cell. Pressure measurement: Manometer types, Strain gauge, diaphragm gauge, capsule, bellows, bourdon tube, piezoelectric sensor.

Temperature measurement

Temperature scales, Mechanical thermometers: Filled insystems, Metallic expansion, Electrical thermometers: RTD, Thermo-couple, Semiconductor temperature sensors.

Level and Flow measurement

Mechanicalmethods: floatanddisplacer. Electricalmethods: Resistance,inductive, capacitance type.Ultrasonic level gauging. Basic principles of flow measurement. Differential pressure devices: orifice, venturi, flow nozzle, pitot tube, annubar.

Actuators

Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria.

Electrical actuating systems

Solid-state switches, Solenoids, Electric Motors- Principle of operation and its application: D.C motors - AC motors - Single phase and 3 Phase Induction Motor; Synchronous Motor; Stepper motors - Piezoelectric Actuator.

Micro Sensors

Principles and examples, Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors. Simulation and characterization of various sensors using COMSOL Multiphysics.

Micro actuators

Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of microactuators: Electrostatic, magnetic, fluidic, inversepiezoeffect.

Textbook

1. Industrial instrumentation and control, S.K.Singh, 3rd Edition,TMH

Reference Books

1. Transducers and Instrumentation, Murthy.D.V.S,2001,PrenticeHallofIndia.
2. Sensors and transducers, Patranabis.D,2003,PHI.
3. Microsystem Technology and Microrobotics, Sergej Fatikowand Ulrich Rembold, 1st edition, Springer-Verlag Berlin Heidelberg.
4. Shape memory actuators, Manfred Kohl, first edition, Springer.

ENERGY STORAGE TECHNOLOGY

Course Code : EE40035
Credit : 3
L-T-P : 3-0-0
Prerequisite : Chemistry (CH10001)

COURSE OBJECTIVE

This course introduces the procedure for energy storage and provides a broad understanding and scientific principles of operations and the importance of the Fuel cell for recent needs.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Describe application of different energy storage systems,
CO2: Compare the performance of different types of energy storage devices,
CO3: Analyse the principle of different types of fuel cells,
CO4: Contrast between different types of battery technologies,
CO5: Estimate the state of charge of batteries using different techniques,and
CO6: Discuss waste heat recovery and green house heating.

COURSE CONTENT

Introduction

Energy availability, Demand and storage, Need for energy storage, Different types of energy storage; Mechanical, Chemical, Electrical, Electrochemical, Biological, Magnetic, Electromagnetic, Thermal, Comparison of energy storage technologies.

Mechanical, Thermal Energy Storage

Flywheel storage, Hydro storage, Capacitor, Principles and applications, Thermal energy storage, principles and applications, Phase change materials; Energy analysis of thermal energy storage, solar energy and thermal energy storage.

Electrochemical Energy Storage

Electrochemical energy storage: Battery fundamentals and technologies, characteristics and performance comparison of Lead-acid, Nickel-Metal hydride, Lithium Ion; Battery system model, emerging trends in batteries, Voltages and Capacities of Electro-chemical Cells, Equivalent Circuit of an Electrochemical Cell, Charging and discharging operation of batteries, State-of-charge (SOC) of batteries, battery management systems.

Fuel Cells

Hydrogen as energy carrier and storage; Hydrogen resources and production; Basic principles; Fuel cell types: AFC, PEMFC, MCFC, SOFC, Microbial Fuel cell; Fuel cell performance; Fuel cell applications for power and transportation.

Application of Energy Storage

Food preservation, Waste heat recovery, Solar energy storage: Greenhouse heating; Drying and heating for process industries.

Text books

1. Huggins R. A., Energy Storage: Fundamentals, Materials and Applications, second edition, Springer International Publishing, 2015.
2. Dincer I., and Rosen M. A., Thermal Energy Storage: Systems and Applications, second edition, Wiley, 2011.

Reference Books

1. Fuel Cell Fundamentals, O'Hayre R., Cha S., Colella W., and Prinz F. B., Wiley, Second Edition, 2009.
2. Chemical and Electrochemical Energy System, Narayan R. and Viswanathan B., Universities Press, (1998).
3. Battery Systems Engineering, Rahn C. D. and Wang C., First Edition, Wiley, 2013.
4. Electrochemical Energy Storage for Renewable Sources and Grid Balancing, Moseley P. T., and Garche J., Elsevier Science, 2014.
5. Compressed Air Energy Storage, Miller F. P., Vandome A. F., and John M. B., VDM Publishing, 2010.

MICROPROCESSOR AND EMBEDDED SYSTEM

Course Code : EE30004
Credit :3
L-T-P : 3-0-0
Prerequisite : Analog and Digital Electronics Circuit (EE20007)

COURSE OBJECTIVE

The objective of this course is to teach students the fundamentals of microprocessors and microcontrollers. Additionally, the course discusses the fundamentals of advanced microcontrollers and different processor-related industrial applications.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Distinguish between 8 bit and 16 bit Microprocessors,
CO2: Practice in assembly language programs in 8085 and 8086 microprocessors,
CO3: Describe the architecture of 8051 microcontroller,
CO4: Analyze the different programs of 8051 microcontroller,
CO5: Acquire the knowledge of the AVR microcontrollers,and
CO6: Demonstrate different applications of microprocessors and microcontrollers.

COURSE CONTENT

8085 and 8086 Microprocessors

History of microprocessor, Architecture of 8085, Fetchand execute operation,Addressing mode of 8085, Data Transfer Instruction, Arithmetic, Logical, remote, branch and machine control instructions, Development of 8085 assembly language programs, Interrupts of 8085, Memory and I/O interfacing, Architecture of 8086, Minimum and maximum mode configurations of 8086, Addressing modes of 8086, Instructions set of 8086, Assembly language programming of 8086.

8051 Microcontroller

Introduction, Architecture of 8051, Instruction-sets of 8051, Assembly language programming of 8051.

AVR Microcontroller

Introduction, Overview of AVR family, Architecture of AVR, Addressing modes of AVR, Assembly language programs of AVR.

Industrial Application of Microprocessors

ADC, DAC interfacing, Automation and control application, Digital PID controller, PWM control of a DC motor, Stepper motor control.

Textbooks

1. B. Ram, “Fundamentals of Microprocessors and Microcontrollers ", 7th Edition, Dhanpat Rai publications, 2010.
2. Douglas V Hall Microprocessor and Interfacing, TMH publication.

Reference Books

1. Muhammad Ali Mazidi, Sepehr Naimi,"Sarmad Naimithe AVR Microcontroller And Embedded Systems Using Assembly and C" PHI,1st Edition, Inc, 2017.
2. R. Theagarajan "Microprocessors and Microcontrollers"-1st Edition, SCITECH publications (India) Private limited, 2004.
3. Desmukh , "Microcontrollers –Theory and Application"- 1st Edition, TMH Publication, 2005.
4. A. P. Mathur, "Introduction to microprocessors" e-TMH Publication – 3rd edition, 2011
5. Md. Rafiquzzaman, "Microprocessors & Microcomputer based System Design",2nd edition,1995.

DIGITAL SYSTEM DESIGN USING FPGA

Course Code : EE40020
Credit : 3
L-T-P : 3-0-0
Prerequisites : Analog and Digital Electronics Circuits (EE20007)

COURSE OBJECTIVE

This course deals with basic digital system design, introduces essential FPGA concepts and programming. The course covers the technological background of FPGA both theoretically as well as practical implementation of digital solutions.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Learn advanced design methodologies for high-performance FPGA applications,
CO2: Analyze the implementation of a complete sophisticated digital system using FPGA,
CO3: Apply translating software models of digital signal processing applications,
CO4: Comprehend sophisticated optimization techniques for streaming applications,
CO5: Understand design procedure and compare performance of FPGA based system,and
CO6: Synthesize VHDL based digital system.

COURSE CONTENT

SystemLevel Design

System- level architecture design for FPGAs. TMS322F series architecture.

VHDL

Review of VHDL programming basics, Synthesizable VHDL, synchronous and asynchronous processes, finite state machines, and memory.

Programming Spartan-3E using VHDL

Practical test bench design, performance testing. Counter design using Spartan 3E.

Design Optimization using FPGA interface in NI-CRIO-9082

Design optimizations and performance comparison, FIFOs and streaming architectures, Analog signal processing using NI-CRIO FPGA interface.

Synthesis of Design Using VHDL

Design, optimize, simulate, and analyze the performance for a digital application, FPGA synthesis and iterative performance optimizations. (Xilinx software), Circuit synthesis for delay circuit design.

Textbooks

1. The Designer's Guide to VHDL, Peter J. Ashenden; HDL Chip Design, Douglas J. Smith;
2. Advanced FPGA Design Architecture, Implementation, and Optimization, Steve Kilts

Reference Book

1. Digital System Design with FPGA, Implementation using Verilog and VHDL, Cem Unsalan, Bora Tar.1st Edition TMH publication.

SPECIAL MACHINES AND CONTROL

Course Code :EE30022
Credit : 3
L-T-P :3-0-0
Prerequisite :Electrical Machine I (EE20003) and Electrical Machine II (EE20002)

COURSE OBJECTIVE

To understand the working of special machines like stepper motor, switched reluctance motor, BLDC motor & PMSM and Linear induction motor with proper design of controller for smart inverter used to control the above special machine.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Understand the operation of different special machines,
CO2: Select different special machines as part of control system components,
CO3: Analysis of Linear induction motor and its control,
CO4: Design digital controllers for different machines,
CO5: Apply the knowledge of axial and radial flux motor into a way of thinking to solve in real time applications,and
CO6: Design smart Inverters and its sizing for grid and off grid connection.

COURSE CONTENT

Stepper Motors

Introduction, Hybrid stepping motor, construction, principles of operation, energization with two phase at a time, essential conditions for the satisfactory operation of a 2-phase hybrid steper motor ,very slow speed synchronous motor for servo control-different configurations for switching the phase windings-control circuits for stepping motors,an open-loop controller for a 2-phase stepping motor.

Linear Induction Motor

Development of a double-sided LIM from rotary type IM- A schematic of LIM drive for

electric traction development of one-sided LIM with back iron-field analysis of a DSLIM fundamental assumptions.

Synchronous Motors

Construction- Principle of operation of Permanent Magnet Synchronous Motors – EMF and

torque equations – Starting – Rotor configurations –Dynamic model, Synchronous Reluctance Motors: Constructional features–axial and radial flux motors – operating principle – characteristics.

Control of PMSM, BLDC and Switched Reluctance Motor

Bipolar optical sensor based control of Trapezoidal BLDC Motor, Sensorless control of BLDC motor, Torque ripple control of BLDC motor,Unipolar control for SRM, Torque ripple control of SRM.

Smart Inverters

Selection of power conditioning unit (PCU), Sizing of solar inverter for roof top and grid connected projects, Passive and active protection, IEC/IEEE /Grid Compliance of inverters, Grid-Connected Inverters vs. Stand-Alone Inverters.

Textbooks

1. Miller, T. J. E., Brushless Permanent Magnet and Reluctance Motor Drives, Oxford Science Publications, 1989.
2. Kenjo, T., and Sugawara, A., Stepping Motors and their Microprocessor Controls, Oxford Science Publications, 1984.

Reference Books

1. Krishnan, R., Electric Motor Drives: Modeling, Analysis, and Control. Prentice Hall, (2001).
2. Krishnan, R., "Permanent Magnet and BLDC Motor Drives", CRC Press, 2009.
3. Chang-liang, X., "Permanent Magnet Brushless DC Motor Drives and Controls", Jun 2012.

HYBRID ELECTRIC VEHICLES

Course Code : EE40044
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OBJECTIVE

The objective of this course is to provide students with a comprehensive understanding of hybrid electric vehicle technology, systems, and design principles. The course aims to equip students with the necessary knowledge and skills to design, develop, and analyze hybrid electric vehicle systems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Understand the modeling of Electric Vehicles and Hybrid Electric Vehicles,
CO2: Know the mechanism of propulsion drive system,
CO3: Control the output voltage and current of Traction Inverter,
CO4: Analyze the control of the speed and torque of various traction motors,
CO5: Explain the different energy storage systems,and
CO6: Know the design of Hybrid Electric Vehicle.

COURSE CONTENT

Introduction

History of hybrid and Electric vehicles, social and environmental importance of hybrid and electric vehicles.

Electric Drive-trains:

Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Hybrid Electric Drive-trains:

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Propulsion unit

Introduction to electric components used in hybrid and electric vehicles, configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, and Switch Reluctance Motor drives, drive system efficiency.

Storage and its analysis

Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

Energy Management Strategies

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, Comparison of different energy management strategies. concept of tariff management in charging stations.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Textbooks

1. Electric and Hybrid Vehicles: Design Fundamentals, by Iqbal Husain, CBC Press, Second Edition, 2010.
2. Vehicular Electric Power Systems by Ali Emadi, Willis Press, 2003

Reference Books

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. Electric Vehicle Technology by James and John, John Wiley & Sons, Ltd First Edition, 2004.

ROBOTICS AND CONTROL

Course Code : EE400042
Credit :3
L-T-P : 3-0-0
Prerequisite :Network Analysis (EE30034), Linear Control System (EE20004)

COURSE OBJECTIVE

This course helps the student to basic idea of Robots. Students are introduced to the basic design consideration of robots. Concepts like trajectory planning, obstacle avoidance, kinematics and dynamics of robotic manipulators are introduced. Industrial applications of robotic manipulators are also included as part of the course to get an overall idea on robotics

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Gain knowledge about configuration of robot,
CO2: Analyze the kinematics and dynamics of robot,
CO3: Understand the trajectory planning of robot,
CO4: Design controller for robot,
CO5: Apply robot to solve industrial issues,and
CO6: Know about various sensors in robotics.

COURSE CONTENT

Introduction to Robotics

Basic Structure of Robots, Robot Anatomy, Classification of Robots, Fundamentals about Robot Technology, Factors related to use Robot Performance, Basic Robot Configurations and their Relative Merits and Demerits, the Wrist & Gripper Sub-assemblies.Kinematics of Robot Manipulator: Direct Kinematics problem, Geometry Based Direct kinematics problem, Co-ordinate and vector transformation using matrices, Rotation matrix, Inverse Transformations, Problems, Composite Rotation matrix, Homogenous Transformations, Robotic Manipulator Joint Co-Ordinate System, Euler Angle & Euler

Transformations, Roll-Pitch-Yaw (RPY) Transformation, D-H Representation & Displacement Matrices for Standard Configurations, Jacobian Transformation in Robotic Manipulation.

Trajectory Planning

Joint space trajectory planning- cubic polynomial, linear trajectory with parabolic blends, trajectory planning with via points; Cartesian space planning, Point to point vs continuous path planning. Obstacle avoidance methods based on classical techniques (e.g. Artificial Potential field, A* algorithms). Dynamics of Robotic Manipulators: Lagrange's formulation – Kinetic Energy expression, velocity Jacobian and Potential Energy expression, Generalized force, Euler-Lagrange equation, Dynamic model of planar and spatial serial robots up to 2 DOF. Control design for Robotic System: Control Loops of Robotic Systems, trajectory, velocity and force control, Computed Torque control, Linear and Nonlinear controller design of robot. Design of controller for robot in Matlab programming.

Industrial Applications of Robotics

Material handling, welding, Spray painting, Machining. Case studyfor a typical industrial application including robot selection considerations such as number of axes, work volume, capacity & speed, stroke &reach, Repeatability, Precision and Accuracy, Operating environment. Applications of robotics in active perception, medical robotics, autonomous vehicles, and other areas. Sensors for Robotics: Wheel/motor sensors, Heading sensors, Accelerometers, Inertial measurement unit (IMU), Ground beacons, Active ranging, Motion/speed sensors, Vision sensors. art systems.

Text books

1. Robert. J. Schilling , "Fundamentals of robotics – Analysis and control", Prentice Hall of India,1990, (Latest reprint).
2. Introduction to Robotics- John J. Craig, Addison Wesley Publishing, 3rd edition, 2010.

Reference Books

1. R K Mittal & I. J. Nagrath, Robotics and Control, McGraw Hill Publication, 201.
2. Groover, M.P. Weiss, M. Nagel, R.N. & Odrey, N.G., Ashish Dutta, Industrial Robotics, Technology, Programming & Applications, Tata McGraw Hill Education Pvt. Ltd. New Delhi.
3. Introduction to Robotics by S K Saha, Mc Graw Hill Education

CYBER SECURITY

Course Code :EE40047
Credit : 3
L-T-P : 3-0-0
Prerequisite :Nil

COURSE OBJECTIVE

The objective of the "Cyber Security" course is to provide students with a comprehensive understanding of the principles, techniques, and best practices in the field of cybersecurity.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Understand the need of cyber security for an organization,
CO2: Know the different hacking, hijacking and security to reduce the risk of cyber exploitation,
CO3: Measure the performance and troubleshoot cyber security systems,
CO4: Analyze the management of electronic records and relevancy for cyber security,
CO5: Comprehend the tools and methods in Cybercrime,and
CO6: Design Cloud and IoT based security measures for cyber crime.

COURSE CONTENT

Introduction

Introduction of Cyber Crime, Challenges of cyber crime, Classifications of Cybercrimes: E-Mail, Spoofing, Spamming, Internet Time Theft, Salami attack/Salami Technique.

Web Jacking

Online Frauds, Software Piracy, Computer Network Intrusions, Password Sniffing, Identity Theft, cyber terrorism, Virtual Crime, Perception of cyber criminals: hackers, insurgents, and extremist group etc. Web servers were hacking, session hijacking.

Cyber Crime and Criminal Justice

Concept of Cyber Crime and the IT Act, 2000, Hacking, Teenage Web Vandals, Cyber Fraud and Cheating, Defamation, Harassment and E-mail Abuse, Other IT Act Offences, Monetary Penalties, jurisdiction and Cyber Crimes, Nature of Criminality, Strategies to tackle Cyber Crime and Trends.

Indian Evidence Act

The Indian Evidence Act of 1872 v. Information Technology Act, 2000: Status of Electronic Records as Evidence, Proof and Management of Electronic Records; Relevancy, Admissibility and Probative Value of E-Evidence, Proving Digital Signatures, Proof of Electronic Agreements, Proving Electronic Messages.

Tools and Methods in Cybercrime

Proxy Servers and Anonymizers, Password Cracking, Key loggers and Spyware, virus and worms, Trojan Horses, Backdoors, DoS and DDoS Attacks , Buffer and Overflow, Attack on Wireless Networks, Phishing : Method of Phishing, Phishing Techniques.

Cloud and IoT are the latest emerging technologies and every other organization wants to implement it. Therefore, it is understandable to learn security measures under this category.

Text books

1. Principles of Cyber crime, Jonathan Clough Cambridge University Press
2. John R.Vacca, Computer Forensics:Computer Crime Scene Investigation, 2nd Edition, Charles River Media, 2005

Reference Books

1. Cyber Law Simplified, VivekSood, Pub: TMH.
2. Cyber Security by Nina Godbole, SunitBelapure Pub: Wiley-India
3. Information Warfare: Corporate attack and defense in digital world, William Hutchinson, Mathew Warren, Elsevier.
4. Cyber Laws and IT Protection, Harish Chander, Pub:PHI.
5. Cryptography and Network Security: Principles and Practice, Global Edition, 7/E, William Stallings, Pearson.

WIRELESS NETWORK SYSTEMS

Course Code :EE40048
Credit : 3
L-T-P : 3-0-0
Prerequisite :Nil

COURSE OBJECTIVE

The objective of the "Wireless Network Systems" course is to provide students with a comprehensive understanding of the principles, protocols, and technologies used in wireless network systems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Know the fundamentals of wireless communications and advanced cellular system,
CO2: Comprehend the domains of application of Radio Propagation,
CO3: Understand the concepts of Cellular Communication,
CO4: Analyze the CDMA and FDMA communication systems,
CO5: Evaluate the utility of WANs,and
CO6: Create new wireless systems for the mankind.

COURSE CONTENT

Introduction
Overview of wireless communications and systems Review of digital communications, Cellular systems from 1G to 3G Wireless 4G systems.

Radio propagation and propagation path-loss model
Free-space attenuation, Multipath channel characteristics, Signal fading statistics, Path-loss models

Fundamentals of cellular communications
Hexagonal cell geometry, Co-channel interference, Cellular system design, Sectoring using directional antennas

Multiple access techniques
Frequency division multiple access (FDMA), Time division multiple access (TDMA), Code division multiple access (CDMA), Space division multiple access (SDMA), Orthogonal frequency division multiplexing (OFDM), Multicarrier CDMA (MC-CDMA), Random access methods

Wireless Network
Wide-area wireless networks (WANs) GSM – IS-136, IS-95, UMTS, Cdma2000

Long Term Evolution Technologies (LTE)

OFDM, MIMO channels, Space Time Codes, LTE Advanced, Other Wireless systems IEEE 802.11 WLAN (WiFi), WiMAX

Textbooks

1. Wireless Communications: Principles and Practice, 2nd Edition. Theodore S. Rappaport, Pearson publications
2. Mobile Wireless Communications. Mischa Schwartz. Paperback (2013) ISBN:9781107412712. Cambridge University Press.

Reference Books

1. The evolution to 4G cellular systems: LTE-Advanced. Ian F. Akyildiz, David M. GutierrezEstevez, Elias Chavarria Reyes. Broadband Wireless Networking Laboratory, School of Electricaland Computer Engineering, Georgia Institute of Technology.
2. Vijay K. Garg, Wireless Communications and Networking, Morgan Kaufmann Publishers, 2007, ISBN 978-0-12-373580-5

POWER TRANSMISSION AND DISTRIBUTION

Course Code : EE30007
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OBJECTIVE

To give the students requisite basic knowledge about the key parameters of transmission and distribution of modern power supply system, analyze the performance of transmission lines, cables, distribution systems and mechanically design the components of a power system.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Understand the concept of complex power and per unit value of a power system,
CO2: Evaluate the line constants in different configuration of overhead lines,
CO3: Analyze the performance of transmission lines,
CO4: Design the mechanical parameter of overhead transmission system,
CO5: Analyze the corona loss and the performance of underground cables,and
CO6: Determine the current and voltage distribution in different distribution modules.

COURSE CONTENT

Introduction
Single and 3-phase transmission, Concept of complex power, Per Unit system, Power System layout. Supply System: Comparison of AC and DC transmission, Advantage of high voltage transmission, Advantages and Disadvantages of EHV (AC) and HVDC Transmission.

Line constants
Resistance, Inductance of Single phase and three phase line with symmetrical and unsymmetrical spacing, GMD and GMR calculation, Transposition of power line, Capacitance of Single-phase line, Effect of earth on line capacitance, Charging current due to capacitance effect, Bundle conductors, Skin and Proximity effect.

Performance of Transmission line
Analysis of short, medium and long Transmission Line, ABCD constants and its calculation for Short, Medium and Long Transmission Line, Ferranti effect, Surge Impedance and Surge Impedance Loading, Line compensators.

Mechanical Design of overhead transmission lines
Types of conductors and insulator, Insulating materials, Potential distribution over a string of suspension Insulators, String Efficiency, Methods of equalization of the potentials, Sag and Stress calculation, Effect of ice and wind loading, Vibration dampers.

Corona
Critical disruptive voltage, Visual critical voltage, Corona Power losses, Factors affecting corona, Advantages and Disadvantages of Corona, Problem Discussion, Radio Interference between power and communication line.

Underground Cable

Overhead line verses underground cables, Type and construction, Grading of cables, Insulation resistance of cable, Capacitance of three core cable, dielectric losses.

Distribution Systems
Classification of distribution system, Types of AC and DC distributors, Feeder, Voltage drop and load calculation for concentrated and distributed loads, Radial and ring main system, Economic choice of conductor, Kelvin's law.

Textbooks

1. Electrical Power System, C.L. Wadhwa, New Age International (P) Limited, Publishers, 2009.
2. A Text Book on Power System Engineering, A. Chakrabarti, M.L. Soni, P.V. Gupta and U.S. Bhatnagar, Dhanpat Rai and Co., Reprint 2012.

Reference Books

1. A Course in Power System, J. B. Gupta, S K Kataria and Sons Publishers and Distributors, 2011.
2. Power System Analysis and Design- By B. R. Gupta, S. Chand Publications, 3rd Edition, Reprint, 2003.
3. Principle of Power System by V.K.Mehta, S.Chand Publishers, 2012.
4. Elements of Power System Analysis, W.D. Stevenson Jr, TMH, 1982.

POWER ELECTRONICS

Course Code : EE30001
Credit : 3
L-T-P : 3-0-0
Prerequisite : Analog and Digital Electronics Circuits (EE20007)

COURSE OBJECTIVE

It aims to familiarize readers with switching devices, power converters, and their uses in different power control systems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Relate basic semiconductor physics to properties of power devices to identify for converter Application,
CO2: Analyze performance of single phase and three phase controlled rectifiers,
CO3: Assess efficacy of various topologies of DC to DC converters,
CO4: Evaluate the control schemes for single phase and three phase Inverters,
CO5: Determine the quantitative outcomes of AC to AC voltage regulator,and
CO6: Elaborate the merits and demerits of mid point type cyclo-converter.

COURSE CONTENT

Introduction to Power Electronics

Comparison of power devices operating in the switch mode to those operating in the active region.

Power Electronic Devices

Thyristor characteristics, Turn ON methods, Dynamic Characteristics of thyristors, Ratings, Protection, Snubber circuit, Two Transistor Model of thyristor, Characteristics and construction of Power MOSFETS, Characteristics and construction of IGBT, SiC based power devices and applications.

AC to DC Converters

Single Phase Converters – Half Wave with R, RL, RLE load and effect of free Wheeling diode, Single Phase half and full controlled full Wave converters with R and RLE Load, performance parameters of single phase AC to DC converters, Effect of source Inductance, 3 Phase half and fully controlled rectifiers, Power factor correction circuit.

DC to DC Converters

Step up and Step Down choppers, 4 quadrant choppers for control of DC motor. basic concepts of bi-directional converter,Forward and Flyback converters.

Inverters

Single Phase Half Bridge and Full Bridge Inverters, 3 Phase Inverters, 180° and 120^0 conduction, Voltage Control of inverters, Concept of multi level inverters, modulation techniques.

AC to AC Converters

Single phase AC Voltage regulator with R and RL load, Single phase mid-point type cyclo-converter with R-L Load.

Text books

1. Power Electronics by M. H. Rashid, Pearson Education, 3rd Edition, 2009.
2. Power Electronics, by P S Bhimbra, Khanna Publishers, 5th Edition, 2011.
3. Fundamentals of Electric Drives, G.K. Dubey, Second Edition, Narosa Publishers, 2007.

Reference Books

1. Power Electronics, Converters, Applications and Design N. Mohan, Undeland and Robbins, John Wiley and Sons , 3rd Edition ,2009.
2. Modern Power Electronics by P. C Sen, S Chand Publisher- 2013.
3. Power Electronics K.R.Varmah and Chikku Abraham, Cengage Publications- 2014.
4. Power Electronics by M. D. Singh and K.B. Khanchandani, Tata McGraw - Hill publishers, 2nd edition, 2008.
5. Bimal K. Bose, Power Electronics and Motor Drives: Advances and Trends, Academic Press, Har/Cdr edition (13 September 2006).

ELECTRIC DRIVES AND CONTROL

Course Code : EE30024
Credit : 3
L-T-P :3-0-0
Prerequisite :Power Electronics (EE30001)

COURSE OBJECTIVE

It aims to familiarize readers with steady-state performance, starting, dynamic and regenerative braking, plugging and reverse direction operation, speed control, sudden and temporary overloads, ambient conditions and mechanical coupling of machines.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1. Select the motors for different types of loads in industry,
CO2. Understand the various braking methods of electrical drives,
CO3. Know the applications of different electric motors,
CO4. Analyze the open loop and closed loop control techniques of different drives,
CO5. Understand different speed control techniques for various industrial drives,and
CO6. Analyze the performance of Permanent Magnet Synchronous and Brushless DC motor drives.

COURSE CONTENT

Introduction

Basic elements of an electric drive, Four quadrant operation of an electric drive, Dynamics of motor load combination, Types of loads, Stable operating condition of various motor load combinations, Fundamental load torque equation, Speed and current limit control, Load curve, load equalization, motor selection and rating calculations.

DC Motor Drives

Review of characteristics of DC motors, Modification of characteristics of DC shunt and series motors, Concept of Electric Braking, Regenerative, Dynamic and Counter current braking of DC motors.

Control of DC motor drives

Open loop speed control, Closed loop Speed control, Closed loop speed and current control, Closed loop Torque control, Hysteresis controller, PI controller.

Solid State Control of DC drive

Chopper and rectifier based DC Separately excited motor and series motor drive control, four quadrant drive using dual converter.

Induction Motor Drives

Review of characteristics of three phase Induction motors, Modification of speed torque characteristics due to variation of stator voltage, Stator frequency and rotor resistance, Electric Braking of Induction Motors: Regenerative Braking, DC Dynamic braking and Plugging, Slip Power recovery.

Speed Control of Induction Motors

Control of IM by three phase AC-AC Voltage controller, PWM Voltage Source Inverter fed induction motor drives, Current source inverter fed induction motor drives, Comparison of VSI and CSI fed drives, slip compensation schemes, closed loop control (V/f control).

Synchronous and Brushless DC Motor Drives

Synchronous motors, cylindrical rotor, salient pole synchronous motor, permanent magnet synchronous motor, synchronous reluctance motor, Transients due to load disturbances, Braking, Permanent magnet AC motor drives, Sinusoidal PMAC motor drives, Brushless DC motor Drives.

Text books

1. G.K. Dubey, Fundamentals of Electric Drives, Second Edition, Narosa Publishers, 2007.
2. S. K. Pillai: A First Course On Electrical Drives, New Age International Publishers, 2nd Edition, 2007.

Reference Books

1. Bimal K. Bose, Power Electronics and Motor Drives: Advances and Trends, Academic Press, Har/Cdr edition (13 September 2006).
2. N. K. De, P. K. Sen: Electric Drives, PHI Learning Pvt. Ltd., 7th Edition, 2004.
3. Modern Power Electronics and AC Drives by Bimal. K. Bose, PHI Publisher, 1st Edition, 2013.
4. S.A. Nasar, Boldea , Electrical Drives, CRC Press, Second Edition, 2006
5. M. A. El-Sharkawi , Fundamentals of Electrical Drives , Thomson Learning, 1st Edition, 2000.
6. R. Krishnan, Electrical Motor Drives, PHI, 2003

POWER SYSTEM PROTECTION

Course Code : EE40041
Credit : 3
L-T-P : 3-0-0
Prerequisite : Network Analysis (EE30034)

COURSE OBJECTIVE

The objective of this course is to provide students with a comprehensive understanding of power system protection principles, techniques, and practices. The course aims to equip students with the necessary knowledge and skills to design, implement, and maintain protection systems for electrical power systems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Describe the need of protective devices in power system,
CO2: Distinguish in different types of Circuit Breakers,
CO3: Demonstrate the principle of operation of different relays,
CO4: Realize the different scheme of protection for alternator, transformer,
CO5: Apply different types of protection schemes for bus bar, feeder and transmission line,and
CO6: Know the different protection scheme against surges.

COURSE CONTENT

Introduction

Protection system and its attributes, Philosophy of protection, requirement of ideal protective scheme, different terms in protective systems, Basic elements in protective scheme, Requirement of circuit breakers, characteristics of an electric arc, principle of AC and DC arc interruption, Recovery voltage, re-striking voltage, current chopping, resistance switching.

Circuit Breakers: Types of AC and DC circuit breakers, Arc extinction methods, oil circuit breaker, air blast circuit breaker, vacuum and SF_6 circuit breaker, Principle of miniature circuit breaker and molded case circuit breaker, determination of circuit breaker capacity, circuit breaker ratings. Protective Elements: Concept of Fuse, need, construction, principle, characteristics of H.R.C fuse. Earthing: Introduction, Methods of neutral grounding (solid earthing, resistance earthing and Peterson coil earthing and its effects on fault conditions), Construction, Principle of operations of Electromagnetic type, induction type: over current, directional, distance relays, Differential relay. Activity-Bulk and minimum oil circuit breaker, control switch operation of circuit breaker, MCB, MCCB, RCCB, Relay characteristics.

Alternator Protection

Different types of faults, differential protection with biasing, restricted earth fault protection, negative sequence protection, automatic field suppression and neutral circuit breakers. Transformer Protection: Buchholz relay, Biased differential protection, restricted earth fault protection, harmonic restraint, protection of combined alternator and transformer. Bus Bar Protection: Differential scheme for both phase and line faults, introduction to digital protective relay and microprocessor-based relays.

Feeder Protection

Time graded protection: radial, parallel and ring feeders; over current and earth fault protection, calculation of graded time setting, split core protection of feeders, carrier current protection. Pilot Wire Protection: Circulating current differential protection (Merz-Price protection), Biased or percentage differential protection scheme, opposed (balanced) voltage

differential protection system, Translay scheme; static relays. Protection against Surges: Ground wire, Surge diverters: rod gap, horn gap lighting arresters, surge absorbers.

Text books

1. Fundamentals of Power System Protection", Y. G. Paithankar, S. R. Bhide, 2nd edition, Prentice Hall of India Private Limited, New Delhi, 2011.
2. Power System Protection and Switchgear by B Rabindranath and M Chander , Wiley Eastern 2017, 2nd Edition.

Reference Books

1. A Course in Power Systems, J. B. Gupta, S. K. Kataria and Sons Publishers and Distributors, 2009.
2. Principles of Relaying", Van Warrington, Y. G. Paithankar. TMH, 2009.
3. Power system Switchgear and Protection N.Veerappan and S R Krishnamurthy, S Chand Publication, Revised edition 2013.
4. Power system Protection and Switchgear, Badri Ram and D N Vishwakarma Tata McGraw Hill, 2nd reprint 2012
5. Electrical Power System, C.L. Wadhwa, New Age International (P) Limited, Publishers, 2009.

IOT IN ELECTRIC VEHICLES

Course Code : EE40046
Credit : 3
L-T-P : 3-0-0
Prerequisite :Nil

COURSE OBJECTIVE

Understand the fundamentals of electric vehicles (EVs) and their integration with the Internet of Things (IoT). Explore the key components of an IoT-enabled electric vehicle system, including sensors, actuators, connectivity, and data management. Examine the benefits and challenges of implementing IoT in electric vehicles, such as improved energy efficiency, enhanced safety, and effective fleet management.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Categorize the components of IoT.
CO2: Analyze various protocols of internet.
CO3: Compare various IoT networking techniques.
CO4: Distinguish the Security and Privacy of IoT.
CO5: Categorize various techniques of inter connected vehicles.
CO6: Analyze IoT application in electric vehicle.

COURSE CONTENT

Introduction

Definition, Components in the internet of things, Sensing and Actuation Anywhere, Anytime, Genesis of the Internet of Things, Power Sources, Internet Principles, sensor types and properties, different transducers and actuators, Internet Communications: An Overview (IP, TCP, The IP Protocol Suite (TCP/IP), UDP), IP Addresses (DNS, Static IP Address Assignment, Dynamic IP Address Assignment, IPv6), MAC Addresses, TCP and UDP Ports.

IoT Protocols

MQTT, XMPP, CoAP, IEEE802.15.4, ZigBee, LORA, RFID, Client Server Model, HTTP, Thingspeak, AWS, Cloud MQTT.

IoT Security

Network and transport layer challenges, IoT Gateways, IoT Routing attacks, Fog computing, IoT Fog.

Vehicle with IoT

Levels of operations, vehicle to everything, V2X paradox, VANETs, Information centric networks, CCN for VANET, three layered architecture, intelligent connected vehicles.

IoT Application in EV

Charging management system (CMS), smart charging, Block-chain IoT for interconnected vehicle, transportation management system, logistic management system.

Text books

1. Precision: Principles, Practices and Solutions for the Internet of Things, Timothy Chou, TMH.
2. Designing the Internet of Things", Adrian Mc Ewen, Hakim Classically, Wileypublication,1st Edition, November2013.
3. The Internet of Things in the Power Sector Opportunities in Asia and the Pacific, Ramamurthy, A. and Jain, P,2017.

Reference Books

1. The Internet of Things: A Survey, Journal on Networks, Luigi Atzori, Antonio Lera, Giacomo Morabit, Elsevier Publications, October,2010.
2. The Internet of Things in the Cloud: A Middle ware Perspective, Honbo Zhou, CRCPress-2012.
3. Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, Springer,2011.

VEHICLE CHARGING TECHNOLOGY

Course Code : EE40022
Credit : 3
L-T-P : 3-0-0
Prerequisites : Electric Circuit Analysis (EE21001) and Power Electronics (EE30001)

COURSE OBJECTIVE

To develop the charging infrastructure, assessment of the location of the charging station, selection, and sizing of various components and connectors required for the EV charging as per the standards.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Understand the basics of Electric Vehicles and their charging,
CO2: Realize the various components required in EV charging,
CO3: Demonstrate the types of charging and their modes,
CO4: Analyze the proper selection and sizing of charging components and connectors,
CO5: Realize the necessary charging standard and process of commissioning,and
CO6: Design the charging station for EVs.

COURSE CONTENT

Introduction

History of EV, Components of Electric Vehicle, EV classification, and their electrification levels

Types of EV Chargers

Charging Equipment, Basic charging Block Diagram of Charger, Difference between Slow charger and fast charger, Slow charger design rating, Fast charger design rating, AC charging and DC charging Inboard and off-board charger specification, Types of Mode of charger Mode -2, Mode-3 and Mode-4, Wireless Charging: static charging and dynamic charging

Selection and sizing of the fast and slow chargers (AC and DC)

AC Pile Charger, DC Pile Charger, EVSE Power Module selection and technical specification, Selection of EVSE Communication Protocol (PLC / Ethernet / Modbus/ CAN Module), Communication gateway, Specification of open charge point protocol (OCCP 1.6/2.0), Bharat DC001 & AC001 Charger specification, Communication Interface between charger and CMS (central management system)

Selection and sizing of Common types of connectors and applications

Selection of AC charger type-1 type -2 and type -3, Communication between AC charger and EV, Selection of DC charger connector GB/T, CHAdeMO CCS-1 and CSS-2, Communication methodology of DC fast chargers, IS/ IEC/ARAI/ standard of Charging topology Communication and connectors (IEC 61851-1, IEC 61851-24,62196-2), Selection sizing of Charger connector cable

Public Charging infrastructure

Basic Requirements for Charging System, Charger Architectures Preparation of EV Charger Single Line Diagram, Assessment of site Location for Public charging station, Selection and Sizing of Distribution transformer, HT Equipment (VCB, CT, PT, Metering), HT Cables and LT cables, Selection and sizing of Distribution Board/feeders, Sizing calculation of LT and HT cable, Selection and of Compact Substation (CSS for EV CS).

Text books

1. Rim, C. T., & Mi, C. (2017). Wireless power transfer for electric vehicles and mobile devices. John Wiley & Sons.
2. Code of Practice for Electric Vehicle Charging Equipment Installation. (2018). United Kingdom: Institution of Engineering & Technology.

Reference Books

1. Chan, C. C., & Chau, K. T. (2001). Modern electric vehicle technology (Vol. 47). Oxford University Press on Demand.
2. Vahidinasab, V., &Mohammadi-Ivatloo, B. (Eds.). (2022). Electric vehicle integration via smart charging: technology, standards, implementation, and applications. Springer Nature.
3. Hayes, J. G., &Goodarzi, G. A. (2018). Electric powertrain: energy systems, power electronics, and drives for hybrid, electric, and fuel cell vehicles.
4. Husain, I. (2021). Electric and hybrid vehicles: design fundamentals. CRC press.

HYDROGEN AND FUEL CELL TECHNOLOGY FOR ELECTRIC AND HYBRID VEHICLE

Course Code : EE40045
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OBJECTIVE

To understanding the principles of hydrogen as an energy carrier and its application in fuel cell technology.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Know the working principle and operation of fuel Cell,
CO2: Illustrate the reaction kinetics of fuel cell,
CO3: Understand the characteristics of the fuel cell,
CO4: Analyze the mathematical modelling of the fuel cell,
CO5: Integrate the Fuel Cells in Electric Vehicles and their Performance,and
CO6: Analyze economic and policy aspects of hydrogen and fuel cell technology.

COURSE CONTENT

Introduction to Fuel Cells
Introduction – working and types of fuel cell – low, medium and high temperature fuel cell, liquid and methanol types, proton exchange membrane fuel cell solid oxide, hydrogen fuel cells – thermodynamics and electrochemical kinetics of fuel cells.

Fuel Cells for Automotive Applications
Fuel cells for automotive applications – technology advances in fuel cell vehicle systems – onboard hydrogen storage – liquid hydrogen and compressed hydrogen – metal hydrides, fuel cell control system – alkaline fuel cell – road map to market.

Fuel Cell Components and Their Impact on Performance
Fuel cell performance characteristics – current/voltage, voltage efficiency and power density, ohmic resistance, kinetic performance, mass transfer effects – membrane electrode assembly components, fuel cell stack, bi-polar plate, humidifiers and cooling plates.

Integration of Fuel Cells in Electric Vehicles and their Performance
Hybrid electric vehicles (HEVs) and fuel cell electric vehicles (FCEVs), Integration of fuel cells with electric drive trains, Benefits and limitations of fuel cell vehicles, Performance characteristics of fuel cell vehicles, Fuel efficiency and range considerations, Maintenance and servicing of fuel cell system, Diagnostics and troubleshooting in fuel cell vehicles

Economic and Policy Aspects of Hydrogen and Fuel Cell Technology
Cost analysis of fuel cell systems and hydrogen production, Government policies and incentives promoting fuel cell vehicles, Market trends and commercialization prospects, Future developments and challenges in hydrogen and fuel cell technology

Text books

1. Fuel Cells: From Fundamentals to Applications by Supramaniam Srinivasan
2. Fuel Cells: Principles, Design, and Analysis by Jochen Valentin and Michael W. G. Hoffmann

Reference Books

1. Fuel Cell Fundamentals by Ryan P. O'Hayre, Suk-Won Cha, Whitney G. Colella, Fritz B. Prinz
2. Introduction to Hydrogen Technology, by Roman J. Press and Raymond L. Markiewicz
3. Hydrogen and Fuel Cells: A Comprehensive Guide, by Rebecca L. Wagner
4. Hydrogen and Fuel Cells: Advances in Transportation and Power, by David A. J. Rand

IoT IN INDUSTRY

Course Code :EE40049
Credit : 3
L-T-P : 3-0-0
Prerequisite : Nil

COURSE OBJECTIVE

The objective of this course is to understand the concepts and principles of IoT and its applications in industrial settings as well as exploring the key components and technologies involved in building IoT systems for industry.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Categorize the components of IoT and Industrial IoT,
CO2: Apply AI and Bigdata in Industrial IoT,
CO3: Analyze the architecture approach of Industrial IoT,
CO4: Understand the communication technique of Industrial IoT,
CO5: Design building blocks of Industrial IoT,and
CO6**:** Design IoT system for various industrial cases.

COURSE CONTENT

Smart Industry

Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories, Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis.

Architecture

Industrial Processes, Industrial Sensing & Actuation, Industrial Internet Systems, Business Model and Reference Architecture, IoT Reference Architecture, Industrial IoT- Layers, Sensing, IoT Processing, IoT Communication

Security

Security and Fog Computing, Fog Computing in IoT, IoT Application Domains Design,

Interconnected Healthcare IoT architecture design, Open source IoT design for agricultural application, Facility Management. Industrial IoT design based on Application Domains: Oil, chemical and pharmaceutical and process industry.

Text books

1. Designing the Internet of Things, Adrian McEwen, Hakim Cassimally, Wiley publication, 1st Edition, November 2013.
2. The Internet of Things in the Power Sector Opportunities in Asia and the Pacific, Ramamurthy, A. and Jain, P, 2017.

Reference Books

1. The Internet of Things: A Survey, Journal on Networks, Luigi Atzori, Antonio Lera, Giacomo Morabito, Elsevier Publications, October, 2010.
2. The Internet of Things in the Cloud:A Middleware Perspective, Honbo Zhou, CRC Press-2012.
3. Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, Springer, 2011.

SMART BIO-MEDICAL INSTRUMENTATION

Course Code :EE40050
Credit : 3
L-T-P : 3-0-0
Prerequisite :Basic Electronics(EC10001), Science of Living Systems (LS10001)

COURSE OBJECTIVE

The objective of the "Smart Bio-Medical Instrumentation" course is to provide students with a comprehensive understanding of fundamental concepts in biomedical instrumentationand its role in healthcare. Application-specific biomedical sensors and non-invasive diagnostic parameters has also been introduced in this course.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO1: Demonstrate various biomedical signal sources.
CO2: Illustrate various Physiological system of the human body.
CO3: Understand cardiovascular system and related measurements.
CO4: Know working principle of measurement instrument for respiratory and nervous system.
CO5: Identify the non-invasive diagnostic parameters.
CO6: Analyze the performance characteristics of various sensors in biomedical equipment.

COURSE CONTENT

Introduction of Bio-medical Instrumentation

Sources of Bioelectric Potentials and Electrodes. Introduction to man-instrument system, components of the man-instrument system, Physiological system of the body, Problems encountered in measuring a living system. Resting and action potentials.

Cardiovascular System and Measurements

The heart and cardiovascular system, ECG, blood pressure and its measurement, respiration and pulse rate, characteristics and measurement of blood flow meter.Measurement of Heart Rate using Stethoscope, Blood pressure using Sphygmomanometer, Pulse Rate and SpO_2measurement using Pulse Oximeter

Respiratory systemand Measurements

The physiology of the respiratory system, test and instrument for the mechanics of breathing.Use of Spiro meter.

Neuro-muscular System and Measurements

Somatic nervous system,EEG,EMG ,GSR

Measurement and Recording of Noninvasive Diagnostic Instrument

Principle of ultrasonic measurement, thermography, elements of intensive care monitoring-ray, CT – Scan, MRI, Tonometer, Dialysis and Diathermy .

Biomedical Sensors

Recognize the role of sensors in biomedical instrumentation, basic mechanisms and principles of biomedical sensors.

Text books

1. Cromwell, L. and Weibell, F.J. and Pfeiffer, E.A., Biomedical Instrumentation and Measurement, Dorling Kingsley (2006) 2nd edition.
2. Carr, J.J. and Brown, J.M., Introduction to Biomedical Equipment Technology, Prentice Hall India (PHI) (2000) 4th edition.

Reference Books

1. Geddes, L.A., and Baker, L.E., Principles of Applied Biomedical Instrumentation, Wiley InternationalScience (1989) 3rd edition.

2. Khandpur, R.S., Handbook of Biomedical Instrumentation, McGraw Hill (2003) 2nd edition.
3. Webster, J.G., Medical Instrumentation Application and Design, John Wiley (2007) 3rd edition
4. Medical Device Technologies: A Systems Based Overview Using Engineering Standards, G. Baura, Academic Press, 2011

BIO-INSPIRED ALGORITHM

Course Code : EE40051
Credit : 3
L-T-P : 3-0-0
Prerequisite :Nil

COURSE OBJECTIVE

The objectives of this course are to learn bio- inspired theorem and algorithms, to understand simulated annealing, genetic algorithm, differential evolution, swarm optimization, ant colony for feature selection.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Understand the basic concept of evolutionary computation,
CO2: Demonstrate swarm intelligence for existing systems,
CO3: Interpret the implementation issues of evolutionary algorithms,
CO4: Calculate the appropriate parameter settings for algorithm convergence,
CO5: Evaluate new evolutionary operators, representations and fitness functions,and
CO6: Identify different evolutionary algorithms for engineering applications.

COURSE CONTENT

Evolutionary Computation

Biological and artificial evolution, Evolutionary computation, Different historical branches of EC, Genetic Programming: Trees as individuals, Major steps of genetic programming, e.g., functional and terminal sets, initialization, crossover, mutation, fitness evaluation, etc. Search operators on trees, automatically defined functions, Issues in genetic programming, e.g., bloat, scalability, etc. Selection schemes: Fitness proportional selection and fitness scaling, Ranking, including linear, power, exponential and other ranking methods, Tournament selection, Selection and its impact on evolutionary search, Search Operators: Recombination/Crossover for strings (e.g., binary strings), e.g., one-point, multi-point, and uniform crossover operators, Mutation for real-valued representations, e.g., Gaussian and Cauchy mutations, self-adaptive mutations, etc., Generational cycle-convergence of Genetic Algorithm.

Introduction to Swarm Optimization

Conventional Computing versus Swarm Computing; Classification of meta-heuristic techniques- single solution based and population based algorithms – exploitation and exploration in population based algorithms; Properties of Swarm intelligent Systems;

Particle Swarm Optimization: PSO Model, global best, Local best, velocity update equations, position update equations, velocity clamping, inertia weight, constriction coefficients, synchronous and asynchronous updates, Binary PSO.

Different Evolutionary Algorithms

Historical development, types of bees and their role in the optimization process, Introduction to Ant Systems, Ant Colony Optimization Technique, Pheromones and its Density as Deciding Factor. Artificial bee colony (ABC) algorithms binary ABC and continuous ABC algorithms; Bacterial foraging techniques-taxes-elimination-dispersals bacteria motility and swarming; Biological immune systems and artificial immune systems affinity measures- representations; Basic immune models and algorithms.

Text books

1. Genetic Algorithms in Search, Optimization & Machine Learning, D E Goldberg, Addison-Wesley, 1989
2. James Kennedy and Russel E Eberheart, 'Swarm Intelligence', The Morgan Kaufmann Series in Evolutionary Computation, 2001

Reference Books

1. Eric Bonabeau, Marco Dorigo, and Guy Theraulaz, "Swarm Intelligence: From Natural to Artificial Systems", Oxford University Press, 1999
2. Engelbrecht, A.P. Computational Intelligence: An Introduction, Second Edition, John Wiley and Sons, 2007.
3. Dorigo, M., Stutzle, T., Ant Colony Optimization, MIT Press, 2004
4. Parsopoulos, K.E., Vrahatis, M.N., Particle Swarm Optimization and Intelligence: Advances and Applications, Information Science Reference, IGI Global, 2010

IoT SENSORS AND PROTOCOLS

Course code : EE40052
Credit : 3
L-T-P : 3-0-0
Prerequisite : NIL

COURSE OBJECTIVE

The objective of the "IoT Sensors and Protocols" course is to provide students with a comprehensive understanding of the various sensors and protocols used in Internet of Things (IoT) systems. By the end of the course, students should be able to understand the principles and working mechanisms of different types of sensors used in IoT applications. Gain practical knowledge in the deployment and integration of sensors within IoT systems. Explore the characteristics, advantages, and limitations of commonly used IoT protocols such as MQTT, CoAP, and HTTP. Understand the role of data acquisition.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Categorize the components of IoT sensors,
CO2: Analyze various types of actuators for IoT applications,
CO3: Access Various Protocols for IoT,
CO4: Prioritize various clouds and its application,
CO5: Distinguish an embedded development platform,and
CO6: Design devices based ob enduser applications.

COURSE CONTENT

Introduction to Sensor
Sensor types and properties, different transducers and actuators, IoT sensors :Temperature sensors, Proximity sensor, Pressure sensor, Water quality sensor, Gas sensor, Smoke sensor, IR sensors, Level sensors, Image sensors, Motion detection sensors, Accelerometer sensors, Gyroscope sensors, Humidity sensors, Optical sensors.

Communications

An Overview (IP, TCP, The IP Protocol Suite (TCP/IP), UDP), IP Addresses (DNS, Static IP Address Assignment, Dynamic IP Address Assignment, IPv6), MAC Addresses, TCP and UDP Ports.

IoT Protocols

MQTT, XMPP, CoAP, IEEE802.15.4, ZigBee, LORA, RFID.

Advanced Embedded Development Platforms
System on Chip (SoC), ARM®, Raspberry Pi, Evolution of Pi and technical specification comparative study, GPIO Interfacing Cloud, Analytics & UI, Client Server Model, HTTP, Thingspeak, AWS, CloudMQTT.

IoT framework Design

Selection of sensors for use cases, IoT end node hardware design, IoT dashboard Design for end user applications.

Textbooks

1. Designing the Internet of Things, Adrian McEwen, Hakim Cassimally, Wiley publication, 1st Edition, November 2013.
2. The Internet of Things in the Power Sector Opportunities in Asia and the Pacific, Ramamurthy, A. and Jain, P, 2017.

Reference Books

1. The Internet of Things: A Survey, Journal on Networks, Luigi Atzori, Antonio Lera, Giacomo

Morabito, Elsevier Publications, October, 2010.
2. The Internet of Things in the Cloud: A Middleware Perspective, Honbo Zhou, CRC Press-2012.
3. Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, Springer, 2011.

ELECTRICAL MACHINES LABORATORY

Course Code :EE29002
Credit :1
L-T-P :0-0-2
Prerequisite(s) : Electric circuit Laboratory

COURSE OBJECTIVE

The main objective of the Electrical machines laboratory is to provide the practical exposure to the student regarding operation of various electrical machines like DC generators, DC Motors, Alternators, Synchronous motors, Induction Motors, Special Motors and Transformers. Students are allowed to conduct various experiments for the validation of performance characteristics of all the machines. From this laboratory courses student will gain the skill to select correct machine for a specific application.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Memorize the working principle and applications of different electrical machines,
CO 2: Understand the challenges in industrial applications of electric motors,
CO 3: Utilize different electrical machines,
CO 4: Analyse different electrical machine according to the requirement in the industrial applications,
CO 5: Assess the safety precautions to be taken while using electrical equipment,and
CO 6: Design the equivalent circuit of the transformer and construct the circle diagram of an induction motor.

COURSE CONTENT

Topics:

- No Load and Load Characteristics of a (i) D.C Shunt Generator and (ii) Separately Excited Generator.
- Design of the equivalent circuit by using the open circuit and short circuit test on a single phase Transformer.
- Determination of the voltage regulation of a three phase alternator using the Open circuit and short circuit test.
- Design of the circle diagram using the No load and Block rotor test on three phase induction motor.
- Speed control of D C Motor by using the different Methods.
- Connection of three single Phase transformers in star-star, star-delta, delta-star, delta-delta and

open delta.

- Testing of a D C motor to find the different parameters and to draw the performance characteristics.
- Draw the V curve and inverted V curve of a three phase synchronous motor.
- Draw the performance characteristics of a single phase induction motor by using the different tests.

Textbooks

1. Electrical Machinery, P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.
2. Electrical Machines, by P. K. Mukherjee and S. Chakravorti, Dhanpat rai Publication, 18th reprint 2013

Reference Books

1. Electrical Machines, Ashfaq Hussain, Dhanpat Rai, Delhi, 2nd Edition, 2008.
2. Electrical Technology, Volume -II. B. L. Theraja, S .Chand Publications. 2010.
3. Electric Machines, C. I. Hubert, Pearson Education, 2003.
4. Electric Machines ,by Kothari. D P and I J Nagrath, 3rd Edn, Tata McGraw-Hill, New Delhi. 2004.

POWER ELECTRONICS LABORATORY

Course Code :EE 39001
Credit :1
L-T-P :0-0-2
Prerequisite(s) : Electric circuit laboratory

COURSE OBJECTIVE

Utilities of Power Electronic Converters are introduced. The AC-DC converters are examined in details with R and RL loads. Analysis of DC-DC converters are done so that experimental verification can be facilitated. The principle of chopper is applied in the Fly-Back Converters for SMPS. The waveforms and the output voltage equation of SMPS are experimentally verified.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Choose an appropriate converter for variety of needs,
CO 2: Comprehend the principles of operation of various converters,
CO 3: Apply AC-DC converters for rectification,
CO 4: Analyze the parameters and the waveforms of the output of the converters,
CO 5: Assess the efficacy of a converter,and
CO 6: Discuss about the merits and demerits of the converters.

COURSE CONTENT

Topics

- Study of output voltage waveforms and parameters of three phase uncontrolled rectifier.
- Study of single phase fully controlled AC-DC converter with R and RL laod.
- Verify the performance of DC-DC Buck-Boost converters.
- Verify the performance of Fly-Back Converters for SMPS.

Textbooks

1. Power Electronics by M. H. Rashid, Pearson Education, 3rd Edition, 2009.
2. Elements of Power Electronics, by Philip T. Krein, Oxford University Press, 25 Sept 1997.
3. Power Electronics, by P S Bhimbra, Khanna Publishers, 5th Edition, 2011.

Reference Books

1. Power Electronics, Converters, Applications and Design, by N. Mohan, Undeland and Robbins, John Wiley and Sons , 3rd Edition ,2009.
2. Modern Power Electronics by P. C Sen, S Chand Publisher- 2013.
3. Power Electronics, by K.R.Varmah and Chikku Abraham, Cengage Publications- 2014.
4. Power Electronics, by M. D. Singh and K.B. Khanchandani, Tata McGraw - Hill publishers, 2nd edition, 2008.

POWER SYSTEMS PROTECTION LABORATORY

Course Code :EE49001
Credit :1
L-T-P :0-0-2
Prerequisite(s) : Nil

COURSE OBJECTIVE

The main objective of the Power Systems protection laboratory is primarily used for teaching power system protection basic and advance modelling of transformers, transmission lines, fault analysis, protective relays characteristics and its schematics. The Power Systems protection Laboratory is equipped with different Protection Scheme of Alternator, over Current Relay, over voltage relay, Percentage biased Differential Relay, Microcontroller based negative sequence relay, Transmission line simulator kit etc.. From this laboratory courses student will gain the skill to analyse the performance of power system networks, study different power system protective relays & develop computer software programs for analysis of power systems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Spell the characteristics of a transmission line.
CO 2: Comprehend the uses of different relays in power systems.
CO 3: Apply suitable techniques to locate the fault of an underground cable.
CO 4: Analyze the results of short circuit analysis for symmetrical and unsymmetrical faults.
CO 5: Assess the characteristics of a solar PV module.
CO 6: Discuss the procedural steps needed to implement for interpreting the results of the power system software.

COURSE CONTENT

Topics

- Determine the ABCD parameters of a transmission lines.
- Study of electromechanical type over current relay & over voltage relay
- Fault location of Under Ground Cable by Varley Loop Test
- Develop software programs for analysis of power systems

Textbooks

1. Modern Power System Analysis, I. J. Nagrath, D. P. Kothari, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 4th Edition 2013.
2. Electrical Power System, C.L. Wadhwa, New Age International (P) Limited, Publishers, 2010.

Reference Books

1. Power system analysis by Hadi Sadat Tata McGraw Hill.
2. Fundamentals of Power System Protection, Y. G. Paithankar, S. R. Bhide, 2nd edition, Prentice Hall of India Private Limited, New Delhi, 2011
3. A Text Book on Power System Engineering, A. Chakrabarti, M.L. Soni, P.V. Gupta and U.S. Bhatnagar, Dhanpat Rai and Co., Reprint 2012

ELECTRIC VEHICLES LABORATORY

Course Code :EE 49005
Credit :1
L-T-P :0-0-2
Prerequisite(s): Nil

COURSE OBJECTIVE

This course provides a comprehensive study of Electric Vehicles (EVs), focusing on their various components, configurations, and power train characteristics. Students will analyze battery charging and discharging profiles, investigate the requirements of battery electric vehicles for different drive cycles, and determine the performance characteristics of Permanent Magnet Synchronous Motor (PMSM) drive. Additionally, the course covers the examination of inductive wireless power for EV charging and the design characteristics of 2-wheelers, 3-wheelers, and 4-wheelers.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Understand and explore various configurations of Electric Vehicles,
CO2: Basic Design and analysis of Power train configuration of the vehicle,
CO3: Analyze the battery charging and discharging profile,
CO4: Realize and understand the solar powered electric vehicle,
CO5: Study the simulation of PMSM drive,and
CO6: Understand the concept of inductive power transfer for the charging of electric vehicles.

COURSE CONTENT

Topics

- To Know the various components of the Electric Vehicle (EV) and Study the different types of EV configurations
- Analysis and design of EV power train Characteristics
- Study and Analysis of the battery charging and discharging profile.
- Investigation on various requirements of Battery electric vehicle for various drive cycle simulations
- Determination of performance characteristics of PMSM drive
- Examination and basic study of Inductive wireless power for EV charging
- Study and Analysis of design characteristics for 2W.
- Study and Analysis of design characteristics for 3W.
- Study and Analysis of design characteristics for 4W.

Textbooks

1. Husain, I. (2021). Electric and hybrid vehicles: design fundamentals. CRC press.
2. Zhang, Y., & Mi, C. (2018). Automotive power transmission systems. John Wiley & Sons.

Reference Books

1. Larminie, J., & Lowry, J. (2012). Electric vehicle technology explained. John Wiley & Sons.
2. Rim, C. T., & Mi, C. (2017). Wireless power transfer for electric vehicles and mobile devices. John Wiley & Sons.

IOT LABORATORY

Course Code :EE 49003
Credit :1
L-T-P :0-0-2
Prerequisite(s):Nil

COURSE OBJECTIVE

This Internet of Things (IoT)-lab is the network of physical objects or 'things' embedded with electronics, software, sensors, and connectivity to enable objects to exchange data. IoT allows direct integration between the physical world and computer-based systems, helping to connect people, processes and devices.This course focused on learning methodical and logical idealization of various protocols which is highly essential for solving a network. The course intends to make the students familiar with various parts of sensors and cloud storage and analytic of storage data.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Realize the importance of sensors and its parameters.
CO 2: Adopt team working skills as a member of group with common objective.
CO 3: Identify the different protocols and its applications.
CO 4: Identify the different types of cloud storage of things data.
CO 5: Present and Analyze the experimental results through IoT analytic.
CO 6: Design Internet of Things architecture.

COURSE CONTENT

Topics

- Familiarisation of ESP32/Raspberry Pi and perform necessary software installation.
- To interface analog voltage input to ESP32/Raspberry Pi.
- To interface DHT11/DHT22, pressure, voltage and current sensor date input to ESP32/Raspberry Pi.
- To interface motor using relay with ESP32/Raspberry Pi.
- To interface OLED with ESP32/Raspberry Pi and write a program to print temperature and humidity.
- Write a program on ESP32/Raspberry Pi to retrieve tempurature and humidity data from DHT11/DHT22 to Thingspeak Cloud.

- Write a program to generate Thingspeak SNS alert service.
- Write a program on ESP32/Raspberry Pi to publish DHT11 data through MQTT protocol.
- To install MySQL data on ESP32/Raspberry Pi and perform SQL queries.
- Write a program to create TCP server on ESP32/Raspberry Pi and transfer data from TCP client.

Textbooks

1. Designing the Internet of Things, Adrian McEwen, Hakim Cassimally, Wiley publication, 1st Edition, November 2013.
2. The Internet of Things in the Power Sector Opportunities in Asia and the Pacific, Ramamurthy, A. and Jain, P, 2017.

Reference Books

1. The Internet of Things: A Survey, Journal on Networks, Luigi Atzori, Antonio Lera, Giacomo Morabito, Elsevier Publications, October, 2010.
2. The Internet of Things in the Cloud:A Middleware Perspective, Honbo Zhou, CRC Press-2012.
3. Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, Springer, 2011

SENSOR AND CONTROL LABORATORY

Course Code : EE49002
Credit :1
L-T-P :0-0-2
Prerequisite(s) :Nil

COURSE OBJECTIVE

The course of Sensor and Control Laboratory comprises of various key technologies used in sensing and control of electric vehicles, like speed, displacement, temperature, etc. It is a specialized practical oriented course which intends to develop and understand various principles of sensors and transducers and also the use in control application. The course focused on learning methodical and logical idealization of various schemes of EV which is highly essential. The course intends to develop the ability of problem solving by analyzing control strategies. This lab helps the students to understand the principle of control operation of various essential parameters.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Measure the linear displacement using LVDT and temperature using RTD,
CO 2: Know and realize the impact of stress by measuring the same,
CO 3: Control the speed of PMDC Motor using encoder as feedback sensor,
CO 4: Identify and monitoring of position control of DC Motor using PID Control,
CO 5: Know controlling a stepper motor using microcontroller,and
CO 6: Know and familiarize with the application of embedded MCUs.

COURSE CONTENT

Topics

- To study and measure linear displacement using LVDT
- Measure temperature using RTD
- Strain measurement using Strain Gauge
- Speed Measurement using Encoder and control the speed of a PMDC Motor
- Position Control of DC Motor using PID control
- Control of Stepper Motor using Microcontroller
- Familiarization and application of embedded MCUs

Textbooks

1. Ian R Sinclair, Sensors and transducers, Third Edition, Newness Publishers, 2001.
2. Doebelin E O, Measurement Systems, Application and Design, McGraw Hill, Fifth Edition, 2004.

Reference Books

1. Jack P Holman, Experimental Methods for Engineers, Seventh Edition, McGraw Hill, USA, 2001.

PROGRAMMABLE LOGIC CONTROL LABORATORY

Course Code :EE 39007
Credit :1
L-T-P :0-0-2
Prerequisite(s):Nil

COURSE OBJECTIVE

PLC Laboratory is to aware the students about the Industrial Automation Techniques. The students will be familiar with different switches, sensors, actuators and measuring instruments which are most frequently used in process control industries. The students will be enabling with the upgraded relevant advanced software based controller utilized in modern industry. PLC laboratory gives the effort for making them

efficient to design and construct the hardware part related to desired process control. Students can be able to know the technique and logical programme behind the Industrial process Control.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Spell typical components of a Programmable Logic Controller.
CO 2: Explain the concept of electrical ladder logic and its relationship to programmed PLC instruction.
CO 3: Apply the concept of basic digital electronics and data manipulation.
CO 4: Analyse the timers and counters using intermediate programming functions.
CO 5: Evaluate the PLC circuits for entry-level PLC applications.
CO 6: Design and program automated industrial production line.

COURSE CONTENT

Topics

- Introduction to PLC programmable logic controller
- Details of programming language as LAD
- LADDER Programming using NO ,NC
- Programming on SPST and SPDT Logic
- Introduction to TIMER and COMPARATOR BLOCK
- Introduction to COUNTER BLOCK

Textbooks

1. Programmable logic Controller by Vijay R. Jadhav KHANNA PUBLISHERS Second Edition 2012
2. Industrial Automation Using PLC,SCADA and DCS by R.G Jamkar Laxmi Publications Private Limited; First edition 2017

Reference Books

1. PLC and SCADA by Prof Rajesh Mehra and Er. Vikrant Vij Published by University Science Press, 1st edition
2. Programmable logic Controller: Programming methods and Applications By John R Hackworth and Frederick D. Hackworth Jr. PEARSONEdition: 1st Edition, 2006

CIRCUITS, SIGNALS AND COMMUNICATION

Course Code: **EC30014**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The aim of Circuits, Signals, and Communication is to help students from non-electronics specialization to become familiar to analog & digital circuits, fundamentals of systems & signal processing, and technologies used for information communication. This course will bring the students of other disciplines to a common learning level, while fulfilling the prerequisite knowledge required for many other open elective courses.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Determine the DC and AC parameters of OPAMP; analyze and comprehend the difference between circuits using Op Amps (Closed loop: negative and positive feedback or open loop),
CO 2: Design and analyze instrumentation amplifier, V-I converter, active filters,
CO 3: Analyze and plot continuous and discrete signals, determine various operations on signals, Classify various types of systems and analyze system characteristics in time domain,
CO 4: Analyze the characteristics of signals and systems in frequency domain using Fourier analysis and its properties,
CO 5: Identify the need of communication and analyze different Amplitude and Angle Modulation based communication systems and their functions,and
CO 6: Analyze and compare different Pulse and Digital Modulation based communication systems and their functions.

COURSE DETAILS

Operational amplifier & its parameters

Introduction to operational amplifier, opamp parameters- Input offset voltage, Input Bias current, Input offset current, total output offset voltage, Thermal drift, PSRR, Common mode configuration and CMRR, Noise in Op-amp, Slew rate, Op-amp circuits using negative feedback (voltage series feedback & voltage shunt feedback), Differential amplifier.

Operational amplifier applications

Instrumentation amplifier, Voltage to current converter and vice versa, Active filters, Analog-to-digital converter, Digital-to-analog converter

Introduction to Signals & Systems

Classification of signals, Basic elementary operation on signals, Basic properties of Systems, Linear Convolution and Correlation

Continuous time Fourier analysis

Signals in time and frequency domain, Fourier Analysis of Periodic Signal, Dirichlet's condition, Convergence and properties of continuous time Fourier series, Approximation of Fourier series to Fourier transform for a periodic signal, Fourier transform of useful signals and properties, Frequency response of LTI system.

Amplitude Modulation Techniques

Introduction to communication system, Need of Modulation, Frequency Translation, Principle of AM, side bands, Power Relationship, Assignable Frequency spectrum, Side band Transmission, DSB, SSB, VSB, AM modulators and Demodulators, AM Radio Receiver, Super hetero-dyne Principle.

Frequency Modulation Techniques

Principle of FM, Frequency Deviation, Spectrum of FM wave, Power in Modulated wave, Narrow and wide band FM, Pre-emphasis and De-emphasis, Block Diagram of FM Transmitter, FM Detector, Block Diagram of FM Receiver. Application of analog modulation for broadcasting and point to point communication systems

Pulse Modulation Techniques:

Analog vs Digital modulation, Sampling Process, Pulse Amplitude Modulation, Pulse Width Modulation, Pulse Position Modulation, The Quantization Process, Pulse Code Modulation.

Digital Modulation Techniques, Principles involved in ASK, PSK (BPSK, QPSK, $\pi/4$ QPSK), FSK.

Application of Digital modulation for broadcasting and point to point communication systems

Textbooks

1. R. K. Gayakwad, Op-Amp & LIC, PHI, 4th Edition,2015
2. A. V. Oppenheim A. S. Willsky and S. H. Nawab, ``Signals and Systems", New Delhi: Prentice Hall of India
3. H. Taub & D.L.Schilling, Principles of Communication System,TMH, 3rd Edition

Reference Books

1. D. Ray Choudhury & Shail Jain, Linear Integrated Circuits, New Age, 4th Edition
2. Tarun kumar Rawat, Signals and systems, Oxford university press, 2010
3. Simon Haykins, Introduction to Analog & Digital Communication System, Wiley Student edition, 2011

INTRODUCTION TO SENSOR TECHNOLOGY

Course Code: **EC30016**
Credit: **3**

L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course provides in depth knowledge in physical principles applied in sensing, measurement and a comprehensive understanding on how measurement systems are designed, calibrated, characterized, and analyzed. It further gives a fundamental knowledge on the basic laws and phenomena on which operation of sensor transformation of energy is based.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze the basic measurement techniques and sensor fundamentals,
CO 2: Apply the concepts in common methods for converting a physical parameter into an electrical quantity,
CO 3: Choose an appropriate sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like acceleration, shock, vibration, etc,
CO 4: Apply the appropriate Biosensors and Chemical sensors,
CO 5: Explain the functioning of microphones,and
CO 6: Design the machinery vibration monitoring systems.

COURSE DETAILS

Basics of measurements and Sensor fundamentals and characteristics

Basics of measurements, Sensor Characteristics, System Characteristics, Instrument Selection, Data Acquisition and Readout

Sensor Signal Conditioning

Conditioning Bridge Circuits, Amplifiers for Signal Conditioning, Analog to Digital Converters for Signal Conditioning, Signal Conditioning High Impedance Sensors

Technology Fundamentals, Selecting and Specifying Accelerometer, Applicable Standards, Interfacing and Designs, Quartz Sensors, Strain Gage Sensors, Sensor Manufacturers

Biosensors and Chemical Sensors

What Is a Biosensor, Origin of Biosensors, Transduction Mechanisms in Biosensors, Application Range of Biosensors, Chemical Sensor Technology and Applications, Sensor Manufacturers

Test and Measurement Microphones

Electromagnetism and Inductance, Magnetic Field Sensors, Measurement Microphone Characteristics, Frequency Response, Effect of Environmental Conditions, Specialized Microphone Types, and Calibration, Sensor Manufacturers

Machinery Vibration Monitoring Sensors

Introduction, Technology Fundamentals, Accelerometer Types, Selecting Industrial Accelerometers, Applicable Standards, Sensor Manufacturers

Textbook

1. Jon S. Wilson, Editor-in-Chief, "Sensor Technology Handbook", Elsevier, 1st, 2005.

Reference books

1. Edited by Krzysztof Iniewski, Optical, Acoustic, Magnetic, and Mechanical Sensor Technologies, CRC Press, 1st, 2012.
2. Winncy Y Du, Resistive, Capacitive, Inductive, and Magnetic Sensor Technologies, CRC Press, 1st, 2015.

EVOLUTION OF COMMUNICATION TECHNOLOGY

Course Code: **EC30018**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The is intended to make the students understand the Wireless communication system, Principle and working Cellular communication system, means and medium of wireless communication. They will able to analyze the Evolution of different wireless communication techniques and can differentiate between the feature and technology behind different generation wireless communication technology. Also they will able to comprehend the various standards for different generation wireless technology.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the basic concept of 2G Wireless systems Like GSM, IS-95 and their architecture,
CO 2: Analyze the concept of 2.5G wireless systems like GPRS and EDGE,
CO 3: Explain and analyze the concept of 3G systems,
CO 4: Discuss the concept of LTE based 4G wireless systems,
CO 5: Explain and analyze the concept of LTE Advance and 5G communication,and
CO 6: Analyze the supportive technologies like Massive MIMO, Evolution of IOT and the concept of 6G Communication.

COURSE DETAILS

GSM

Air-Interface Standards: GSM, IS-95, WiFi, GSM,GSM Architecture Description,GSM Bands Part 1,GSM Bands Part 2,GSM Channels,GSM Basic Call Flow,GSM Cells,GSM Identifiers Part 1,GSM Identifiers Part 2, IS-95, WiFi

GPRS

GPRS Introduction,GPRS Architecture,GPRS Channels,GPRS Questions

EDGE

EDGE Technology, EDGE Questions

3G

3G Identifiers, WCDMA Concept, 3G Codes, Handovers, 3G Questions

LTE and 4G

LTE Frequency Bands, 4G Network, LTE Resource Block, LTE Key Points, LTE Voice Solution, LTE Optimization, LTE Drive Test, LTE DT Parameters, LTE Coverage Factors, LTE Cell Planning, VoLTE & ViLTE, 4G LTE Questions

5G and Beyond

LTE Advance, 5G introduction, 5G Air Interface, Massive MIMO, 5G Small Cells, 5G Questions, Evolution of the Internet of Things, The Situation and Development of 5G and Future 6G, Futuristic Communication Technology.

Textbook

1. Ajaya R Mishra, Fundamentals of Network Planning and Optimization 2G/3G/4G: Evolution to 5G, Wiley, 2nd Edition

Reference books

1. C. Y. Lee, Wireless and Cellular Communication, McGraw Hill, 3rd Edition
2. J. Schiller, Mobile Communication, Pearson Education, 2nd Edition
3. T.S.Rappaport, Wireless Communication Principles and Practice, Pearson Education, 2nd Edition

ELECTRONICS AND PCB DESIGN

Course Code: **EC30020**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This is a basic course for designing of Electronic Circuits and implement on their own PCB (Printed Circuit Board).

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain and analyze Electronic Components towards Circuit,
CO 2: Design a Electronics circuit,
CO 3: Design PCB layout of their design,
CO 4: Create PCB of their own circuit,
CO 5: Debug and analyze the PCB design steps, starting from schematic, through layout,and
CO 6: Discuss the technologies used for PCB fabrication in electronic industry.

COURSE DETAILS

Introduction

Active and Passive components, Simple Analog and Digital Circuits Design, Rectifier, Amplifier, Oscillator, Counter, voltage regulator circuit, Analyze and construct basic circuits, Assemble and get them running.

Printed Circuit Board

Need for PCB, Types of PCBs, Single and Multilayer, Technology- Plated Through Hole, Surface Mount, PCB Material, Electronic Component packaging, PCB Designing, Fabrication, Production, Electronic Design Automation Tools- Proprietary tools like Eagle, Ultiboard, Orcad and Open source tools like KiCad,

PCB Designing: Schematic Entry, Net listing, PCB Layout Designing, Prototype Designing, Design Rule Check (DRC), Design for Manufacturing (DFM) PCB Making, Printing, Etching, Drilling, Assembly of components. Design Issues- Transmission line, Cross talk and Thermal management, PCB testing and debugging.

Textbooks

1. Jon Varteresian, Fabricating Printed Circuit Boards, Newness, 2002.
2. Marc J. Madou, Fundamentals of Microfabrication, CRC Press, 2nd edition.

Reference books

1. C. Coombs, Printed Circuits Handbook, McGraw Hill, 7th edition.
2. V. Shukla, Signal Integrity for PCB Designers, Reference Design 2009
3. D. Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall, 2003

OPTIMIZATION TECHNIQUES IN ENGINEERING

Course Code: **EC40001**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

Students will gain expertise in designing algorithms based on conventional techniques and be able to deal with intractable problems and implement algorithms given the description. At the end of this course, students will be able to comprehend and apply various optimization techniques for numerical analysis of different engineering and design related problems. Course modules include various methods to obtain the extremum (minimum or maximum) of a non-dynamic system and the use of these methods in various engineering applications.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze the need for optimization, the concepts of design variables and constraints,
CO 2: Apply various unconstrained optimization techniques and develop corresponding Python/MATLAB codes,
CO 3: Apply various multi-variable optimization techniques and develop corresponding Python/MATLAB codes,
CO 4: Analyze various constrained optimization techniques and utilize them for evaluating engineering problem statements,
CO 5: Investigate various complex problems using dynamic programming algorithms,and
CO 6: Analyze various advanced metaheuristic techniques and develop Python/MATLAB codes for analysis.

COURSE DETAILS

Introduction
Design variables, constraints, variable bounds, local and global optimization, classification of optimization techniques.

Unconstrained Optimization Techniques
Single-variable optimization techniques - Concepts of Bracketing (Exhaustive Search) and Region Elimination (Interval Halving), Programming in Python/MATLAB.Gradient Based techniques - Newton-Raphson method and its application, Programming in Python/MATLAB.Multi-variable optimization techniques - Concepts of Direct Search (Hooke-Jeeves pattern search method) and Gradient based search (Cauchy's method, Newton's method).

Constrained Optimization Techniques
L1 and L2 norm based optimization, Kuhn-Tucker (KT) necessity and sufficiency theorems, Penalty function method, Method of multiplier.

Dynamic Programming
Dynamic programming algorithms, shortest path problems, time optimal control.

Metaheuristics
Genetic Algorithm, Particle Swarm Optimization, Simulated Annealing, Differential Evolution - Grey Wolf Optimization, Programming in Python/MATLAB.

Textbook

1. Deb, Kalyanmoy, Optimization for engineering design: Algorithms and examples. PHI Learning Pvt. Ltd., 2012.

Reference books

1. Stephen P. Boyd, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.
2. Deb, Kalyanmoy, Multi-objective optimization using evolutionary algorithms: an introduction. Springer London, 2011.
3. Rao, S. S.,Engineering optimization: theory and practice. John Wiley & Sons,2019.
4. Bellman, R. E. and Dreyfus, S. E., Applied dynamic programming (Vol. 2050). Princeton university press, 2015.

SEMICONDUCTOR TECHNOLOGY

Course Code: **EC20007**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

This course aims to make the students understand the fundamentals of electronic devices and familiarization with the fabrication of semiconductor devices, integrated circuits, and Micro-systems. In addition, students will gain knowledge of opto-electronic devices and quantum technology and appreciate the significance of these devices in various applications.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1**:** Analyze different types of semiconductor materials based on their band diagrams and estimate various electrical properties,
CO 2**:** Evaluate various junction properties and illustrate PN junction fundamentals,
CO 3**:** Analyze various MOS structures and their characteristics,
CO 4**:** Utilize the knowledge of MOS structures to appraise the high electron mobility MOSFET structures and their characteristics,
CO 5**:** Explain and demonstrate the different fabrication processes of MOS devices,and
CO 6**:** Utilize the basic knowledge of semiconductors to analyze emerging devices and technologies .

COURSE DETAILS

Introduction to Semiconductor and P-N Junction theory

Energy band diagram and classification, Density states and Fermi level, Semiconductor under equilibrium Condition (n_0, p_0 and intrinsic carrier concentration), Intrinsic and extrinsic semiconductor, Drift and diffusion current, Carrier generation and recombination, Excess carrier concentration, Continuity equation, Carrier lifetime, Qualitative description of charge flow in a p-n Junction, Junction Theory (concept of potential barrier, built in electric field, depletion layer width, and junction capacitance qualitative only), PN Junction operation under bias, and I~V relationship.

MOSFET

Basics of MOSFET, Two terminal MOS structure and its operation under external bias condition, Threshold voltage of MOS, Qualitative description of MOSFET operation, I-V characteristics of MOSFET, MOSFET as circuit element (CMOS Inverter operation and DC characteristics, qualitative only), High voltage MOSFET and Gallium Nitride power HEMT (structure and operation), III-V high electron mobility transistors, and Multigate MOSFET.

Opto-Electronic Devices

Photo diode, Light emitting diodes, Semiconductor LASER, OLED, Solar cell, Tunnel diode, and Schottky diode.

Semiconductor Fabrication

Historical perspective, Processing overview, Crystal growth, Wafer fabrication and basic properties of Silicon wafers, Clean rooms, Wafer cleaning, Diffusion, Ion-Implantation, Thermal Oxidation of Silicon, Lithography, Etching (Wet and Dry), Thin film deposition, Epitaxy, Metallization, and Overview of CMOS N-well process.

Emerging Devices and Technologies

Quantum confinement in semiconductor devices, Quantum dot, quantum well devices, Spintronic, and QLED.

Textbook

1. Simon M. Sze, Ming-Kwei Lee, Semiconductor Devices: Physics and Technology, Wiley, 3rd Edition (2021).

Reference Books

1. V K Dugaev and V I Litvinov, Modern Semiconductor Physics and Device Applications, CRC Press, 2022 (Foreign Publication).
2. Pallab Bhattacharya, Semiconductor Optoelectronic Devices, Pearson, 2nd Ed (2017). Robert F. Pierret, Semiconductor Device Fundamentals, Pearson, 1st Edition 9 (2006).

DIGITAL SYSTEMS DESIGN WITH VERILOG

Course Code: **EC30011**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVES

This course will make the student learn the design principles of digital computing systems and the Verilog modelling techniques. They will also be able to learn Boolean Algebra and understand various logic gates along with combinational circuits. Futher the students will be exposed to designing synchronous and asynchronous sequential circuits and CMOS level gate design.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Design and implement complicated digital systems using Verilog,
CO 2: Design a VLSI circuit for an application,
CO 3: Analyze the digital design logic,
CO 4: Design and Analysis of a given digital circuit – combinational and sequential,
CO 5: Apply Boolean simplification techniques to design a combinational hardware circuit,and
CO 6: Apply advance concepts of digital systems to design high speed arithmetic circuits.

COURSE DETAILS

Basic VLSI System Design

Introduction to digital systems and VLSI design, Moore's Law, VLSI Design flow, Design hierarchy, Introduction to Verilog HDL, operators and Modelling techniques (gate-level, data-flow,and behavioral)

Binary Codes & Boolean Algebra
Signed Binary numbers and its arithmetic (1's and 2's complement form), Binary codes (Weighted and non-weighted codes, Gray codes, BCD codes), Boolean Algebra-Laws and Axioms, SOP and POS (Min-term and Max-term), K-Maps (2-,3-,4- variables with don't care condition)

Combinational Circuits
Adders (Half adder, Full adders, Binary Parallel Adders), Subtractor (Half Subtractor, Full Subtractor), Code conversion algorithms, Combined Adder-Subtractor Block, Design of code converters, Decoders and Encoders, Multiplexer and Demultiplexer. Implementation of Combinational Circuits using Gate-level and Data-flow level of modelling.

Sequential Circuits
Basic latch, Flip-flops (SR, D, JK, T, Master-Slave), Triggering of flip-flops, FF conversions, Shift Registers (SISO,SIPO,PISO,PIPO), Counter Design (Synchronous and Asynchronous) Implementation of sequential circuits using Behavioral level of modelling.

Advanced Concepts
Overview of CMOS, CMOS level gate design (Basic and Universal gates), Design of general Boolean circuits using CMOS gates, CMOS level design of latches and flip-flops. Verilog description of CMOS level design.

Textbooks

1. Morris Mano, and Michael D. Ciletti, "Digital Design", Fifth Edition, PHI, 2012.
2. Samir Palnitkar, "Verilog HDL", Second Edition, Pearson Education, 2003.

Reference books

1. Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL", Second Edition, Pearson Education,2010.
2. Stephen Brown, "Fundamentals of Digital Logic with Verilog", McGraw Hill, 2007.

OPTICAL & SATELLITE COMMUNICATION

Course Code: **EC30013**
Credits: **3**
L-T-Pl: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

The course intend to make the students to learn the Optical Communication and Networking Concept, primarily signal propagation through optical fiber, Modulation for optical Communication, Losses, Dispersion, Link Budget and Networking. The knowledge of Satellite Communication and Systems are also very important for a communication Engineering student. The aim of the course is to develop the industry identified competencies within the students like Maintenance of optical communication systems and Satellite communication systems through various teaching and learning processes.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the significance of terminology associated with optical communication, analyze the principle of light propagation through optical fiber with concept of modes and solve problems on this concept,
CO 2: Analyze various types of losses and dispersion in optical fiber and solve related problems associated with the concept,
CO 3: Analyze the structure, principle of operation and the characteristics of optical sources and detectors,
CO 4: Identify the optical communication system link elements, preparation of link budget and estimate basic entities of optical Networking,
CO 5: Identify the Satellite communication elements and analyze the principles,and
CO 6: Analyse the Satellite Communication Systems and design the satellite Link budget.

COURSE DETAILS

Principles of Optical Communication and Wave Propagation in Optical Fiber

Optical frequencies used in optical fibers, Principle of light propagation in optical fibers, Advantages of optical fiber communication. Relation, Basic structure of optical fibers and ray diagram of optical path in an optical fiber, Acceptance angle, Numerical aperture. Concept of modes, Different types of modes in optical fibers, Relation between modes and rays, Cut-off condition for guided modes, Boundary conditions, single mode / multi-mode fibers, Concept of V number and its importance.

Losses in Fiber and Dispersion

Intrinsic / Extrinsic losses, Material or impurity losses, Rayleigh scattering loss, Absorption loss, Bending loss. Loss versus wavelength plot, Concept of dispersion, Intermodal dispersion, Intramodal dispersion, Wave guide and material dispersion, minimization of dispersion.

Optical Sources, Detectors, and Fiber Optic Links

Characteristics of optical sources, Principle of operation of LED and LASER diode,Intensity modulation circuits for LED and Laser diode. Principle of operation of PIN diode and APD, Basic structures, Current characteristics, SNR calculation and Noise equivalent power, Bit error rate, fiber optic links - power budget, rise-time budget.

Single-wavelength networks

SONET/SDH, FDDI, WDM networks - Broadcast- and-select WDM LAN, Wavelength-routed metro and wide-area networks, passive optical networks for access segment.

Principle and elements of Satellite Communication

Introduction, Frequency spectrum for satellite communication, Types of orbits, Kepler's Laws of planetary motion, Orbital perturbations, Geostationary orbit, Satellite launching, General satellite communication, Block diagram uplink, Downlink frequencies, Types of modulation techniques used

Losses, Attenuation and Satellite Link Budget

Signal loss on transmission through earth's atmosphere, Atmospheric losses, Ionosphere effects, Rain attenuation. Satellite link budget : Transmission losses, Interference, System noise temperature, Link power budget

Satellite sub-systems

Antenna sub-systems, Attitude and orbit control sub-system, Power sub-system, Communication sub-system, TTC&M sub-systems.

Textbooks

1. J. C. Palais, Optical Fiber Communication, Pearson Education, 2022 reprint

2. Pratt, Bostien, Allnut, Satellite Communication, John Willey Publications, 2nd edition, 2013

Reference books

1. G. Kaiser, Optical Fiber Communication, McGraw Hill, - 5th edition, 2013

2. Denish Roddy, Satellite Communication, McGraw Hill, 3rd edition, 2001

INFORMATION THEORY & CODING

Course Code: **EC30019**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

The course will help in forming a strong foundation for the broad areas of information theory, coding and

cryptography. It emphasizes on the basic concepts, lays stress on the fundamental principles and motivates their application to practical problems. This course starts with the basics of information theory and source coding. The theory of linear block codes (including cyclic codes, BCH codes, RS codes), convolution codes are explained. Basics of secure communications including cryptography and physical layer security are covered.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the mathematical definitions of information, using conditional and unconditional probability theorem,
CO 2: Analyze and differentiate several sources of information and coding techniques,
CO 3: Explain and analyze channel coding schemes and Shannon's information theory,
CO 4: Distinguish between various error decoding schemes,
CO 5: Design and simplify different codes such as cyclic codes, CRC codes (cyclic Redundancy Codes) and BCH codes, generate Convolution codes,and
CO 6: Discuss practical applications of coding for secure communication.

COURSE DETAILS

Introduction

Introduction to Information Theory, Entropy, Mutual Information, Conditional and Joint Entropy, Measures for Continuous Random Variable, Relative Entropy

Source Coding

Variable Length Codes, Prefix Codes, Source Coding Theorem, Various source coding techniques: Huffman, Arithmetic, Lempel Ziv, Run Length, Rate Distortion Functions, Entropy rate of Stochastic Proces. Introduction to Image Compression, JPEG Standards.

Channel Capacity & Coding

Channel models, Channel Capacity, Shannon Limit, Channel capacity of MIMO systems,

Error control coding

Linear Block Codes, Hamming Codes, parity chech coding, Cyclic code for burst error correction, BCH Codes and convolutional Codes, Trellies Coded Modulation

Coding for Secure Communication

Introduction to Cryptography, Overview of Encryption Techniques, Symmetric (Secret Key) Cryptography, Data Encryption Standard (DES), Hashing techniques, quantum cryptography, Biometric Cryptography

Textbooks

1. Ranjan Bose, Information Theory, Coding and Cryptography, McGraw Hill, 2nd edition, 2011

2. J. Das, P. K. Chatterjee & S. K. Mullick, Principle of Digital CommunicationNew age Internationals, 2008

Reference Books

1. T. M. Cover & J. A. Thomas, Elements of Information Theory, Wiley-Interscience-2nd edition 2010.

2. J. G. Proakis, Digital Communication, McGraw Hill Education, 4th edition

CONSUMER ELECTRONICS

Course Code: **EC40023**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **EC30014**

COURSE OBJECTIVE

This course discusses about current state of the art of digital consumer devices as per current leading-edge technology. This course broadly covers audio systems, video systems, telecommunication principles, office equipment and domestic appliances to make understand of current digital technology.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Apply DC and AC Technology used in consumer Electronics,
CO 2: Categorize different electrical & electronics components,
CO 3: Apply knowledge for the use of Sensors for acquiring Acoustic and Electromagnetic waveform and their Manipulation,
CO 4: Apply knowledge of Audio and Video System for Consumer Electronics Circuit Design,
CO 5: Analyze the concepts of electronics gadgets and home appliances and their applications,and
CO 6: Create desired Electronics Equipment based on requirement and specifications.

COURSE DETAILS

DC, AC Technology, Components and Circuits, Waveforms:

DC and AC Technology, Electrical and Electronics components(Passive, Active Components) and their Nomenclatures, Testing of Components and Circuits, Fundamental and Harmonic Waveforms, Acoustic and Electromagnetic Waveforms, Wave-shaping

Transducers and Sensors:

Different Transducers/Sensors, properties, application, CRT, Recording and Reproduction System (8)

Audio and Video System:

Audio Systems and standards, Monochrome and Color TV Systems, (13)

Electronics Gadgets and Home Appliances:

Telecommunications Systems, Mobile Radio Systems, Facsimiles, CAR Infotainment, Washing Machines, Microwave Ovens, Air conditioners and Refrigerators, Set-Top boxes(10)

Textbook

1. S. P. Bali, Consumer Electronics, Pearson Education,1st Edition, 2009

Reference Books

1. Amit Dhir, The Digital Consumer Technology Handbook, Elsevier, 1st Edition, 2004
2. Gerald B. Halt, Jr., John C. Donch, Jr., Robert Fesnak, Amber R. Stiles, Intellectual Property in Consumer Electronics, Software and Technology Startups, Springer, 2014.
3. Ian Sinclair and John Dunton, Electronic and Electrical Servicing, Taylor & Francis, 2nd Edition, 2007

FUNDAMENTALS OF DATA ACQUISITION SYSTEMS

Course Code: **EC40025**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **NIL**

COURSE OBJECTIVE

This course offers study of different aspects of data acquisition systems such as data acquisition system hardware, communication bus, design of data acquisition systems, software for data acquisition systems, smart data acquisition system.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain different components of data acquisition systems,
CO 2: Compare different hardware of the data acquisition systems,
CO 3: Examine the communication bus standards,
CO 4: Design the data acquisition systems,
CO 5: Explain the software of the data acquisition systems,and
CO6: Build smart data acquisition systems.

COURSE DETAILS

Introduction

Overview of Data Acquisition Systems, Sensors and Transducers, DAQ Hardware, DAQ Software, Communications Cabling, Parameters of a DAQ System.

Data Acquisition Systems Hardware

Plug-in DAQ Systems, Signal Conditioning, Converters A/D, Converters D/A, Digital Signal Processing, Microprocessor and Microcontrollers, Amplifier, Multiplexer/Demultiplexer, Power Management, Timing System, Filtering, Memory Board, Bus Interface.

Communication Bus

Bus USB and FireWire, Serial Communications, Wireless, Ethernet, and Bluetooth, GSM for Data Acquisition Systems, PCI and PCI Express, Standard VME.

Design of Data Acquisition Systems

Introduction to the Design, Functional Design of High Speed Computer-Based DAS, Portable DAS, Design Guidelines for High-Performance, Multichannel.

Software for Data Acquisition Systems

LabView, Android for DAQ, Design of Firmware, Example of Implementation of a Software for Data Acquisition System via VME Bus.

Smart Data Acquisition System

General Description of MAX1329, Complete DAQ.

Textbooks

1. Maurizio Di Paolo Emilio, Data Acquisition Systems, Springer, 1st, 2013.

Reference Books

1. John Park and Steve Macka, Practical Data Acquisition for Instrumentation and Control Systems, 2003, Newnes.
2. Psumathi, LabVIEW based advanced instrumentation system, 1st edition,2007, springer science Elsevier

EMBEDDED SYSTEMS DESIGN AND APPLICATIONS

Course Code: **EC40027**
Credits: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course covers fundamentals of embedded system hardware and firmware design. Topics such as embedded processor selection, hardware/firmware partitioning, circuit design, circuit layout, circuit debugging, development tools, firmware architecture, firmware design, and firmware debugging will be discussed. The Intel 8051 and PIC18F series microcontroller with instructions will be studied. The course briefly covers ARM processor architecture, instruction set and programming. The course will culminate with a significant design examples using ARM processor.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the architecture, programming, and interface requirements of ARM,
CO 2: Learn to use assemblers, compilers, simulators and emulators to help with design and verification for ARM processors,
CO 3: Interface a microprocessor to displays, memories, different I/O ports,
CO 4: Apply ALP to solve real-time problems like timers, counters, A2D, Motors, etc. using ARM
CO5. : understand RTOS and its functionality for real time application,and
CO 6: Develop closed and open embedded/Linux based systems for ARM processors.

COURSE DETAILS

Overview of Embedded System

Embedded System, Embedded Processor in System, Components of Embedded System, Brief introduction to Embedded software in system, Design Process in Embedded System.

Embedded Hardware: Processor & Memory

Brief overview of 8051 Architecture and real world interfacing, Processor and Memory organization, Parallelism in instruction level, Processor and memory selection.

I/O Types

Serial and Parallel communication Ports, Timer and Counting devices, Watchdog timers, real time clock, Serial bus Communication Protocols- I2C, CAN, and Parallel Communication Protocol-ISA.

Interrupt Service Mechanism

Concept of ISR, different interrupt sources, Interrupt handling Mechanism, Multiple Interrupts, Interrupt Latency and deadline.

Embedded Software Development

Programming concept in ALP (assembly language programming) and High level language-C, Processor directives, functions and macros and other programming elements, Embedded C++ concept only.

Embedded System Design using ARM

PIC: Introduction to PIC Architecture, Memory Mapped programming using Embedded C, Interfacing Programming- ADC, UART, PWM, I2C, SPI

ARM Architectures

Register Organization, ARM Memory Map, CPSR, ARM Data Format and Directives, The Program Counter and Program ROM Space in the ARM, Addressing Modes, RISC Architecture in ARM, The ARM Instruction Set, ARM Organization and Implementation- 3-stage pipeline ARM, 5-stage pipeline in ARM.

ARM Instruction Set and ARM Assembly Language Programming

Data processing instructions, Data transfer instructions, Control flow instructions, Introduction to assembly language programs, Examples of ARM Assembly Language Programming, Interfacing with peripherals- ADC, Data EEPROM, Asynchronous serial port, SPI mode, I2C mode, Interfacing with LCD, ADC, sensors, stepper motor, key board, DAC.

RTOS(Real time operating System)

OS overview, Process, Interrupt and memory management, RTOS overview, Basic Design rule using RTOS, Task scheduling using Priority based scheduling, cyclic scheduling and round robin scheduling.

Case study of different types of Embedded System

Design of Automated Chocolate Vending Machine, Digital Camera.

Textbooks

1. Raj Kamal, Embedded Systems: Architecture, Programming & Design, TMH, 2011
2. ARM Assembly Language:Fundamentals and Techniques by William Hohl
3. Christopher Hinds, CRC Press, 2nd Edition, 2015.

Reference Books

1. Rank Vahid, Embedded System Design : A unified Hardware/Software Introduction, Wiley Student Edition, Wiley, 2002
2. Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, Arm Assembly Language Programming & Architecture: Volume 1, Microdigitaled.com, 2nd Edition, 2016

COMMUNICATION NETWORK FUNDAMENTALS

Course Code: **EC40029**
Credit: **3**
L-T-P : **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE:

The course is designed for non electronics engineers. It will give the student an overview of how internet and cellular communication work. The student can go for detailed study after completion of this course.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend the techniques of analog and digital communication.
CO 2: Analyze the working of data network in different media,
CO 3: Apply the routing protocols used for different configurations,
CO 4: Choose relevant transport and application layer protocols,
CO 5: Comprehend the basics of cellular communication,and
CO 6: Evaluate how the spectrum efficiency increased in different evolution stages of cellular communication.

COURSE DETAILS

Basics of Communication

Introduction to communication system, Amplitude Modulation and Demodulation, Angle Modulation and Demodulation, Noise in Communication Systems, Multiplexing, Digital Modulation and Demodulation Techniques

Data Communication Basics

Introduction, Media, Physical Layer, MAC Protocols, Link Layer Protocols

Data Communication Intermediate

Routing Protocols

Data Communication Advanced

Transport Layer Protocols, Application Layer Protocols

Mobile Communication Basics

Basics of Cellular Communication, Large Scale and Small Scale Fading

Mobile Communication Advanced

WCDMA Basics, LTE Basics, 5G Core and NR

Textbooks

1. B. A. Forouzan, Data Communications and Networking, McGraw-Hill, 4th Edition, 2011.
2. H. Taub, D. L. Schilling, & G. Saha, Principles of Communication Systems, McGraw-Hill, 4th Edition, 2013.

Reference Books

1. Sassan Ahmadi, LTE Advanced, Elsevier, 2014.
2. Eric Dahlman, Stefan Parkvall, Johan Skold, 5G NR The Next Generation Wireless Access Technologies, Elsevier, 2018.

PRINCIPLES OF OPTO-ELECTRONICS

Course Code: **EC40031**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **EC30014**

COURSE OBJECTIVE

This course aims at covering the physics and engineering issues that define the basic semiconductor optoelectronics devices. We start off with the concept of an energy band representation for the electrons and holes in semiconductors and relate the energy of the free electrons to the electrical and optical properties. The behavior of p-n junctions and other barrier potentials in semiconductor structures are analyzed. These junctions are presented as simple instruments that enable electrical injection of electrons with excess potential energy for radiative emission of photons. In reverse, these same junctions cause photo-generated electrons to drift rapidly across the field to generate a photocurrent. Semiconductor optoelectronic devices such as the LED, the laser diode, the photodetector are presented as mere converters of electrical energy to photon energy and vice-versa. Optical modulators are devices for controlling the intensity or phase of an optical beam using an electrical input. The course contains a good mix of the electrical properties and optical properties of semiconductors and the interplay between photons and the free electrons within.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn To know the basics of solid state physics and understand the nature and characteristics of light,
CO 2: Understand different methods of luminescence, display devices and laser types and their applications,
CO 3: Apply the principle of optical detection mechanism in different detection devices,
CO 4: Analyze the different light modulation techniques and the concepts and applications of optical switching,
CO 5: Evaluate the integration process and application of optoelectronic integrated circuits in transmitters and receivers,and
CO 6: Develop critical thinking ability for analysis of Optoelectronic Channel Waveguide Components.

COURSE DETAILS

Elements of Light and Solid State Physics

Wave nature of light, Polarization, Interference, Diffraction, Light Source, review of Quantum Mechanical concept, Review of Solid State Physics, Review of Semiconductor Physics and Semiconductor Junction Device.

Display Devices and Lasers

Introduction, Photo Luminescence, Cathode Luminescence, Electro Luminescence, Injection Luminescence, Injection Luminescence, LED, Plasma Display, Liquid Crystal Displays, Numeric Displays, Laser Emission, Absorption, Radiation, Population Inversion, Optical Feedback, Threshold condition, Laser Modes, Classes of Lasers, Mode Locking, laser applications.

Optical Detection Devices

Photo detector, Thermal detector, Photo Devices, Photo Conductors, Photo diodes, Detector Performance.

Optoelectronic modulators and switches

Introduction, Franz-Keldysh effect, Quantum confined Stark effect in quantum well semiconductors, Analog and Digital Modulation, Electro-optic modulators, Magneto Optic Devices, Acoustoptic devices, Optical, Switching and Logic Devices.

Optoelectronic Integrated Circuits

Introduction, hybrid and Monolithic Integration, Application of Opto-electronic Integrated Circuits, Integrated transmitters and Receivers, Guided wave devices.

Optoelectronic Channel Waveguide Components

Passive waveguide components: The power divider, Wavelength filters/ multiplexers, waveguide reflectors, resonators, the optical time delay line

Textbook

1 J. Wilson and J. Haukes, Optoelectronics, Third Edition, Pearson Education, 2018

Reference Books

1. Pallab Bhattacharya, Semiconductor Optoelectronic Devices, Second Edition, Pearson Education 2017
2. Jasprit Singh, Opto Electronics: An Introduction to materials and devices, McGraw-Hill International Edition, 1998.
3. Emmanuel Rosencher, Borge Vinter and P. G. Piva, Optoelectronics, Cambridge University Press, 2010.
4. William S. C. Chang, Fundamentals of Guided-Wave Optoelectronic Devices, Cambridge University Press, 2010.
5. Kevin F Brennan, The physics of semiconductors-with applications to optoelectronic devices, Cambridge University Press, 1999

PRINCIPLE OF MODERN COMMUNICATION SYSTEMS

Course Code: **EC40033**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **EC30014**

COURSE OBJECTIVE

This is intended to make the students understand the communication system, Principle and working communication system, means and medium of communication. They will able to analyze the Principle and working of different modulation techniques and can differentiate between analog and digital communication. Also they will able to comprehend the Principle and working of Cellular, Satellite and optical fiber communication.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend the basic concept of Communication, means and medium of Communication and Familiar with ―AM‖ and ―FM ―techniques,
CO 2: Comprehend the basic concept of Pulse Modulation techniques,
CO 3: Comprehend and analyze the concept of various Carrier Modulation techniques for digital transmission Like ASK,FSK,PSK and QPSK,
CO 4: Comprehend the basic concept of cellular and mobile Communication,
CO 5: Comprehend the basic concept of Satellite Communication,and
CO 6: Comprehend the basic concept of Optical Fibre Communication.

COURSE DETAILS

Analog Modulation Techniques

Block diagram of electronic communication system. Modulation, need and types of modulation (AM, FM & PM).

Amplitude modulation – representation, modulation index, Various forms of Amplitude Modulation (DSB, SDB/SC/SSB/SC), frequency spectrum, power relations.AM Detectors, Limitations of AM.

Frequency *M*odulation- definition, modulation index, frequency spectrum, bandwidth requirements, frequency deviation and carrier swing. Block diagram of AM and FM transmitter and receivers. Comparison of AM and FM.

Introduction to pulse communication: types- PAM, PWM, PPM, PCM – quantization, advantages and applications

Digital Modulation Techniques

Data Form, Principles involved in ASK, PSK (BPSK, QPSK, $\pi/4$ QPSK), FSK.

Satellite Communication - Introduction, need, geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites. Satellite visibility, transponders (C - Band), path loss, ground station, simplified block diagram of earth station. Uplink and downlink.

Cellular Communication Principle

Cellular Concept System Architecture, Spectrum Allocation, Frequency Reuse, Channel Assignment Strategies, Co-channel Interference & System Capacity, Hand off, Hand off structure, Practical Hand off

consideration, Prioritizing Hand off, Power Control, Near – Far Problem, System capacity, Improvement Techniques: Cell splitting, Sectoring, Micro cell Zone concept.

Optical Fiber Communication

Introduction – need for OFC. Block diagram of OFC system. Fiber optic cables, light propagation through fiber – step index fiber, graded index fiber, Snell's law, numerical aperture (derivation). Types of optical fiber cables, light sources – requirements, LEDs and semiconductor laser diodes. Photo detectors – PN, PIN and avalanche photodiodes. Losses and Dispersion in optical fibers – Rayleigh scattering, absorption, leaky modes, bending, joint junction losses. Advantages and disadvantages of OFC over metallic cables.

Textbook

1. Louis E. Frenzel Jr., Principles of electronic communication systems, Fourth edition, McGraw Hill Education

Reference Books

1. B.P. Lathi, Modern Digital and Analog Communications Systems, Oxford University Press
2. H. Taub & D.L.Schilling, Principles of Communication System, TMH
3. Simon Haykins, Introduction to Analog & Digital Communication System, Edition 2011, John Wiley.

DATA ANALYTICS

Course Code: EM30009
Credit: 3
L-T-P: 3-0-0
Prerequisites: Nil

COURSE OBJECTIVE

Objective of this course is to familiarize students with the concepts of data science, gain knowledge on Big data technologies and tools, become familiar with statistical concepts and apply data analytics techniques.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Make use of data science concepts to handle big data,
CO 2: Examine the statistical concepts for finding relationships among variables and estimate data samplings,

CO 3: Select the data analytics techniques&models for both data prediction and performance analysis,
CO 4: Develop rules using frequent item sets and association mining,
CO 5: Solve real-time problems using classification and clustering techniques,and
CO 6: Apply the mining techniques for data streams.

COURSE DETAILS

Introduction to Data Science

Introduction to data, Data science, Challenges of traditional systems, Evolution of analytic ccalability, Types of computing (Distributed, Parallel, Grid), Data analytics life-cycle, Introduction to Big Data (Characteristics) and Hadoop (Hadoop Ecosystem, MapReduce, Hbase, Pig, Hive, Sqoop, NOSQL), Visualizations

Statistical Concepts

Data exploration: Distribution of a single variable, Basic concepts (populations and samples, Data sets, variables, and observations, types of data), Descriptive measures for categorical variables, Descriptive measures for numerical variables, Outliers and missing values. Finding relationships among variables: Categorical variables, Numerical variables, Sampling and distributions: Terminology, Estimation, Confidence interval estimation, Sampling distributions, Confidence interval, Hypothesis testing, Chi-square test for independence

Data Analytic

Introduction, Types of data analytic, Importance of data analytics, Data analytics applications, Regression modelling techniques: Linear regression, Multi-variable regression, Non linear regression, Logistic regression, Time series analysis, Performance analysis (RMSE, MAPE).

Frequent Item-sets and Association

Introduction to frequent itemsets, Market-basket model, Algorithm for finding frequent, Itemsets, Association rule mining, Apriori algorithm and correlations.

Classification & Clustering

Introduction to classification and clustering, Distance-based algorithms: K-Nearest Neighbour (KNN), Decision Tree-based algorithms: Decision Tree (ID3 Algorithm), Linear Support Vector Machines, Naves Bayes. Overview of clustering techniques, Hierarchical clustering, Partitioning methods, K- means algorithm.

Data Streams

Introduction to mining data streams, Data stream management systems, Data stream mining, Examples of data stream applications, Stream queries, Issues in data stream query, Processing, Sampling in data streams, Filtering streams, Counting distinct elements in a stream, Estimating moments.

Textbook

1. Radha Shankarmani, M.Vijayalaxmi, Data Analytics, Wiley India Private Limited, ISBN: 9788126560639.

Reference Books

1. S. Christian Albright and Wayne L. Winston, Business Analytics: Data Analysis & Decision Making . 6th Edition, Cengage Learning. (ISBN: 9781305947542)
2. Jiawei Han, Micheline Kamber, and Jian Pei, Data Mining: Concepts and Techniques 3rd Edition. Morgan Kaufmann. (ISBN: 9780123814791)
3. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services (Editor), Wiley, 2014
4. DT Editorial Services, Big Data, Black Book, Dreamtech Press, 2015

DATA MINING

Course Code: **EM30011**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **NIL**

COURSE OBJECTIVE

This course is an introductory course on data mining. It introduces the basic concepts, principles,methods, implementation techniques, and applications of data mining, with a focus on two major data mining functions: (1) pattern discovery and (2) cluster analysis.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Articulate the role of data mining in decision-making,
CO 2: Perform data processing and analysis,
CO 3: Recall important pattern discovery concepts, methods, and applications, such as frequent pattern, and association rules,
CO 4: Recall basic concepts, methods, and applications of cluster analysis,
CO 5: Evaluate the output of data mining for decisions and practical application,and
CO 6: Demonstrate the benefits of data mining from business perspective.

COURSE DETAILS

Introduction

What is data mining? Why data mining? Data mining process, Introduction to data mining tasks (Classification, Clustering, Association Analysis,Anomaly Detection).

Data Pre-processing

Understanding of data, Types of attributes, Properties of attribute values, Types of data, Data quality, Sampling, Data normalization, Data cleaning, Similarity measures, Feature selection/Instance selection, Importance of feature selection/ instance selection in various big data scenarios

Classification

Decision-Tree based approach (e.g. C4.5), Rule-based approach (e.g. Ripper), Instance-based classifiers

(e.g. k-Nearest Neighbor). Support Vector Machines (SVMs), Ensemble learning, Classification model Selection and evaluation, Applications: B2B customer buying stage prediction, Recommender systems

Clustering

Partition and hierarchical clustering methods, Graph-based method, Density-based methods, Cluster validation applications: Customer profiling, Market segmentation.

Association Analysis

Apriori algorithm and its extensions, Association pattern evaluation, Sequential patterns and frequent sub-graph mining, Applications: B2B customer buying path analysis, Medical informatics, Telecommunication alarm diagnosis.

Anomaly Detection

Statistical-based and density-based methods, Ethics of data mining, Privacy in data mining

Case Studies

Big data analytics in mobile environments, Fraud detection and prevention with data mining techniques, Big data analytics in business environments

Textbook

1. Han, J., Kamber, M., & Pei, J., Data mining: Concepts and techniques, 3rd ed., Waltham: Morgan Kaufmann

Reference Books

1. Foster Provost and Tom Fawcett, O'REILLY, Data Science for Business, ISBN: 978-1-449-36132-7, 2013
2. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Addison Wesley, ISBN: 0-321-32136-7

CYBERSECURITY

Course Code: **EM40006**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

This course aims to provide a comprehensive introduction and effective defence to distinct challenges like; securing the infrastructure, securing devices, and securing local networks.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand what cybercrime is and appreciate the importance of legal perspective on cybercrime and organizational implications,
CO 2: Explain types of cyberattacks, role of cybercafes and what is cyberstalking,
CO 3: Understand the security challenges in mobile devices, removable medias, and organizational measures needed to protect information systems,
CO 4: Describe tools ans methods used in cybercrime,
CO 5: Learn about phishing-pharming-phoraging and different types of ID thefts,and
CO 6: Understand global and Indian IT Act in cybercrime perspective.

COURSE DETAILS

Introduction of Cybersecurity

Cybercrime, Classifications, Legal perspectives, Ethics of Hacking and Cracking

Cyber offenses

Active and Passive Attacks, Cyberstalking, Botnets, Benefits of Cloud Computing

Vulnerbility

Autthentication Security and Attacks on Mobile Devices, Email Attacks and Browser based vulnerabilities, Server Vulnerability,TCP/IP Vulnerability, Incident handling, Organizational Security Policy

Tools and Methods Used in Cybercrime

Proxy Servers, Phishing, Spoofing, Encryption & Password Cracking, Session Hijacking, Hacking Network Devices, Trojan Horses, Malware in Action

Prevention and Mitigation

Buffer overflow detection and Prevention, Organizational Security Policies, Digital Forensic tools, , Incident Handling

Social, Political, Ethical and Physiological Dimensions

Intellectual property in Cyberspace, Ethical Dimensions, Legal Perspective, Information Technology Act

Textbooks

1. Nina Godbole, Sunit Belapure, Kamlesh Bajaj, Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives Paperback – January 1, 2011, Wiley India

2. Alfred Basta, Cyber Security And Cyber Laws, Cengage Learning India Pvt Ltd

Reference Books

1. Yuri Diogenes and Dr. Erdal Ozkaya, Cybersecurity – Attack and Defense Strategies: Counter modern threats and employ state-of-the-art tools and techniques to protect your organization against cybercriminals.

2. Ashish Mishra, Modern Cybersecurity Strategies for Enterprises: Protect and Secure Your Enterprise Networks, Digital Business Assets, and Endpoint Security with Tested and Proven Methods

BIOINFORMATICS

Course Code: **EM40008**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Bioinformatics is a rapidly evolving interdisciplinary field in which computational resources are necessary to investigate and interpret complex biological data. The students will gain the basic knowledge of sources of sequences and protein structure data, an understanding of the relevance and importance of this data, and some exposure to basic algorithms used for processing this data.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand fundamental concepts and application of Bioinformatics,
CO 2: Have an overview of the most important methods and tools that are used,
CO 3: Understand how some of the basic methods for biological sequence analysis works,
CO 4: Understand the need for methods to be accurate and efficient,
CO 5: Implement some of the algorithms,and
CO 6: Using existing tools to perform simple sequence analyses.

COURSE DETAILS

Introduction to Bioinformatics

Introduction to Bioinformatics; Biological databases: Nucleotide databases, Protein databases, Specialized databases; Laboratory data submission and data retrieval; Various file formats for biomolecular sequences: Genbank, EMBL, FASTA, GCG, msf, nbrf-pir etc.; Basic concepts of sequence similarity: identity and homology, definitions of homologues, orthologues, paralogues; Sequence patterns and profiles

Sequence Alignment and Database Searching

Introduction, Evolutionary Basis of Sequence Alignment, Optimal alignment method, Statistical Significance of Alignment. Database searching Artifacts; Database similarity searching: FASTA, BLAST, Various basic and advance version, Multiple sequence alignment: progressive method and Iterative method; Applications of pairwise and multiple sequence alignment; Tools for multiple sequence alignment: CLUSTALW and Pileup (Algorithmic concepts).

Introduction to Genes and Proteins

Genome Sequences, ORFs, Genes, Introns, Exons, Splice Variants, DNA/RNA Secondary Structure Triplet Coding, Protein Sequences, Protein Structure: Secondary, Tertiary, Quaternary, The notion of Homology. Scoring matrices: Basic concept of a scoring matrix, Similarity and distance matrix, Predictive Method using Nucleotide Sequence: Introduction, Marking repetitive DNA, Database search, Codon bias detection, detecting functional site in DNA.

Phylogenetics

Phylogeny and concepts in molecular evolution; nature of data used in taxonomy and phylogeny; definition and description of Phylogenetic trees and various types of trees; Different methods of Phylogenetic tree construction: UPGMA and Fitch-Margoliash Algorithm; case studies in phylogenetic sequence analysis.

Machine learning for Bioinformatics

Unsupervised learning, K-means clustering, Hierarchical clustering, Heatmap representations. Dimensionality reduction, Principal Component Analysis (PCA). Hands-on session with unsupervised learning analysis of cancer cells further highlighting practical considerations and best practices for the analysis and visualization of high dimensional datasets.

Textbook

1. A. M. Lesk, Introduction to Bioinformatics, Oxford University Press, 2022

Reference Books

1. T. K. Attwood & D. J. Parry-Smith, Introduction to Bioinformatics, Pearson Education Ltd, Low Price Edition, 2001.
2. D.W. Mount, Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, 2001.
3. D. Baxevanis and F. Oulette, Bioinformatics : A practical guide to the analysis of genes and proteins, Wiley Indian Edition, 2002.
4. M.D.B. Bergeron, Bioinformatics Computing, Prentice Hall India (Economy Edition), 2003.

MOBILE AD HOC NETWORKS

Course Code: EC30010
Credits: 3
L-T-P: 3-0-0
Prerequisites: Nil

COURSE OBJECTIVE

Wireless networks play an increasingly important role in the world of communications.This course provides an introduction to operation and developing standards for mobile networks, such as Vehicular Networks, Unmanned Air Vehicles, and Small Satellites, and students will learn to analyze the performance of these cutting-edge networks. Related protocols and their performance are studied using formal analytical tools and realistic simulations.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze and evaluate characteristics, Architecture, features, factors and challenges related to Mobile Ad Hoc Networks (MANET).
CO 2: Compare different Medium Access Control (MAC) protocols in the context of MANET and choose apt MAC protocol based on application requirements and network design specifications.
CO 3: Compare different Routing protocols in the context of MANET and choose apt Routing protocol based on network scenario.
CO 4: Assess issues and challenges for providing Quality of Service (QoS) in Ad Hoc wireless Networks and plan required QoS solutions in MAC and Network layers.
CO 5: Evaluate various Energy Management schemes in Ad Hoc Wireless Networks and would be able to judge the best scheme based on network specifications.
CO 6: Perceive various Ad Hoc Nomadic Mobile Applications to acquire skills required for designing and creating scenario specific Ad Hoc Mobile Applications.

COURSE DETAILS

Introduction

Origin Of Ad Hoc :Packet Radio Networks - Technical Challenges - Architecture of PRNETs - Components of Packet Radios - Introduction to Ad Hoc networks - Definition, characteristics features - Issues in Mobile Ad Hoc networks- Types of Ad Hoc Mobile Communications - Types of Mobile Host Movements - Ad Hoc wireless Internet. Characteristics of Wireless channel Mobility models - Indoor and Outdoor.

Medium Access Protocols

MAC protocols: design issues, goals and classification. Contention based protocols - With reservation, scheduling algorithms, protocols using direction antennas - Distributed packet reservation - Multiple access protocol, collision avoidance time allocation protocol. IEEE standards: 802.11 a, 802.11 b, 802.11g.

Routing Protocols and Multicast Routing in Ad Hoc Networks

Introduction - Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks - Classifications of Routing Protocols Table Driven routing protocols: Destination Sequenced Distance Vector Routing Protocol - Cluster head Gateway switched routing protocol. On Demand routing protocol: Dynamic source routing protocol, AODV routing protocol, temporarily ordered routing algorithm. Hybrid routing protocols: Zone routing protocol, Zone based Hierarchical link state routing protocol. Architecture Model for Multicast Routing Protocols - Classifications of Multicast Routing Protocols - Tree Based Multicast Routing Protocols - Mesh- Based Multicast Routing Protocols - Energy-Efficient Multicasting - Comparisons of Multicast Routing Protocols.

QOS and Energy Management

Issues and Challenges in Providing QoS in Ad Hoc Wireless Networks - Classifications of QoS Solutions - MAC Layer Solutions - Network Layer Solutions. Need for Energy Management in Ad Hoc Wireless Networks
- Classification of Energy Management Schemes - Battery Management Schemes - Transmission Power Management Schemes - System Power Management Schemes.

Ad Hoc Nomadic Mobile Applications

In the Office, While Traveling, Arriving Home, In the Car, Shopping Malls, The Modern battlefield, Car-to-Car Mobile Communications, Mobile Collaborative Applications - Location/context based mobile services - Introduction to wireless mesh networks and vehicular Ad Hoc networks.

Textbook

1. C.Sivaram Murthy and B.S Manoj, Ad Hoc Wireless Networks, Pearson Education, Second Edition India, 2001.

Reference Books

1. K Toh, Ad Hoc mobile wireless networks, Protocols and Systems, Pearson Education, 2nd Edition, 2009.
2. Stefano Basagni, Mobile Ad hoc Networking, Wiley Inter science, IEEE Press, 2004.
3. George Aggelou, Mobile Ad Hoc Networks, McGrawHill, 2004.
4. Thomas Krag and Sebastin Buettrich, Wireless Mesh Networking, OǒReilly Publishers, 2nd Edition, 2007.

INDUSTRIAL INTERNET OF THINGS

Course Code: **EC30021**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

The course is intended to introduce the students, the basics of Industrial Internet of Things, its architecture, protocols, design requirements, and key technologies. The learner will be able to understand the key concepts of industrial data transmission and acquisition. Application of data analytics and machine learning methods provides insights into IIoT data science. Some case studies will help the reader to understand the application of IIoT in various industrial sectors.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze the basic concepts of IIoT and Industry 4.0,
CO 2: Explain key technologies for IIoT and Industry 4.0,
CO 3: Apply the sensors and actuators in industrial applications,
CO 4: Develop industrial data transmission and acquisitions systems,
CO 5: Develop machine learning and data science methods for IIoTs,and
CO 6: Analyze case studies on IIoT use cases in Industries and develop allied methods and applications.

COURSE DETAILS

Introduction
Overview of IoT, architecture, application-based IOT protocols, cloud computing, Big Data IIoT and Industry 4.0, Industry 4.0 Basics, Design requirements, Sustainability, Cybersecurity and Impacts of Industry 4.0, IIoT Basics, Industrial Internet systems, Industrial Sensing, Processes. Business models of IIoT, Reference architecture of IIoT

Industrial Process and Devices: Technical requirements, The industrial process, The CIM pyramid, The I-IoT data flow

Industrial Data Flow and Devices

Technical requirements, The I-IoT data flow in the factory, Controllers. Sensors: Introduction, Characteristics, Categories. Actuators: Introduction, Thermal, Hydraulic, Pneumatic, and Electromechanical Actuators.

Industrial data transmission

Foundation Fieldbus, Profibus, HART, Interbus, Bitbus, CC-Link, Modubus, Batinbus, DigitalSTORM, CAN, DeviceNet, LonWorks, ISA 100.11, LoRa. Acquisition: Distributed control system, PLC, SCADA. Inventory management and quality control

Case Studies

Manufacturing, Automotive, and Mining Industry

Industrial IoT Security

Cyber security vs cyber physical IoT security, Divergence in IT and OT security fundamentals, Industrial threats, Vulnerabilities, and Risk factors. Evolution of cyber-physical attacks. Securing Connectivity and Communications, Distinguishing features of IIoT, Connectivity, Security Assessment of IIoT Connectivity and Protocols.

Textbooks

1. Sudip Misra, Chandana Roy, Anandrup Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0 published , CRC Press, First Edition 2021
2. Giacomo Veneri and Antonio Capasso, Hands-On Industrial Internet of Things, Packet Publishing Ltd.

Reference Books

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things published, Apress 2016
2. Sravani Bhattacharjee, Practical Industrial Internet of Things Security: Packt Publishing 2018

3. D. Pyo, , J. Hwang, , and Y. Yoon, Tech Trends of the 4th Industrial Revolution, Mercury Learning & Information

QUANTUM COMMUNICATION

Course Code: **EC40004**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Nil**

COURSE OBJECTIVE

This course introduces students to basic laws of quantum mechanics and provides an introduction to the revolutionary quantum technologies.This course is about the potential for quantum technologies, a field that promises to revolutionize the way we compute by using the dynamics of quantum mechanics. The boundary between classical and quantum physics, quantization of EM field and its consequences, quantum electromagnetic and atomic physics and their applications in quantum communication, quantum computations and quantum sensing are discussed. The course aims to develop conceptual understanding of quantum phenomena and identifies engineering challenges of various quantum technologies.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify fundamental differences between quantum and classical technologies,
CO 2: Analyze mathematically simple quantum phenomena,
CO 3: Explain quantum signatures in experimental data,
CO 4: Discuss quantum errors and error correction methods,
CO 5: Analyze engineering challenges of quantum technologies,and
CO 6: Discuss methods of fault-tolerant quantum computation.

COURSE DETAILS

Overview of Quantum Technologies

Quantum Engineering, Motivation: Quantum Computing, Quantum Communication, Motivation: Quantum sensing, Fundamentals of Quantum Mechanics

Essential Concepts in Quantum Mechanics

The Birth of quantum mechanics, Postulates of quantum mechanics, Hamiltonian and Schrodinger Equation, Dirac notation, Density operator

Quantum Resources

EM waves: Quantum EM fields, Polarization of optical fields, EM resonators, Single photon detection, E-

field detection, Quantum light.

Atoms: Two-level atom, Introduction to light-atom interactions, Trapping and cooling atoms, Three-level atoms, Rydberg atoms, Trapped ions

Superconducting Devices: Fundamentals of superconductors, Superconducting two-level systems, Superconducting qubits, Superconducting qubits and challenges

Quantum Sensing and Communication

Light interferometry-LIGO, Particle interferometry- Ramsey measurement, Sensing via defects in diamond, Quantum cryptography, Quantum teleportation, Quantum Memory, Entanglement distribution

Quantum Computing

Introduction to classical computing, Introduction to quantum computing, Experimental implementation of quantum computation, Deterministic two-qubit logic gates, Single and two-qubit photonic gates, Superconducting gates, Quantum logic operation using trapped ions, Quantum logic operation using Rydberg atoms, Linear optics quantum computing, Engineering Quantum Systems

Textbook

1. Nielsen, M., & Chuang, I., Quantum Computation and Quantum Information: 10th Anniversary Edition. Cambridge: Cambridge University Press,2010, doi:10.1017/CBO9780511976667;

Reference Books

1. David A. B. Miller, Quantum Mechanics for Scientists and Engineers Illustrated Edition, Advanced Quantum Communications: An Engineering Approach Sandor Imre, Laszlo Gyongyosi, ISBN: 978-1-118-00236-0, December 2012 Wiley-IEEE Press
2. A.M. Zagoskin, Quantum Engineering: Theory and Design of Quantum Coherent Structures, Cambridge, Cambridge University Press, 2011, ISBN 978-0-521-11369-4.

ESSENCE OF BIOMEDICAL SIGNAL PROCESSING

Course Code: **EC40020**
Credit: **3**
L-T-P: **3-0-0**
Pre-requisites: **Nil**

COURSE OBJECTIVE

A biomedical engineer must have a qualitative understanding of the importance of biomedical signal processing. Biomedical signals are essentials of human life and and indicate the functionality of the body organs. The main the goal is to provide the theoretical and practical knowledge required for processing biomedical signals in order to detect anomalies.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the origin and characteristics of biomedical signals
CO 2: Assess the artifact and its removal techniques from biomedical signals
CO 3: Appraise the basic concepts and tools for real time processing of signals.
CO 4: Analyze processing of physiological signals through digital signal processing techniques and to address biomedical problems.
CO 5: Interpret the nature of physical processes and pathological conditions and to evaluate the usefulness of biomedical signal processing in a clinical context.
CO 6: Apply DSP techniques to solve complex problems related to biomedical domain.

COURSE DETAILS

Introduction to Biomedical Signals

Generation of action potential, Origin and waveform characteristics of basic biomedical signals like Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Electroneurogram (ENG), Objectives of biomedical signal analysis, Artifacts, Difficulties in biomedical signal Analysis, Computer-Aided Diagnosis.

Signals & Systems
Data Acquisition: Sampling in time, aliasing, interpolation, and quantization, Fundamentals of Deterministic Signal, Linear Time-invariant systems, Convolution, Transform domain analysis of signals: Discrete Fourier Transform (DFT),, discrete-time Fourier transform (DTFT), the fast Fourier transform (FFT), the spectrogram, correlation, Power spectral density, Noise figure of the systems.

Filter Design And Noise Removal

Sampling and aliasing, spectral analysis, Types of noises. Design parameters for a filter, Linear time-invariant filters: Time domain filters, Synchronized averaging, Moving average filters, Derivative based filters, the overlap-save algorithm, digital filtering of continuous-time signals, Butterworth filters, Notch and comb filters, Chebyshev and elliptic filters, Bilinear transform.

Cardiological Signal Processing

Pre-processing, Event detection, Morphological analysis, Envelope extraction, Feature extraction, Case studies, Removal of artifacts, QRS Detection and classification of ectopic beats in ECG signals, Adaptive filters like LMS adaptive filter, adaptive noise cancellation, Cancellation of 60 Hz interference in ECG, Cancellation of maternal ECG in fetal ECG, Arrhythmia detection.

Neurological Signal Processing

Modeling of EEG Signals. Detection of spikes and spindles, Detection of Alpha, Beta and Gamma Waves. Auto Regressive (A.R.) modeling of seizure EEG. Sleep Stage analysis. Inverse Filtering. Least squares and polynomial modeling.

Textbooks

1. R.M. Rangayyan, Biomedical Signal Analysis, IEEE Press, 2001.
2. A. Oppenheim, R. Schafer, Discrete-Time Signal Processing, Prentice Hall, 2009.

Reference Books

1. E.N Bruce, Biomedical Signal Processing and Signal Modeling, John Wiley & Son's -publication, 2001.
2. M. Kutz, Biomedical Engineering and Design Handbook, Volume I, McGraw Hill, 2009.
3. D.C Reddy, Biomedical Signal Processing, McGraw Hill, 2005.

IMAGING TECHNIQUES

Course Code: **EC40022**
Credit: **3**
L-T-P : **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Imaging Techniques is a comprehensive course that introduces students to the principles and applications of various imaging modalities used in medical, scientific, and industrial settings. The course covers the fundamental concepts and techniques of imaging acquisition. Students will gain knowledge of the physical principles underlying different imaging modalities, their strengths and limitations, and their applications in diverse fields.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Appraise the basics of imaging techniques,
CO 2: Apply the basic principles of medical imaging modalities, including X-ray, computed tomography (CT), magnetic resonance imaging (MRI), ultrasound,
CO 3: Analyze the concepts of optical imaging and its applications,
CO 4: Explain the principles of satellite imaging and its applications,
CO 5: Investigate the knowledge of thermal imaging and its applications,and
CO 6: Discuss the applications of various imaging modalities.

COURSE DETAILS

Introduction to Imaging Techniques

Definition of imaging, Brief overview of different imaging modalities, Basic principles of image acquisition and image formation.

Medical Imaging

X-ray Imaging: Physics of X-ray production, X-ray image acquisition and processing, Applications and limitations of X-ray imaging. Computed Tomography (CT): Principles of CT imaging, CT image acquisition and reconstruction, Applications and limitations of CT imaging. Magnetic Resonance Imaging (MRI): Principles of MRI, MRI image acquisition and processing, Applications and limitations of MRI. Ultrasound Imaging: Physics of ultrasound. Ultrasound image acquisition and processing, Applications and limitations of ultrasound imaging. Applications of medical imaging.

Optical Imaging

Principles of optical imaging, Optical imaging techniques, including microscopy, endoscopy, and fluorescence imaging, Applications and limitations of optical imaging. Applications of optical imaging.

Satellite Imaging

Definition and importance of satellite imaging, Basic principles of electromagnetic radiation and its interaction with Earth's surface, Overview of satellite sensors and platforms. Different types of satellite sensors (optical, thermal, radar, etc.). Satellite orbits and their implications on image acquisition, Image resolution, spatial, spectral, and temporal. Applications of satellite imaging.

Thermal Imaging

Fundamentals of Infrared Thermal Imaging: Infrared radiation, Radiometry and thermal radiation, Emissivity, Optical material properties in IR. Applications of thermal imaging.

Textbooks

1. Paul Suetens, Fundamentals of Medical Imaging, Cambridge University Press; 2nd edition.
2. John R. Jensen, Remote Sensing of the Environment: An Earth Resource Perspective, Pearson Education, India, 2nd edition,2013

Reference Books

1. Michael Vollmer, Klaus-Peter Möllmann, Infrared Thermal Imaging: Fundamentals, Research and Applications, Wiley-VCH; 2nd edition.
2. Craig Scott, Introduction to Optics and Optical Imaging, John Wiley & Sons Inc; 1st edition.

MACHINE LEARNING BASED SIGNAL PROCESSING

Course Code: **EM30007**
Credits: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Traditionally, signal characterization is performed with mathematically driven transforms and statistical tools. On the other hand, machine learning aims to design algorithms that learn from data. This course discusses the use of machine learning techniques to process and understand signals. This course focuses on, firstly to acquaint students with the representation and characterization of speech, images, and other important signals. Thereafter, designing of ML models for classifying and retrieving information from signals is engrossed. Content delivery will be conceptual oriented and not cover mathematical or optimization methods in detail.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Conceptualize the difference between deterministic and stochastic processes
CO 2: Appreciate various spectral analysis methods
CO 3: Comprehend the methods and underlying challenges in extracting hidden information from various signals
CO 4: Explain clustering methods, fuzzy set, rough set and neural network topology.
CO 5: Explain Neural Network topology and learning algorithms.
CO 6: Apply ML methods for speech, seismic, image analysis and other similar applications.

COURSE DETAILS

Introduction to Various Signals
Audio and Speech Signal, Image Acquisition and Storage, Radar, Sonar & Seismic signals, Signal decomposition using Fourier & Wavelet transforms,

Estimation and Detection
Introduction, Bayesian Hypothesis Testing, Maximum Likelihood Hypothesis, Maximum likelihood estimator, Least Square Estimator, Parametric estimation, Wiener Filter, Kalman Filter, Non-paremetric estimation, Filter Bank Methods.

Spectral Analysis Stochastic Processes
Adaptive Spectral Analysis, Multivariate Signal Processing, Independent Component Analysis, Principal Component Analysis, Markov Process, Gaussian Mixture Model, Linear Prediction Analysis.

Machine Learning
Unsupervised Learning: Clustering Principles, K-Means, Expectation Maximization, GMM Clustering
Basics of Fuzzy Logic and Rough Sets,Fuzzy Clustering, Fuzzy Probabilities
Supervised Neural Network and Ensemble Methods: Perceptron, Multi Layer Perceptron, Stochastic Gradient Descent and Backpropagation algorithm, Deep learning, Linear sequential model using Keras, Transfer learning,

Applications
Selected applications of Machine Learning techniques for speech, image and manifold learning of radar and seismic signals.

Textbooks

1. Francesco Camastra, Alessandro Vinciarelli, Machine Learning for Audio, Image and Video Analysis Theory and Applications, 2nd Edition, 2015, Springer
2. Deepika Ghai, Suman Lata Tripathi, Sobhit Saxena, Manash Chanda, Mamoun Alazab, Machine Learning Algorithms for Signal and Image Processing, 2022, Wiley Online, ISBN:9781119861829.

Reference Books

1. Max A. Little, Machine Learning for Signal Processing: Data Science, Algorithms, and Computational Statistics, Oxford University Press
2. Valliappa Lakshmanan, Martin Görner, Ryan Gillard, Practical Machine Learning for Computer Vision, Released July 2021, Publisher(s): O'Reilly Media, Inc., ISBN: 9781098102364

OPTIMIZATION METHODS IN MACHINE LEARNING

Course Code: **EM40010**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course introduces students to the fundamental concepts, techniques, and algorithms in optimization for machine learning. Students will learn how optimization plays a crucial role in the design and analysis of machine learning models. The course will cover a broad range of optimization methods, with a focus on understanding their theoretical properties and practical implementation.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the foundational concepts of optimization and their importance in the context of machine learning, including the role of loss functions, performance metrics, and optimization problems.
CO 2: Analyze and implement a variety of optimization techniques, including gradient descent and its variants, adaptive learning rate methods, second-order optimization methods, and metaheuristic optimization algorithms.
CO 3: Apply regularization techniques to prevent over fitting and improve the generalization performance of machine learning models.
CO 4: Design and implement optimization algorithms for deep learning models, including proper initialization, back propagation, and fine-tuning strategies.
CO 5: Employ model selection and hyperparameters optimization techniques to enhance the performance of machine learning models on real-world tasks.
CO 6: Utilize distributed and parallel optimization algorithms to scale up optimization processes for large-scale machine learning applications.

COURSE DETAILS

Introduction to Optimization and Machine Learning/Deep Learning

Introduction to optimization, Machine learning basics, The role of optimization in machine learning, Loss functions and performance metrics, Deep learning basics, Back propagation algorithm, Initialization techniques, Transfer learning and fine-tuning

Convex and Non Convex Optimization Techniques

Convex sets and functions, Convex optimization problems, First-order and second-order optimality conditions, Introduction to gradient descent ,Batch gradient descent, Stochastic gradient descent (SGD), Mini-batch gradient descent, Momentum and Nesterov accelerated gradient (NAG) , Adagrad, RMSprop, Adam and its variants, Learning rate scheduling, Early stopping, Dropout, Cross-validation techniques, Grid search, Random search, Bayesian optimization

Second-Order Optimization Methods

Newton's method, Quasi-Newton methods (BFGS, L-BFGS), Conjugate gradient method,

Non -Convex Optimization Techniques

Local and global minima, Saddle points and plateaus, Strategies for escaping saddle points,

Constrained Optimization

L1 and L2 regularization, Elastic net regularization, Equality and inequality constraints, Lagrange multipliers, Karush-Kuhn-Tucker (KKT) conditions Sequential quadratic programming (SQP)

Metaheuristic Optimization Algorithms

Genetic algorithms, Simulated annealing, Particle swarm optimization, Ant colony optimization

Multi-objective Optimization

Pareto optimality, Scalarization methods, Evolutionary multi-objective optimization algorithms (NSGA-II, MOEA/D)

Distributed and Parallel Optimization

Data and model parallelism, Synchronous and asynchronous updates, Distributed optimization algorithms (ADMM, Federated Learning)

Textbooks

1. Goodfellow, I., Bengio, Y., & Courville, A. Deep Learning. MIT Press. (Link: https://www.deeplearningbook.org/)
2. Deb, Kalyanmoy. Optimization for engineering design: Algorithms and examples. PHI Learning Pvt. Ltd., 2012.

Reference Books

1. Boyd, S., & Vandenberghe, L. Convex Optimization. Cambridge University Press. (Link: https://web.stanford.edu/~boyd/cvxbook/)
2. K. Deb.- Multi-Objective Optimization Using Evolutionary Algorithms— (Chichester, U.K.: Wiley, 2001
3. Ruder, S. , An Overview of Gradient Descent Optimization Algorithms. arXiv preprint arXiv:1609.04747. (Link: https://arxiv.org/abs/1609.04747)

4. Sra, S., Nowozin, S., & Wright, S. J. (Eds.). Optimization for Machine Learning. MIT Press.
5. Nocedal, J., & Wright, S., Numerical Optimization. Springer Science & Business Media.

PROJECT (MINOR DEGREE)

Course Code: **EC47004**
Credit: **2**
L-T-P: **0-0-4**
Prerequisite: **Courses earmarked for the minor degree**

COURSE OBJECTIVE

Students can opt for a mini project instead of lab work to complete the requirements of minor degrees. The project work is to be aligned with the specialization of minor degrees and allied areas. It can be carried out individually or in a group in consultation with the project supervisor and is to be completed in one semester. Students will demonstrate higher-level learning outcomes and cognitive skills in implementing the project.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Perform a background study on minor degree related technical aspect and formulate a project objective

CO 2: Outline a pathway for the implementation of the project within the time line

CO 3: Apply fundamental engineering concepts, knowledge of minor degree courses, use modern engineering tools, perform experiments and/or critically analyze the outcomes.

CO 4: Provide engineering solutions, design system components or processes with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

CO 5: Demonstrate self learning skill and innovation in critical thinking.

CO 6: Communicate effectively with a range of audiences and prepare technical reports.

KINEMATICS AND DYNAMICS OF MACHINERY

Course Code: **ME30050**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course consists of basically two parts viz. kinematics and dynamics to assimilate the concept of synthesis and analysis of the most commonly used mechanisms. It starts with basic concepts of mechanisms and kinematic inversions, their velocity and acceleration analysis. The mechanism behind working of flywheels and governors is also included. The dynamic part consists of free and force vibration analysis followed by rotating and reciprocating balancing, Primary and Secondary balance of single and multi cylinder engines. Is also consists of different cam profiles and follower motion. The course ends with description of gear and gear trains.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know the basic kinematics of mechanisms and their inversions,
CO 2: Understand the working principle of working principle of gear drives, governors and flywheels,
CO 3: Apply proper cams profiles for required follower motion,
CO 4: Analyze the degrees-of-freedom (mobility), types of links and joints within mechanisms,
CO 5: Evaluate the parameters for balancing of rotating and reciprocating machines, and
CO 6: Design flexible and rigid mechanical components to transmit power and to design and prescribe necessary components/systems to reduce effects of vibrations.

COURSE DETAILS

Introduction to Mechanisms
Definition, Kinematic pairs, Classification of kinematic chains, Degrees of freedom, Grashof's law, Grubler's criterion for plane mechanism. Kinematic inversions, Equivalent linkages.

Kinematic Analysis of Planar Mechanisms
Mobility analysis and range of movement, Grashof criterion and inversions, Displacement analysis, Relative instantaneous centers, Aronhold-Kennedy theorem, Velocity and acceleration analysis.

Kinematic Inversions
Inversion of four bar chain, Inversion of slider crank chain, Inversion of double slider chain, Quick return mechanism.

Design of Flywheel and Governors
Inertia forces and their balancing for rotating and reciprocating machines.

Dynamics of Machines
Free and forced vibration analysis of single and two degrees of freedom systems, Balancing of inertia forces, Balancing of rotors, Balancing of in-line internal combustion engines.

Cam and Gear
Synthesis of translating flat-face, Translating roller and oscillating roller follower cams, Fundamental law of gearing, Characteristics of involutive action, Analysis of gear trains.

Textbooks

1. Rattan, S. S. (2014). Theory of machines. Tata McGraw-Hill Education.
2. Ambekar, A. G. (2007). Mechanism and machine theory. PHI Learning Pvt. Ltd.

Reference Books

1. Norton, R. L. (2009). Kinematics and dynamics of machiner
2. Uicker, J. J., Pennock, G. R., Shigley, J. E., & Mccarthy, J. M. (2003). Theory of machines and mechanisms (Vol. 768). New York: Oxford University Press.
3. Ghosh, A., & Mallik A. K. Theory of Mechanisms and Machines. East West Press.

MATERIAL SCIENCE AND ENGINEERING

Course Code: **ME20005**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Material Science and Engineering is a specialized course on the extension of physics and chemistry to solve real life engineering problems in nanotechnology, biotechnology and manufacturing. The objective of the course is to understand the structure of materials, metals in particular and its co-relation with its mechanical, thermal, optical and magnetic properties. In addition, the course will also cover the phase diagram, phase transformation and heat treatment of steel. Application of materials science and engineering in to various functional materials will be covered with the help of case studies.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand and identify the structure and defects of materials,
CO 2: Comprehend the concepts of various properties of materials,
CO 3: Analyze and construe the concept of phase and phase diagram in materials,
CO 4: Correlate the application of heat treatment with phase transformation in materials,
CO 5: Evaluate properties of materials with respect to microstructure and phases present, and
CO 6: Create solutions for various engineering problems.

COURSE DETAILS

Introduction and structure of materials
Classification of engineering materials, Structure of atoms - Atomic bonding in solids, Binding energy, Interatomic spacing, single crystals, Polycrystalline, Non-crystalline solids; Imperfection in solids – Vacancies, interstitials, Schottky, Frenkel defects, Edge, and screw dislocations, Surface imperfection, Volume imperfections, Importance of defects, Strengthening mechanisms, Microscopic techniques - Grain size determination, and Distribution.

Properties of Materials
Mechanical properties - Stress, Strain, Elastic properties, Plastic deformation, and Yield criteria, Fundamentals of hot, and Cold working processes, Hardness, Creep, Fatigue, Fracture, and Failure of materials, Concepts in electronic, Magnetic, and Optical properties of materials.

Phase diagrams
Gibbs phase rule, Single component systems, Binary systems, Eutectic, and Peritectic reactions, Lever rule, Application of phase diagram in iron-carbon system.

Phase Transformation in materials
Driving force, Homogeneous, and Heterogeneous nucleation, Growth kinetics, Solidification in isomorphous, Eutectic and peritectic systems, Cast structures, and Macrosegregation, Dendritic solidification, and Constitutional supercooling, Coring, and Microsegregation.

Processing of Materials
Principles of heat treatment in steel: Isothemal transformation of austenite - CCT and TTT curves, Surface hardening treatments, Annealing, Normalizing, Hardening, Tempering, Martempering, Recovery, Recrystallization, and Grain growth, Heat treatment of cast iron, and Aluminium alloys.

Testing and Application
Destructive, and Non-destructive testing of materials, Case studies on nanomaterials, Biomaterials, Smart materials, Energy materials, Other functional materials (Superalloys, Technical ceramics, etc.), Environmental effect on materials.

Textbooks

1. Callister, W. D., & Rethwisch, D. G. (2007). Materials science and engineering: an introduction (Vol. 7, pp. 665-715). New York: John wiley & sons.
2. Smith, W. F., Hashemi, J., & Prakash, R. (2019). Materials Science and Engineering, McGraw Hill.

Reference Books

1. Raghavan, V. (2015). Materials Science and Engineering: A first course. PHI Learning Pvt. Ltd.
2. Higgins, R. A. (1993). Engineering Metallurgy, Part I: Applied Physical Metallurgy. Chapter IV, 67.
3. NPTEL Introduction to Materials Science and Engineering, IIT Delhi by Prof. Rajesh Prasad https://nptel.ac.in/courses/113102080
4. MIT Open coursewares <https://ocw.mit.edu/courses/materials-science-and-engineering/>

SUPPLY CHAIN MANAGEMENT

Course Code: ME30016

Credit: 3
L-T-P: 3-0-0
Prerequisite: ME30005

COURSE OBJECTIVE

Supply chain management involves the integration of business processes across organizations, from material sources and suppliers through manufacturing and processing to the final customer. The course provides students with the core knowledge related to a wide variety of supply chain activities, including demand planning, manufacturing planning and control, purchasing, transportation management, warehouse management, inventory control, material handling, product and service support, information technology, and strategic supply chain management.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Describe the fundamental supply chain management concepts,
CO 2: Understand and use fundamental models to make trade-offs between forecasting, inventory, and transportation,
CO 3: Apply core methodologies (probability, statistics, optimization) used in supply chain modeling and analysis,
CO 4: Analyze and improve supply chain processes,
CO 5: Evaluate and manage an effective supply chain, and
CO 6: Design a logistic problem related to transportation and warehousing..

COURSE DETAILS

Understanding the Supply Chain and Strategy
Introduction, Decision phases in supply chain, Process view of supply chain, Supply chain flows. Drivers & Obstacles of Supply Chain Performance, Supply chain performance: Strategic fit and scope.

Supply Chain Drivers and Designing the distribution network
Introduction, Supply chain drivers, Obstacles to Achieving Strategic fit, Role of distribution, Factors influencing distribution, Design option for distribution. Network design in the SC, Factors influencing network design.

Transportation and Sourcing in the supply chain
Introduction, Factors affecting transportation decisions, Modes of transportation and their performance, Sourcing decision in SC, Supplier selection, Supplier assessment. Coordination in the SC, Lack of coordination and the bullwhip effect.

Pricing and Information Technology in supply chain
Introduction, Pricing and revenue management in the SC, Supply chain information system, E-business and supply chain, Warehouse design, Supply chain modelling towards digitisation; case study.
Role of inventory in supply chain. Different analysis of inventory, Different stock limits of inventory, Different models used inventory, Material requirement planning.

Textbooks

1. Chopra, Sunil & Meindl, Peter. Supply Chain Management: Strategy, Planning, and Operation. PHI.
2. David, Semchi-Levi & Philip, Kaminsy. Designing and Managing the Supply Chain. TMH.

Reference Books

1. Saha, Janat. Supply Chain Management: Text and Cases. Pearson Education.
2. Christoper, Martin. Logistics and Supply Chain Management. Pearson Education.

INTRODUCTION TO FLUID MECHANICS AND HEAT TRANSFER

Course Code: **ME30052**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course provides the fundamental knowledge about fluid flow and heat transfer phenomena. Particularly, it gives a root level approach to the problems related to kinematics and dynamics of fluid flow. The mechanism of fluid flow through Pitot tube, venturi meter and orifice meter are discussed with their practical applications. It also includes the conduction, convection and radiation heat transfer along with detail phenomena of boundary layer. The fundamental equations of conduction and convection in Cartesian and polar coordinates are discussed. The deep knowledge of this subject will be helpful for analysing the fluid flow as well as heat transfer problems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Recall the concept of fluid flow and heat transfer phenomena.,
CO 2: Express the mathematical formulation of a physical problem related to fluid flow and heat transfer,
CO 3: Apply the fundamentals to cooling or heating of different equipment based on its various applications,
CO 4: Analyse the different areas of thermo fluid applications,
CO 5: Evaluate the different heat transfer systems in terms of cost, compactness, and impact on the environment with a view to establish a healthy working condition, and
CO 6: Design the heat transfer system using different modes of heat transfer..

COURSE DETAILS

Introduction
Properties of fluids, Types of fluids, Types of fluid flow, Modes of heat transfer, Laws of heat transfer.

Kinematics of Fluid Flow
Streamlines, Path line & streak lines, Stream tube, Types of fluid flow, Continuity equation of motion in three-dimensions, Local and convective acceleration, Velocity potential function and stream function, Vorticity and circulation, Vortex flow, Equation of forced vortex flow, and Free vortex.

Dynamics of Fluid Flow
Euler's equation of motion, Bernoulli's equation from Euler's equation, Practical applications of Bernoulli's equation-Venturimeter, Orficemeter, Pitot tube.

Conduction Heat Transfer
Derivation of the general 3-dimensional heat conduction equation with variable thermal conductivity and internal heat generation in Cartesian coordinates, Transformation of the conduction equation into polar cylindrical and polar spherical coordinates, Different types of boundary conditions encountered in heat conduction, Solution of the one dimensional steady state heat conduction equation with constant thermal conductivity and without heat generation in Cartesian, Cylindrical and Spherical coordinates, Extension of

the solution to composite walls/cylinders/spheres by electrical analogy, Effect of variable thermal conductivity, Introduction to numerical solution of the heat conduction equation.

Convection Heat Transfer
Conservation equations for mass, Momentum and Energy for two dimensional steady state flow in Cartesian, Cylindrical and spherical coordinates, and Non dimensionalization of the conservation equations.

Boundary Layer
Hydrodynamic and thermal boundary layer concepts, Boundary layer growth over a flat plate, Boundary layer thickness, displacement thickness, Momentum thickness, and energy thickness, Laminar and Turbulent boundary layer, Boundary layer equations, Momentum integral and Energy integral equations for boundary layer flow over a flat plate. Solution of the integral equations to derive expressions for drag and heat transfer coefficients. Average values of drag and heat transfer coefficients. Experimental correlations for forced and free convection for various geometries.

Radiation Heat Transfer
Radiation properties, Emissive power and Emissivity, Kirchoff's identity. Planck's relation for monochromatic emissive power of a black body, Stefan-Boltzman law and Wein's displacement law, Radiation shape factor, Relation for shape factor, and Shape factor algebra.

Textbooks

1. Cimbala, J. M., & Cengel, Y. A. (2006). Fluid mechanics: fundamentals and applications. McGraw-Hill Higher Education.
2. Rajput, R. K. (2015). A textbook of heat and mass transfer. S. Chand Publishing.

Reference Books

1. Nag, P. K. (2011). Heat and mass transfer. McGraw-Hill Higher Education.
2. Holman, J. P. Heat transfer. McGraw-Hill Higher Education.
3. Cengel, Y. A. & Ghajar A. J. Heat and mat: Fundamentals and Applications. McGraw-Hill Higher Education.
4. Pati, S. Fluid mechanics and hydraulic machines, McGraw-Hill Higher Education.
5. Som, S. K., Biswas, G., Chakraborty, S. Introduction to fluid mechanics and fluid machines, McGraw-Hill Higher Education.

RENEWABLE ENERGY SOURCES

Course Code: **ME30054**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is intended to cover various prospects and needs of alternative and renewable energy sources in view of the present world energy scenarios. The in-depth discussions have been made on the energy conversion technologies for the various renewable energy sources like- wind, solar (both thermal and PV), biomass, geothermal, tidal, ocean, and wave energy. An overview of the operating plants, utilizing renewable energy sources, across the globe is presented at an introductory level. Thus, students will get an

inside view of this course concerning the teething troubles like the imbalance of fossil fuels demand and supply, and global warming, etc.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: List the characteristics of the alternative and renewable energy sources and underline their need in present energy scenario.,
CO 2: Explain various aspects of the technologies developed for utilizing the renewable energy sources,
CO 3: Apply the basic principles for converting the renewable energy sources into electricity,
CO 4: Analyze the existing renewable energy technologies and their merits and demerits,
CO 5: Assess the performance of the various existing technologies to convert the renewable energy sources to useful energy, and
CO 6: Design a suitable non conventional energy conversion technique for a conventional application.

COURSE DETAILS

Introduction of Renewable Energy
Need for renewable energy sources. Availability, Properties and Different engineering applications of renewable fuels like solar, wind, tidal, biomass, ocean, geothermal, etc. The merits and demerits of various renewable energy sources.

Solar Power Generation
Solar Radiation Measurement, Estimation of Solar Radiation, Solar Thermal Process, Heat Transfer Devices, Solar Energy Storage: Stratified Storage, Well Mixed Storage, Comparison, Hot water System, Practical Consideration, Solar Ponds, Non-convective Solar Ponds, Extraction of Thermal Energy and application of Solar Ponds.

Bio Power Generation
Bio-energy past and present, Biomass as a solar energy store, Biomass as a fuel, Primary biomass energy sources, Plant materials, Secondary biomass sources, Wastes, Residues and Co-products, Physical processing of biomass, Thermo chemical processing, Biochemical processing, Vegetable oils and biodiesel, Environmental benefits and Impacts, Economics, Future prospects for bio-energy.

Wind Power Generation
Energy and power in the wind, Characteristics of wind, Wind turbines (types, horizontal and vertical axis wind turbines), Linear momentum and Basic theory. Aerodynamics of wind turbines, Power generation by a turbine, Electricity generation, Environmental impact, Economics of energy generation, Commercial development and Wind energy potential, Offshore wind energy.

Tidal and Wave Power Generation
Nature of tidal sources, Physics of tidal energy, Power generation from barrages, Economics of tidal barrages, Tidal lagoons, Tidal streams/currents. Physical principles of wave energy, Wave energy sources, Wave energy technology, Integration (wave energy for isolated communities and large electricity grids).

Geothermal Power Generation
Origin and types of geothermal energy and utilization, The mining of geothermal heat, Source of heat, Physics of geothermal resources, Technologies for exploiting high enthalpy stream fields, Technologies for direct use of geothermal energy, Harnessing geothermal resources, Environmental implications, Economics and World potential.

Textbooks

1. Boyle, G. (2012). Renewable energy: power for a sustainable future. Oxford University Press.
2. Sukhatme, S. P. (1990). Solar energy principle of thermal collection and storage. McGraw-Hill Higher Education.

Reference Books

1. Mangal, V. S. (1992). Solar engineering. McGraw-Hill Higher Education.
2. Bansal, N. K. (1989). Renewable energy source and conversion technology. McGraw-Hill Higher Education.
3. Johnson, G. L. Wind energy systems. Prentice Hall Inc, New Jersey.
4. Bansal, N. K. (2014). Non-conventional energy resources, Vikas Publishing House Pvt. Ltd.
5. Rai, G. D. Non-conventional energy sources. Khanna Publishers, Fourth Edition.

FINITE ELEMENT METHOD FOR ENGINEERS

Course Code: **ME30056**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This subject provides the basic and advance knowledge of the finite element method and its application to solve the various one, two, and three-dimensional engineering problems like a beam, rod, heat conduction, triangular nodes, etc. Furthermore, the governing differential equation methods like Rayleigh-Ritz and Galerkin Methods will be briefly discussed and implemented as a solution to the given problems. The last module of the course examines the various FEM commercial softwares and its use to formulate complicated structural and solid mechanics problems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Describe the fundamental theory of the FEA method,
CO 2: Understand the governing FE equations for systems governed by partial differential equations,
CO 3: Apply the FE method for selected heat transfer problem,
CO 4: Construct the finite element models for structural applications like truss and beam,
CO 5: Formulate with Rayleigh-Ritz and Galerkin Method, and
CO 6: Develop the application of the FE method to solve various engineering problems.

COURSE DETAILS

Introduction to FEM
Introduction, Basic concepts of FEM, Comparison of Finite Element and Exact solutions, Applications of FEM.

Direct Formulation

Axial rod problem, Beam problem, Heat conduction problem, Electrical circuit problem.

Basic Procedure
General procedure of FEM, Elements and shape functions, Co-ordinate transformations: Global coordinates and natural coordinates.

Types of Elements
One dimensional linear element, One dimensional quadratic element, Two-dimensional linear triangular elements (CST: Constant Strain Triangle), Isoparametric elements, Three dimensional elements.

Finite Element Formulation
Derivation of Finite Element equations using Rayleigh-Ritz and Galerkin Method. Rayleigh-Ritz method for one dimensional structural (bar) problem, Stiffness matrix and load vector for one dimensional structural problems, Galerkin method for one dimensional heat conduction problem, Conductivity matrix and heat rate vector for one dimensional heat conduction problems.

Assembly of Element Matrices and Treatment of Boundary Conditions
Assemblage of element equations, Treatment of boundary conditions.

Application to Engineering Problems
Application to structural bar problems, Truss problems, Heat conduction problems with various boundary conditions, Electrical, and Magnetic field problems.

Textbook

1. Chandrupatla, T. R. & Belegundu, A. D. (2015). Introduction to finite elements in engineering, Pearson, 4th Edition.

Reference Books

1. Roland, W. L., Nithiarasu, P. &. Seetharamu, K. N. (2004). Fundamentals of the finite element method for heat and fluid flow, Wiley; 1st edition.
2. Hutton, D. V. Fundamentals of finite element analysis. McGraw-Hill Higher Education.

INTRODUCTION TO COMPOSITE MATERIALS

Course Code: **ME30058**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course focuses on the comprehensive study of different types of composite materials, fabrication of polymer and metal matrix composites, characterization of composite materials, secondary processes involved in joining composite material and industrial application of composites. Knowledge of the course will help the students to identify right composite material and its fabrication process for industrial application. At the end of the course the students will be able to cope up with industrial problems related to analysis and fabrication of composite materials through extensive and systematic research.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the science and technology behind the composite materials,
CO 2: Understand various types of fabrication processes,
CO 3: Apply the properties of the composites material in the context of strength, fracture and safety in view of its structural application,
CO 4: Analyse the fracture behaviour of composite materials,
CO 5: Appraise the industrial application of composites, and
CO 6: Design the secondary processes for the joining of composite materials.

COURSE DETAILS

Introduction

Definition of composite material, Classification based on matrix and topology, Constituents of composites, Interfaces and Interphases, Distribution of constituents, Nano composites

Performance of Structural Composites

Combination effects (Summation, Complementation and Interaction), Basic analytical concepts (Qualitative black box approach and Quantitative analytical approach), Performance analysis by various models (Law of Mixtures, Shear lag model, Laminated plate model, Eshelby's models and Other models, - thermoelasticity, plasticity and creep), Strengthening mechanisms, Stress distribution in fibre and the matrix (shear stress and axial tensile stress in the fibre along its length), Critical length of fibre for full strengthening, Analysis of uniaxial tensile stress-strain curve of unidirectional continuous and short fibre composites, Estimation of the required minimum amount of fibre and critical amount of fibre to gain a composite strength, Analysis of strength of a composite during loading at an angle to the fibres, Nano-structured composites.

Performance of Composite in Non-structural Applications

Composites in Electrical, Superconducting and Magnetic Applications, Nano-composite devices.

Fabrication Composites

Fabrication of Metal Matrix Composites, Commonly used Matrices, Basic Requirements in Selection of constituents, solidification processing of composites - XD process, Spray processes - Osprey Process, Rapid solidification processing, Dispersion Processes - Stir-casting & Compocasting, Screw extrusion, Liquidmetal impregnation technique - Squeeze casting, Pressure infiltration, Lanxide process), Principle of molten alloy infiltration, rheological behaviour of meltparticle slurry, Synthesis of In situ Composites, Fabrication of composite.

Polymer Matrix Composites

Commonly used Matrices Basic Requirements in selection of Constituents, Moulding method, Low pressure closed moulding, pultrusion.
Filament winding, Fabrication of ceramic matrix composites - Various techniques of vapour deposition, Liquid phase method and Hot pressing etc., and Fabrication of nano-composites.

Characterisation Composites

Control of particle/fibre and porosity content, particle/fibre distribution, Interfacial Reaction of matrix-reinforcing component, Coating of reinforcing component, Strength analysis.

Secondary Processing and Joining of Composite

Forging and extrusion of composites – Critical issues, Dynamic recovery and Dynamic recrystallization, Mechanical properties, Induction Heating, Fusion Bonding, Ultrasonic welding, Gas tungsten arc welding, Gas metal arc welding, Resistance spot & seam welding, Resistance brazing, Resistance spot joining, Resistant spot brazing, Resistance welding of thermoplastic graphite composite, Weld bonding, Brazing of MMC.

Industrial Application of Composite Materials

Civil constructions of structures/pannels, Aerospace industries, Automobile and other surface transport industries, Packaging industries, House hold, and Sports components etc.

Fracture behaviour of composites, Mechanics and Weakest link statistics, Griffith theory of brittle fracture and modification for structural materials, Basic fracture mechanics of composite (Fracture toughness, COD and J-integral approaches, Fatigue crack.

Fracture & Safety of Composite

Textbooks

1. Chawala, K.K. (1987) Composite materials. 2nd ed., Springer-Verlag, New York.
2. Vasiliev, V.V. and Morozov, E.V. (2001). Mechanics and analysis of composite materials. Elsevier Science Ltd, Oxford.

Reference Books

1. Ajayan, P. M., Schadler, L. S., Braun, P. V. (2003). Nanocomposite science and technology. Wiley-VCH Weinheim.
2. Chawala, K.K. (1993). Ceramic matrix composites. Chapman & Hall, London.
3. Piatti, G. Advances in composite materials. Applied Science Publishers Ltd., London.

ENGINEERING METROLOGY

Course Code: **ME40061**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to let the students understand the concept of metrology, the various aspects and factors of metrology. It also highlights the concept of inspection and the errors like systematic and random errors. The course also describes the various types of fits and tolerances in machine parts. Different measuring tools and comparators are cored in this course. Measurements like, force, torque, strain, pressure, temperature, surface roughness, etc are being measured using various instruments. Modern measuring techniques such as Transmission Electron Microscopy (TEM), Scanning Electron Microscopy

(SEM), Atomic Force Microscopy (AFM), X-ray Diffraction Systems (XRD) are also covered in this course.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: understand the different measurement techniques,
CO 2: understand the fundamental knowledge of various Metrology techniques,
CO 3: evaluate the tolerance and types of fits in various machine components,
CO 4: apply suitable metrological methods for measuring various entities,
CO 5: analyze the results from the various metrological methods, and
CO 6: design the procedures for getting the final results.

COURSE DETAILS

Metrology
Definition, Needs of inspection, principle and methods of measurements, Sources of error, and Precision and accuracy.

Standards of measurement.
Line, End and Wave length standards.

Limits, Fits and Tolerances
Basic concepts of limit fits and tolerance, Interchangeability and selective assembly, ISO system of tolerance, Fundamental deviation, Hole & Shaft basis systems, Limit gauges, Taylor's principle of limit gauge design, and Basic Gauge design rules for plug and ring gauges.

Simple measurement tools
Rules, Callipers, Height gauges, Micrometers, Depth gauge, Dial indicator, Slip gauges, Sine bar, Auto-collimator: Principle, construction and application, and Coordinate measuring machine (CMM) - an introduction.

Screw Thread Measurement
Standard thread profiles, Errors in threads and pitch errors, Measurement of effective diameter by 2-wires and 3-wires methods, and Best wire size.

Surface Roughness
Elements of surface texture, Order of surface irregularity, Evaluation of surface finish, Measurement of surface roughness using Tomlinson surface meter and Taylor Hobson's Talysurf, Measurement of straightness, flatness, parallelism, squareness, and roundness (circularity) testing.

Comparators
Needs of comparator, Basic principle, use, classification and characteristics of comparators, Types of mechanical comparators, and Pneumatic comparator and its sensitivity.

Measurement of Force, Torque and Strain
Direct methods of force measurement, Elastic members: Load cells, Cantilever beams, Proving rings, Differential transformers, Torsion bar dynamometer, Servo controlled dynamometer, Absorption dynamometer, Mechanical strain gages, Theory of strain gage, Gage factor, Methods of strain measurements, and Strain gauge bridge arrangement.

Measurement of Temperature and Pressure
Methods of measuring temperature, Thermocouples, Law of thermocouples, Thermistor, Pyrometry, IR Thermography, Methods of pressure measurement, Static pressure measurement, Elastic pressure transducers, Dead weight pressure gauges, Measurement of vacuum, and Measurement of high pressure.

Textbooks

1. Jain R. K., Engineering Metrology, Khanna Publication
2. Beckwith T.G. and Buck M. Lewis, Mechanical Measurements, Oxford & IBH Publishing

Reference Books

1. Sirohi R. S., Radha Krishna H. C. (1991), Mechanical Measurements, New Age International.
2. Sawhney A.K., Sawhney Puneet, A course in Mechanical Measurements and Instrumentation, Dhanpat Rai & Co.

INDUSTRIAL ENGINEERING AND OPERATIONS RESEARCH

Course Code: **ME30005**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course focuses on the understanding of various aspects related to production planning and control which are inevitable for the effective and efficient production of goods and services. Moreover, this course emphasizes on the learning of some of the optimization techniques and their applications, especially linear programming. These techniques are used for decision making and finding the best solution for a given problem.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Describe the forecast of demand, and prepare the aggregate production plan and material requirement plan,
CO 2: Classify the different inventory control problems and calculate the economic order quantity,
CO 3: Solve the different quality control problems using X bar, R, C and P control charts,
CO 4: Analyse the linear programming problems and solve by using simplex method,
CO 5: Evaluate the optimum solution of assignment and transportation problem, and
CO 6: Design the network diagram and calculate the duration of project completion.

COURSE DETAILS

Introduction
Introduction to Industrial Engineering and Operations Research, Types of Production processes (Project, Job, Batch, Mass/Line, Continuous, Introduction to Production Planning & Control (PPC) and its functions, and Lean Manufacturing

Production Planning
Factors influencing facility location, Gravity location problem, Classification of plant layout, Line balancing using rank positional weighted method (RPWM), Forecasting methods: Moving average (Simple and Weighted), Single Exponential smoothing, Linear regression, Aggregate Production Planning (APP), Material Requirement Planning (MRP), Single machine scheduling, Flow shop scheduling using Johnson's algorithm

Inventory and Quality control
Inventory costs, Basic EOQ Model without shortages, Model with Quantity discount without shortages, Manufacturing model without shortages, P and Q system of inventory, safety stock, and reorder level, Quality definitions, Quality characteristics for a product, Statistical process control using X Bar, R Chart, p, and c chart, and Introduction to acceptance sampling.

Linear programming
Formulation of linear programming problem (LPP), Solution using graphical and simplex method, and Introduction to duality.

Assignment and Transportation problems
Feasible solution of transportation problems using Least cost method, North-West corner rule and penalty cost method, VAM, Optimum solution of transportation problems using MODI method, Optimum solution of assignment problems using Hungarian method, and
Queing Model

Project Scheduling
Network construction, Critical path method (CPM): Determination of critical path and slack of an activity, program evaluation and review committee (PERT): Determination of the expected duration of a project, and Crashing and Updating.

Textbooks

1. R. Paneerselvam, Production and Operation Management, PHI
2. H. A. Taha, Operations Research – An Introduction, Pearson

Reference Books

1. A.K. Garg, Production and Operations Management, TMH.
2. Hillier et al., Introduction to Operations Research, TMH.
3.Gupta and Hira, Operations Research, S. Chand.
4.M.T. Telsang, Industrial Engineering and Production Management, S. Chand.

MANUFACTURING PROCESSES

Course Code: **ME40077**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course will offer a detailed understanding of manufacturing processes used in industry such as casting, forming, welding and various conventional and non-convention machining processes. Knowledge of the

course will help the students to relate the design requirements of a part to the possible manufacturing processes. Successful completion of the course will also provide the student with the benefits, limitations, and applications of different conventional and non-conventional machine tools and engineering materials for product manufacturing. The overall aim is to establish the technical knowledge for selection and planning of manufacturing processes and systems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Describe the appropriate casting processes for manufacturing industrial products,
CO 2: Understand the forging, extrusion process for various components and its application,
CO 3: Apply the suitable rolling process and sheet metal for different material and product,
CO 4: Analyze the principle of various welding processes and its application,
CO 5: Evaluate different non- traditional machining processes for up growing high strength materials,and
CO 6: Develop the strategy to use various conventional machine tools and its related accessories.

COURSE DETAILS

Foundry Process
Pattern making, Pattern materials, Allowances, types of pattern, Sand casting types, Sand cast, moulding Procedure, types of sand, Gates and Riser (basic design considerations) essential properties of moulding sand, Core making, types of cores. Essential qualities, Core mixtures and Binder sand testing, Precision investment casting, shell moulds, Centrifugal casting processes, and Dies casting.

Metal Working Process
Hot and cold working of Metals: Basic Principles of hot and cold working of metals, Types of Rolling, Rolling equipment hot and cold rolling, Smith forging, Drop forging, Press forging & Machine forging, Direct, Indirect and Impact extrusion and their applications, Wire and Rod drawing, Tube drawing, Process variables in drawing process. Deep drawing. Blanking, and piercing.

Fabrication Processes
Classification, Types of welding joints, Gas welding; Principles, Types of flames, equipment, Techniques of gas cutting. Electric Arc Welding; Principles of electric welding equipment and electrodes. Principles of Inert Gas Welding; TIG, MIG, Sub-merged arc welding. Brazing, and Soldering. Welding defects, and inspection.

Conventional Machine Tools
Conventional machining processes. Turning; Taper turning: Shaping; Quick return Mechanisms. Milling; Up milling, Down milling Grinding; Surface grinding, Centerless grinding, Grinding wheel specification, Wheel truing and dressing. Finishing Processes; Reaming and boring, Lapping, Honing, and Super finishing.

Non-conventional machining
Classification and Principles of non-conventional machining processes such as AJM, EDM, ECM, LBM, and EBM.

Textbooks

1. Rao, P.N. (2018). Manufacturing Technology (Part I). Tata Mc-Graw Hill Publication.
2. Kaushish, J. P. (2010). Manufacturing Processes. PHI.
3. Rao, P.N. (2018). Manufacturing Technology (Part II). Tata Mc-Graw Hill Publication.

Reference Books

1. Youssef, H. A., El-Hofy, H. A., & Ahmed, M. H. (2011). Manufacturing technology: materials, processes, and equipment. Crc Press.
2. Cambell, J.S. (1984). Principle of Manufacturing Materials and Processes. McGraw-Hill Education.
3. Little, R. L. (2017). Welding and welding technology. McGraw Hill Education.
4. Ghosh, A., & Mallik, A. K. (2010). Manufacturing science. 0AFF0.
5. Pandey, P. C., & Shan, H. S. (1980). Modern machining processes. Tata McGraw-Hill Education.

QUALITY ENGINEERING

Course Code: **ME40063**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course aims to describe the significance and evolution of quality concept in manufacturing and service sectors. This course enables the student to understand different quality tools and techniques used to improve overall quality i.e. Total quality Management, ISO standards, Six Sigma etc. Implementation and monitoring of process control such as Statistical Process Control and evaluation of reliability of a system is also covered in this course.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the contributions of Quality Gurus,
CO 2: Understand quality engineering methods and tools,
CO 3: Apply SQC methods to improve quality of products and services,
CO 4: Analysis of process capability,
CO 5: Evaluate the different concepts of acceptance sampling, and
CO 6: Design system reliability using knowledge of reliability engineering.

COURSE DETAILS

Introduction to Quality
Defining Quality, Quality as a Management Framework, some important philosophies and their impact on quality (Deming, Juran, Crossby), Quality cost, Quality losses, and Link between Quality and productivity.

Tools for Quality Control
Basic tools of quality (the stem and leaf plot, histogram, box plot etc.), ISO 9000:2000, Six Sigma, Total quality management, introduction to total quality management, the evolution of total quality, and Statistical methods for Quality control and improvement.

Statistical Process control

Process capability analysis using histogram, Use and interpretation of Cp, Statistical Process Control, Specification & Limits, Charts for variables & attributes, Process Control (X, R, P, C chart), Summary of Control Chart Construction, and Designing Control Charts.

Sampling Plan
Design of single sampling plan. Double, multiple and sequential sampling plans, O.C. curve, Acceptance quality Level, and Lot tolerance percentage defective.

Reliability
Reliability analysis and predictions, Bath-Tub Curve, Exponential and Weibull distribution in modelling reliability, System reliability, and ANOVA.

Textbook

1. Mitra A, Fundamental of Quality Control and Improvement, PHI

Reference Books

1. Evans J.R., Total Quality Management, Cengage
2. Bedi, Quality Management, Oxford
3. Levine Gitlow Oppenheim, Quality Management, TMH

PROJECT MANAGEMENT

Course Code: **ME40065**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course aims to Identify project goals, constraints, deliverable, performance criteria, control needs, and resource requirements in consultation with stakeholders and also to Implement project management knowledge, processes, lifecycle and the embodied concepts, tools and techniques in order to achieve project success.It also presents to manage the scope, cost, timing, and quality of the project, at all times focused on project success as defined by project stakeholders. It focuses on project organization. Project selection , project control and project monitoring.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Describe plans with relevant people to achieve the project's goals,
CO 2: Interpret break work down into tasks and determine handover procedures,
CO 3: Apply links and dependencies, and schedule to achieve deliverable,
CO 4: Categorize the human and physical resources required, and make plans to obtain the necessary resources,
CO 5: Evaluate roles with clear lines of responsibility and accountability, and

CO 6: Develop the roles of project manager and selection of project.

COURSE DETAILS

Project Management Concepts and Needs Identification
Attributes of a Project, Project Life Cycle, The Project management Process, Global Project Management, Benefits of Project Management, Needs Identification, Project Selection (AHP technique), preparing a Request for Proposal, Soliciting Proposals, Project organization, The project as part of the functional organization, Pure project organization, The matrix organization, and Mixed organizational systems.

Project Planning and Scheduling
Design of project management system; Project work system; Work breakdown structure, Project execution plan, Work packaging plan, Project procedure manual; Project scheduling; Bar charts, Line of balance (LOB) and Network Techniques (PERT / CPM), and Crashing.

Project Monitoring and Control and Project Performance
Planning, Monitoring and Control; Role of Production, Planning & Control (PPC), New Product Development & Process Design, Aggregate Planning: Relevant cost; Evaluation of strategic alternatives (Level, Chase and mixed, types of capacity, Economics and Diseconomies of scale, Developing capacity alternatives Project Audit, and Project Audit Life Cycle.

The Project Manager
Responsibilities of the Project Manager, Skills of the Project Manager, Developing the Skills needed to be a Project Manager, Delegation Managing Change, Developing a Winning Proposal, Proposal Preparation, Proposal Contents, Pricing Considerations, Proposal Submissions and Follow-Up, and Customer Evaluation of Proposals.

Textbook

1. Clements James P. & Gido Jack (2012), Project Management (5th edition), Cengage Learning.

Reference Books

1. Meredith Jack R., Mantel Samuel J., Jr. (August 2011), Project Management: A Managerial Approach (8th Edition), Wiley Publications.

OPERATIONS RESEARCH

Course Code: **ME40067**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course would encompass a comprehensive study on decision making problem formulation. It will assist the students to understand the theory of optimization methods and its algorithms developed for solving various types of problems. Knowledge of the course will also help the students to develop and promote research interest in applying optimization techniques in problems of Engineering and Technology.

At the end of the course the students will be able to solve decision making related industrial problems through extensive and systematic research.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Describe the importance of optimization in industrial process management,
CO 2: Understand the basic concepts of mathematics to formulate an optimization problem and solve it by simulation,
CO 3: Apply variety of performance measures for various problems like game theory,
CO 4: Analyse the decision making solution alternatives,
CO 5: Evaluate unconstrained & constrained search methods for optimization theory for continuous problems, including the necessary and sufficient optimality conditions, and
CO 6: Design and measure the performance of an algorithm.

COURSE DETAILS

Linear Programming
Mathematical formulation of the problem, graphical solution method, and general linear programming problem.

Simplex & Duplex Method
Introduction, fundamental properties of solution, Simplex method, Artificial Variable Method (Big-M method) computational procedure, concept of duality in simplex method, and dual simplex algorithm.

Transportation Problem
Initial basic feasible solution, Transportation table moving towards optimality, and Degeneracy in transportation problem.

Assignment & Routing Problem
Assignment problem, Assignment algorithm,and Routing problems.

Job sequencing
Johnson's rule (n-job two machine, n-job three machine and n-job m machine).

Game Theory
Introduction, classification, Saddle Point, and Dominance.

Textbook

1. Taha H.A.(2007). Operation Research: An Introduction. PHI.

Reference Books

1. Sharma S.D. (2009). Operation Research. Laxmi Publications
2. Verma A.P., Kataria S.K. & Sons (2012). Introduction to Operations Research (10th Edition)
3. Lieberman G.J. Hillier F.S. (2015). Introduction to Operations Research, 10th Edition McGraw-Hill Higher Education.

THERMODYNAMICS AND HYDRAULIC DEVICES

Course Code: ME40069
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course would include an introductory level study of the principles of thermodynamics, steam properties and cycles, Bernoulli's principle and its application, steam generator and turbine, hydraulic turbine and pump. Knowledge of the course will help the students to learn fundamental concepts, principles of thermodynamics and fluid dynamics with their applications. After successfully completing the course, the students will be able to use the gained knowledge and understanding to design and develop the numerous thermo-fluid mechanical devices.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: State the principles of thermodynamics and fluid dynamics,
CO 2: Explain the working principles of different thermo-fluid mechanical devices,
CO 3: Apply the concepts to know the operation of the thermo fluidic devices,
CO 4: Analyze the performance of different thermo-fluid mechanical devices used for industrial applications,
CO 5: Evaluate the performance of different thermodynamic systems, and
CO 6: Design improved thermo-fluid devices.

COURSE DETAILS

Principle of Thermodynamics
First law of thermodynamics, Internal energy, Enthalpy, Thermodynamic processes, Second law of thermodynamics, Entropy, Carnot cycle, Properties of steam, Use of steam table and Mollier chart, Rankine cycle, Reheat, and regeneration cycle.

Principle of Fluid Dynamics
Introduction, Euler's equation, Bernoulli's equation. Practical applications of Bernoulli's equation- Venturi-meter, Orifice-meter, and Pilot tube.

Steam Turbine
Types,Working principles of impulse and reaction turbines, Work done, and Efficiency.

Hydraulic Turbines
Types, Working principles of Pelton, Francis, Kaplan and propeller turbines, Different heads and efficiencies, Work done and efficiency of turbines, and Equations of specific speed and discharge.

Boiler
Classifications, Fire tube and Water tube boilers.

Centrifugal Pump
Classification, Construction, Work done, Efficiencies, and Cavitation.

Reciprocating Pump
Classification, Construction, Working, Work done, Slip, and Coefficient of discharge.
Textbooks

1. Sarao A. S., (2016). Thermal engineering, Satya Prakasan, 2016th edition, New Delhi.
2. Rajput, R. K., (2018). A textbook of fluid mechanics and hydraulic machines. 6th edition, S. Chand Publishing.

Reference Books

1. Nag, P. K.,(2008). Engineering thermodynamics, Fifth Edition, McGraw Hill Education, New Delhi.
2. Modi, P. N., & Seth, S. M. (2019). Hydraulics and Fluid Mechanics Including Hydraulics Machines, 22nd Edition, Rajsons Publications Pvt. Ltd., New Delhi.

BIOMECHANICS

Course Code: **ME40071**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course encompasses a comprehensive study of mechanics of human body including skeletal joints, muscles, elbow, shoulder, knee, ankle, spinal column etc. Static and dynamic analyses of human body parts along with mechanical properties of biological tissues are focused. Knowledge of the course will help the students to design and develop artificial body parts and setups for physiotherapy applications.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify various artificial joints, limbs, and other parts,
CO 2: Understand the biomechanics of bones, tendons, ligaments, skeletal muscles and articular cartilage and analyze the stress factors and motion of different body parts,
CO 3: Apply principles of mechanics to model human body parts,
CO 4: Analyze the dynamics of human body parts and evaluate the uniaxial motion with constant acceleration,
CO 5: Evaluate the uniaxial motion with constant acceleration, and
CO 6: Create setups for physiotherapy applications..

COURSE DETAILS

Introduction

Mechanics, Biomechanics, Basic Concepts, Newton's Laws, Dimensional Analysis, Systems of Units, Conversion of Units, Mathematics, Scalars and Vectors, Modelling and Approximation, Generalized Procedure, Scope of the Text, and Notation.

Statics Analyses of System in Equilibrium
Overview, Newton's Laws of Mechanics, Conditions for Equilibrium, Free-Body Diagrams, Procedure to analyse Systems in Equilibrium, Notes Concerning the Equilibrium Equations, Constraints and Reactions, Simply Supported Structures, Cable-Pulley systems and Traction Devices, Built-in-Structures, Systems involving Friction, and Center of Gravity Determination.

Applications of Statics to Biomechanics
Skeletal Joints, Skeletal Muscles, Basic Considerations, Basic Assumptions and Limitations, Mechanics of the Elbow, Mechanics of the shoulder, Mechanics of the spinal column, Mechanics of the Hip, Mechanics of the knee, and Mechanics of the ankle.

Stress and Strain
Basic Loading Configurations, Uniaxial Tension Test, Load-Elongation Diagrams, Simple Stress, Simple Strain, Stress-Strain Diagrams, Elastic Deformations, Hooke's Law, Plastic Deformation, Necking, Work and Strain Energy, Strain Hardening, Hysteresis Loop, Properties Based on Stress-Strain Diagrams, Idealized Models of Material Behavior, and Mechanical Properties of Materials.

Mechanical Properties of Biological Tissues
Viscoelasticity, Analogies Based on Springs and Dashpots, Empirical Models of Viscoelasticity, Time-Dependant Material Response, Comparison of Elasticity and Viscoelasticity, Common Characteristics of Biological Tissues, Biomechanics of Bone, Biomechanics of Tendons and Ligaments, Biomechanics of Skeletal Muscles, and Biomechanics of Articular Cartilage.

Introduction to Dynamics & Linear Kinematics
Dynamics, Kinematics and kinetics, Linear, angular, and General Motions, Distance and Displacement, Speed and Velocity, Acceleration, Inertia and Momentum, Degree of Freedom, Particle Concept, Reference Frames and Coordinates Systems, Prerequisites for Dynamic Analyses. Uniaxial Motion, Position, Displacements, Velocity and Acceleration, Dimensions and Units, Measured and Derived Quantities, and Uniaxial Motion with Constant Acceleration

Textbook

1. Nordin, M., Ozkaya, N., Leger, D., Goldsheyder, D. (2012). Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation. Germany: Springer.

Reference Books

1. Knudson, D. V., & Knudson, D. (2007). Fundamentals of biomechanics (Vol. 183). New York: Springer.
2. Nagavani, C. (2003). Textbook of Biomechanics and Exercise Therapy. Dilshuknagar, Hyderabad

FUNDAMENTALS OF COMPUTATIONAL FLUID DYNAMICS

Course Code: **ME40073**
Credit: **3**
L-T-P: **3-0-0**

Prerequisite: Nil

COURSE OBJECTIVE

The prime objective of this subject is to deliver fundamentals of computational fluid dynamics (CFD) and its applications to the practical problems. Initially, scope of the CFD is discussed along with some basic concepts like stability, consistency, and convergence. Thereafter, the mathematical formulation of mass, momentum and energy are discussed with initial and boundary conditions. The subject also includes the detailed description of the finite difference, finite volume, and finite element methods. Furthermore, the course describes the discretization and solution methods for linear algebraic equations. Finally, solution algorithm for fluid flow equations using SIMPLE, SIMPLEC and SIMPLER methods are explained.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Recall the conservation equations of mass, momentum and energy and underline their different forms suitable in the frame work of CFD,
CO 2: Understand the basic principles of finite element method, finite difference method, finite volume method, solution techniques for solving linear algebraic equations, stability, convergence, and
CO 3: Apply fundamental principles for solving differential equations governing various problems of fluid flow and heat transfer,
CO 4:Compare solution techniques for linear algebraic equations, explicit method, implicit method, and various algorithms for solving Navier-Stokes equation,
CO 5: Devise suitable schemes for solving problems of fluid flow and heat transfer considering the aspects of stability, consistency, accuracy, and
CO 6: Predict the accuracy of results generated by various schemes and algorithms.

COURSE DETAILS

Introduction
Definition of CFD, Solution procedure of a CFD problem, Classification of partial differential equations: Elliptic equations, Parabolic equations, Hyperbolic equations, Accuracy, Consistency, Stability, and Convergence.

Mathematical Formulation
Governing Equations, Mass Conservation Equation, Energy Equation, Momentum Equation, The general scalar transport equation, Boundary conditions, and Initial condition.

Discretization Methods
Taylor series expansion, Two-point forward difference and backward difference formula, Central difference formula for uniform grid, Forward and backward difference formula involving higher number of grids, Different types of error (truncation error, round off error), Consistency, Stability, and Convergence.

Finite Difference Formulation
Finite difference formulation, Steady one-dimensional conduction problem, Unsteady one-dimensional conduction problem (explicit method, implicit method, Crank-Nicolson scheme), Two-dimensional heat conduction problem, and Convection-diffusion problem (upwind scheme, exponential scheme, hybrid scheme, power-law scheme).

Finite Volume Formulation
Steady one dimensional conduction problem, Interface conductivity, Source term linearization, Implementation of different types of boundary conditions, Unsteady one dimensional conduction problem,

Two dimensional conduction problem, Steady one dimensional convection-diffusion problem (upwind scheme, exponential scheme, hybrid scheme, power-law scheme), and Two dimensional convection-diffusion problem.

Flow Field Calculation
Discretization of the momentum equation, Staggered grid, SIMPLE algorithm, and SIMPLER algorithm.
Solution Methods
Direct vs Iterative methods, Gauss-Seidel Method, SOR method, and Tri-Diagonal Matrix (TDMA) algorithm.

Textbook

1. Patankar, S. V. (2017). Numerical heat transfer and fluid flow, Crc Press.

Reference Books

1. Anderson, J. D., & Wendt, J. (2010). Computational fluid dynamics, Springer.
2. Versteeg, H. K., & Malalasekera, W. (2008). An introduction to computational fluid dynamics: the finite volume method, Pearson education.
3. Ghoshdastidar, P. S. (1998). Computer Simulation of flow and heat transfer, Tata McGraw-Hill Publishing Company Limited.
4. Özişik, M. N., Orlande, H. R., Colaço, M. J., & Cotta, R. M. (2017). Finite difference methods in heat transfer, CRC press..
5. Muralidhar, K., & Sundararajan, T. (2003). Computational fluid flow and heat transfer, Narosa Publishing House.

AUTOMOBILE TECHNOLOGY

Course Code: **ME40075**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The subject is an elective course designed to give introductory knowledge about different parts and mechanisms of various automobiles along with an overview of automotive maintenance & repair concepts for the student with little or no background in the automotive field. The course covers the construction, operation and maintenance of the engine, combustion system, transmission system, suspension system, steering, brakes, and automotive safety components. The course has also an introduction to the advanced features coming up in automobiles related to the reduction in environmental pollution and uses of alternative energy resources.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Describe the construction and components of automotive vehicles,
CO 2: Recognize the mechanisms and operation of different systems associated with automobiles,

CO 3: Apply the concepts of automotive vehicle components to other allied applications,
CO 4: Analyze the use of appropriate components and its selection depending on application,
CO 5: Evaluate the operational and performance of different automobiles and its components, and
CO 6: Choose and Revise various mechanism in automobiles and similar industrial applications.

COURSE DETAILS

Introduction
Evolution of automobiles, Classification of vehicles, Structure of automobile, Frame, and body.

Engine and Combustion System
Classification of I.C Engines, Two stroke petrol engines construction, Working, Four stroke petrol and diesel engines-construction, Working, Valve timing diagram; Firing order, Fuel Supply system for SI engines; Carburetors, Fuel supply system for CI engines: Fuel filter, Fuel pump and Injector, Air fuel ratio for petrol and diesel. Modern fuel Injection systems – SPFI, MPFI, DI, CRDI, Digital twin spark technology, Comparison of knock in SI and CI engines, Supercharging and Turbo-charging methods, and Performance tests in IC engines.

Transmission System
Requirement of transmission system. Different types of clutch, Principle, Construction, Torque capacity and design aspects. Different types of gear boxes – Sliding, Constant and Synchromesh gearbox. Propeller shaft, Universal joint, Construction of rear axles. Types of load acting on axles. Full floating, Three-quarter floating and Semi-floating rear axles; Differential: construction of differential. Differential locks.

Steering, Suspension and Braking Systems
Front wheel geometry: Camber, Castor, King pin inclination, Toe-in and Toe-out. Condition for true rolling motion. Steering geometry: Ackerman and Davis steering system; Constructional details of steering linkages and layouts. Different types of steering gear levers-construction and operation, Power and Power assisted steering.

Suspension System
Need of suspension system, Types of suspension; Construction details of suspension springs; Leaf springs; Coil springs and Torsion bar; Shock absorbers: Telescopic type shock absorber, Independent suspension system, and Introduction to pneumatic suspension system.

Brakes
Classification of brakes- drum and disc brakes. Different types of breaking system as mechanical, hydraulic, cylinder and pneumatic breaking system, Master cylinder, Tandem master cylinder, Wheel power and Power assisted brakes, and Anti-locking braking systems.

Automotive Safety
Seat belt types and its mounting, Air bags positioning and deployment, Children and pedestrian safety devices, and Driver warning system.

Advanced Automobile
Combined power source vehicles, Hybrid Vehicle, Electric vehicles, Solar powered vehicle, and Hydrogen Oxygen fuel cell vehicle.

Textbook

1. Jain, K. K., & Asthana, R.B. (2007). Automobile Engineering, McGraw Hill Education.

Reference Books

1. Gupta, S. K. (2020). A Textbook of Automobile Engineering. S. Chand Publishing.
2. Crouse, W. H., & Anglin, D. L. (2017). Automotive Mechanics – SIE. McGraw Hill Education.
3. Gupta, K. M. (2014). Automobile Engineering, VOL-I &II. Umesh Publication.
4. Rajput, R. K. (2008). A text book of automobile engineering. Laxmi Publications.
5. Gupta, R. B.(2016) Automobile Engineering, , Satya Publication.

WORK SYSTEM DESIGN

Course Code: **ME40062**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Work System Design deals with the systematic examination of the methods of doing work with an aim of finding the means of effective and efficient use of resources and setting up of standards of performance for the work being carried out. The systematic examination of work involves what is done? And how it is done? As well as what is the standard time to do the work? This is required to have an in-depth analysis of all the elements, factors, resources and relationships affecting the efficiency and effectiveness of the work being studied. The course also aims at scientifically establishing the time required for a qualified¬ worker to carry out a work element at a defined rate of working. Ergonomic aspects of work system design are also included in the course contents. The scope of this course is not only limited to the manufacturing applications but it is also relevant for service sector industry.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Illustrate the basic work content of a specific job for employees of an organization,
CO 2: Understand the level of risk in a job causing stress,
CO 3: Correlate the rate of a worker engaged on a live job and calculate basic, allowed and standard time,
CO 4: Analyze the existing methods of working for a particular job and develop an improved method through questioning technique,
CO 5: Judge the analyzing skills among the students with respect to work place design, working postures and lifting tasks, and
CO 6: Design appropriate wage and incentive plan for the employees of an organization.

COURSE DETAILS

Productivity and Human factor in work-study
Definition, reasons for low productivity, methods to improve productivity, work-study and productivity Relationship of work-study man with management, Supervisor & workers, and Qualities of a work-study man.

Method-study
Definition, objectives, step-by-step procedure, , charts and diagrams for recording data. Like outline process charts, flow process charts, multiple activity charts, two handed process chart, string diagram, travel chart, cycle graph, Chrono-cycle graph, therbligs, micro motion study and film analysis, Simo chart, principles of motion economy, and Development and installation of new method.

Work-Measurement
Definition, various techniques of work-measurement work-sampling, stopwatch time study & its procedure, Job selection, Equipment and forms used for time study, rating, methods of rating, allowances and their types, Standard time, Numerical problems, Predetermined - time standards, and Standard data techniques.

Incentive
Meaning, objectives of an incentive plan, various types of incentive plans Assessment of occupational exposure to noise, heat stress and dust, and Effect of vibration/ noise, temperature, illumination and dust on human health and performance.

Textbook

1. Marvin E, Mundel & David L (2000), "Motion & Time Study: Improving Productivity", Pearson Education.

Reference Books

1. Lawrence S. Aft (2000),Work Measurement and Methods Improvement, John Wiley and Sons, New York.
2. Benjamin E Niebel and Freivalds Andris (1997), "Methods Standards & Work Design", Mc Graw Hill.
3. International Labour organization (2001), "Work-study", Oxford and IBH publishing company Pvt. Ltd., N.Delhi.

POWER PLANT ENGINEERING

Course Code: ME30018
Credit: 3
L-T-P: 3-0-0
Prerequisite: ME21002 & ME31002

COURSE OBJECTIVE

• To understand the principle of power generation
• To gain knowledge for site selection for installing power plants and cost of power generation
• To be able to evaluate the performance characteristics of different components of power plant
• To explore the suitability of power generation method
• To be able to design the optimized equipment for economic power generation
• To select proper method of power generation keeping in view of environmental pollution

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the principle of power generation and sources of energy,
CO 2: Understand the working principles of different components of steam and nuclear power plant,

CO 3: Apply the principles to evaluate the performance of steam power plant,
CO 4: Analyze the combustion mechanisms, steam turbines, nozzles and condenser,
CO 5: Evaluate the performance of boiler, steam turbine, nozzle and condenser, and
CO 6: Design essential components of steam and nuclear power plants.

COURSE DETAILS

Introduction
Principle of operation(Rankin cycle), Sources of energy: fuel, water, wind, solar and nuclear, Types of power plants, Cost of electrical energy, Fixed cost and operating cost, Types of tariff, and load curves.

Combustion mechanism, combustion equipment and firing methods
Fuel bed furnace, Pulverized coal furnace, Cyclone furnace, Fluidized bed combustion, Furnace, Combustion equipment, Air supply systems for combustion, Fuel and ash handling systems, and dust collectors.

Generation of steam and flow of steam through nozzle
Boilers and its mountings & accessories, High pressure water tube boiler,. Nozzle shape for different applications, Choked flow and critical pressure ratio, Effect of variations in nozzle back pressures, and Super saturated flow in nozzles.

Steam Turbines
Types of steam turbines, Axial variation of pressure and velocity through various types of turbines, Flow through turbine blades, Velocity diagrams of impulse (pressure compounded and velocity compounded) and impulse reaction turbine, Degree of reaction. Parsons turbines, Power, efficiency and other related calculations for simple impulse & reaction turbine, Losses in steam turbines, Reheat factor, and Governing of turbines.

Steam condensers and cooling tower for power plant application
Surface condensers, Condenser vacuum and vacuum efficiency, Maintaining vacuum by air pumps, Sources of air leakage into the condenser, Dalton's law of partial pressures applied to steam and air mixtures, Air pump capacity for wet and dry air pumps, Cooling water requirements, and Cooling towers.

Nuclear power plants
Nuclear fuels, Chain reaction, Neutron balance, coolants, Reflectors, Moderators, control rods, types of reactors, Boiling water reactors, pressurized water reactors. CANDU Reactor, Gas cooled Reactors, Liquid metal fast breeder Reactor, Heavy water Reactors, Waste disposal, and Safety of Nuclear power plant.

Textbook

1. Nag, P. K. (2002). Power Plant Engineering. Tata McGraw-Hill Education.

Reference Books

1. Rajput, R. K. Power Plant Engineering (4th Edition). Laxmi Publications (P) Ltd.
2. Gupta, M. K.(2012). Power Plant Engineering. PHI Learning.
3. Sharma, P.C. (2009). Power Plant Engineering, S. K. Kataria & Sons publication.

MECHANICAL SYSTEM DESIGN

Course Code: **ME40064**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course focuses primarily on the design and development aspect of different mechanical components. It enables the students to apply technical skills and imagination to come up with a proper design configuration. Students are able to determine the stresses, shear force and bending moment in different structural elements. It also enables them to get acquainted with the design of temporary, permanent fasteners and tribological system. This course puts emphasize on the importance of vibration study and proper selection of tribological elements in engineering. The governing differential equations of a vibration system are determined along with its solution.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify various types of stresses in different structural elements,
CO 2: Understand the importance of proper selection of tribological elements,
CO 3: Apply technical skill and imagination to construct a proper design configuration,
CO 4: Analyze the difference between damped and undamped system,
CO 5: Determine the governing differential equation of a vibration system and its solution, and
CO 6: Design various temporary and permanent fasteners..

COURSE DETAILS

Simple stress and strain
Concept of stress: Definition, Reason of stress phenomenon, Normal stress and Shear stress; Concept of strain: Types, Stress strain diagram and Its features, Stress strain diagram for ductile and brittle materials, Stress and strain in composite rods, Stress and strain in bolt and nut assembly.

Compound stress and strain
Two-dimensional stresses, principal stress, principal planes, Mohr's circle for the stresses, and Strain analysis, Principal strains.

Shear force and bending moment
Types of support and beams, shear force (SF), bending moment (BM), relation between load, SF and BM, and Shear force diagram and bending moment diagram of beams subject to concentrated and uniformly distributed load.

Design of fastening elements
Design of riveted and welded joints, Design of bolted joints, Design of cotter joints, and Design of knuckle joints.

Degree of Freedom Systems
Generalized Derivation of Equation of motion, Static and dynamic coupling, Langrange's equations, and Undamped dynamic vibration observers.

Torsional Vibration and Vibration of continuous system
Multi-rotor systems, geared system and branched system, Vibration of strings, free longitudinal vibration of prismatic bars, and Lateral vibrations of uniform beams.

Hydrostatic and Hydrodynamic theory of lubrication
Hydrostatic step bearing, application to pivoted pad thrust bearing and other applications, Various theories of lubrication, petroffs equation, Reynold's equation in two dimensions -Effects of side leakage - Reynolds equation in three dimensions, Friction in sliding bearing, Hydro dynamic theory applied to journal bearing, Minimum oil film thickness, Oil whip, and Whirl anti -friction bearing.

Textbooks

1. Rattan S.S., Strength of Materials, TMH
2. Bhandari V B, Design of Machine Elements, (TMH)
3. Ambekar Ashok G., Mechanical Vibrations and Noise Engineering, PHI.
4. Basu, Sen Gupta and Ahuja , Fundamentals of Tribology, PHI

Reference Books

1. Sharma P.C. and Aggrawal D.K., Machine Design.
2. Lehri & Lehri, Strength of Materials, Kataria.
3. Thomson William T., Theory of Vibration and Application, CBS
4. Srivatsava Sushil Kumar, Tribology in Industry, S. Chand &Co.
5. Jalaludeen S. Md., Hand Book- Design Data Handbook.
6. Bhandari V.B., Machine Design Data book

ADDITIVE MANUFACTURING

Course Code: **ME30015**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Additive Manufacturing is a modern manufacturing technology also known as 3D printing process, will provide a clear understanding about the process, acceptability and usability in various field. AM technology classified on the basis material types will be focused with it real life applications with advantages and disadvantages. Different types of errors associated with AM and CAD technology will be discussed with suitable error minimization processes. Various reverse engineering process will be discussed with its application.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know the various liquid, powder and solid material based technologies in Rapid Prototyping and Rapid Tooling process,
CO 2: Understand the concept of additive manufacturing, its benefits and applications in various field,
CO 3: Apply AM process in the field of Biomedical aplliances,
CO 4: Analyse the use of reverse engineering to generate data for fabrication of RP part,
CO 5: Evaluate various types errors in the RP parts and errors during CAD file conversion, and
CO 6: Design solid models and converting it to 3D printing readable file format required for part fabrication.

COURSE DETAILS

Introduction
Need & Development of RP systems, RP process chain, Impact of Rapid prototyping and Tooling on Product Development, Benefits, Applications, Digital prototyping, Virtual prototyping.

Liquid and Solid Based Rapid Prototyping Systems
Stereo lithography Apparatus, Fused Deposition Modelling, Laminated object manufacturing, 3D printing: Working Principles, Details of processes, Products, Materials, Advantages, limitations and applications - Case studies.

Powder Based Rapid Prototyping Systems
Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS), 3D Printing (3DP), Laser Engineered Net Shaping (LENS), Selective Laser Melting (SLM), Electron Beam Melting (EBM), Plasma Transferred Arc Additive Manufacturing (PTAAM), Tungsten Inert Gas Additive Manufacturing (TIGAM), Metal Inert Gas Additive Manufacturing (MIGAM): Processes, Materials, Products, Advantages, Applications and Limitations.

Medical and Bio- Additive Manufacturing
Customized implants, Orthodontics and human prosthesis: Design and production, Bio additive manufacturing: Computer Aided Tissue Engineering (CATE) followed by case studies.

Data Processing for Rapid Prototyping
Process planning for rapid prototyping, CAD model preparation, Data Requirements & geometric modelling techniques: Wire frame, surface and solid modelling data formats - Data interfacing, Tessellation of surfaces, STL file generation Defects in STL files and repairing algorithms, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, Direct and adaptive slicing, Tool path generation.

Issues of Prototype
Accuracy issues in Rapid Prototyping, Strength of RP Parts, Surface roughness problem in Rapid Prototyping, Part deposition orientation and issues like accuracy, Surface finish, Build time, Support structure, Cost etc.

Rapid Tooling
Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect, Fabrication processes, Applications, Rapid tooling techniques such as laminated metallic tooling, Direct metal laser sintering, Vacuum casting.

Reverse Engineering
Introduction to reverse engineering, Integration of reverse engineering with additive manufacturing technology: Advantages and disadvantages.

Textbooks

1.Gibson, I., Rosen, D. W. & Stucker, B. (2015). Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer.
2.Rafiq, I. Noorani (2006). Rapid Prototyping: Principle and Applications. Wiley & Sons.

Reference Books

1.Chua, C. K., Leong, K. F. & Lim, C. S. (2010). Rapid Prototyping: Principles and Applications. Yes Dee Publishing Pvt. Ltd. Third edition.
2.Liou, Frank. W. (2007). Rapid Prototyping And Engineering Applications. CRC Press, Special Indian Edition.
3.Chattopadhyaya, S. (2011). Journey from Rapid Prototyping to Rapid Manufacturing. LAP Lambert Academic Publishing.
4.Cooper, K. G. & Cooper, Cooper. (2001). Rapid Prototyping Technology: Selection and Application. Marcel Dekker Inc. 1st Edition.
5.Roger, N. (2014). Rapid Prototyping of Biomaterials Principles and Applications. ed. Woodhead Publishing.
6.Richard, B., Eggbeer, D. & Paterson, A. (2014). Medical Modelling: The Application of Advanced Design and Rapid Prototyping Techniques in Medicine. Woodhead Publishing.

INDUSTRIAL AUTOMATION AND ROBOTICS

Course Code: ME40066
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

1.To introduce the technology advancements in manufacturing industries.
2.To understand the concepts of automated material handling systems, storage and retrieval systems.
3.To introduce the concepts of drives and the operating valves used in Pneumatic and hydraulic circuits.
4.To inculcate the importance of the Electric and electronic controls used in automation.
5. To indoctrinate the basic concept of robotics and kinematic modeling of the manipulators.
6. To introduce the Robot Programming methods and their application in the industries.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know the industrial automation with computer controlled machines, measurement systems and industrial robots,
CO 2: Understand the principles of application of AGV, ASRS in automated industries,
CO 3: Apply pneumatic and hydraulic circuit using computer for automated factory,
CO 4: Articulate kinematic model for different robot configurations,
CO 5: Generate programm and select the best robotics applications and be able to justify the overall advantages to industry, and
CO 6: Design PLC programs, implement PID using electronic, digital, pneumatic and hydraulic methods to solve industrial control problems.

COURSE DETAILS

Introduction
Introduction to Industrial Automation and Control, Automations, Basic laws and principles, Level of automation, Analysis of automated assembly systems, Line balancing problems, Analysis of automated material handling systems, and Automated storage and retrieval systems.

Laws and principles of Hydraulics and Pneumatics
Components of basic Pneumatic and Hydraulic systems, Characteristics and properties pumps and compressors used in industry, Pneumatic and Hydraulic accessories like filters, lubricators, air dryers, pipelines, connectors, Pneumatic and Hydraulic actuators and their classifications, Proportional and Servo Valves, Construction and working of various Pneumatics and Hydraulics valves, and Pneumatic and hydraulic circuits.

Industrial Control Systems
Continuous and discrete control, Control requirements, Programmable Logic Controllers (PLCs), Sensors and Actuators. Introduction to Process Control, PID Control, Implementation of PID Controllers, Logic circuits: Pneumatic logic circuits, and Electric and electronic controls used in automation.

Industrial Robotics
Introduction to robotics, Robotic Grippers, Sensors in robotics, Homogeneous transformations, D-H parameter notation, Direct & inverse kinematics of manipulators: Examples of kinematics of some common manipulator configurations.

Programming and Applications
Robot Programming, Robot application in machining, Welding and assembly, Hostile and remote environment.

Textbooks

1. Groover, M. P. (2007). Automation, production systems, and computer-integrated manufacturing. Pearson Education India (3rd Edition) ISBN 81-7808-511-9.

2. Mahalik, N. P. (2003). Mechatronics Principles, Concepts and Applications, TMH Publication. ISBN-0-07-048374-4 3. Mittal, R. K., & Nagrath, I. J. (2003). Robotics and control. Tata McGraw-Hill.

Reference Books

1. Gupta A.K. and Arora S.K. (2009). Industrial Automation and Robotics. Lakshmi Publication, New Delhi.
2. Sharma K.L.S. Overview of Industrial Process Automation (1st Edition). Elsevier, ISBN-978-012-415779-8. 3. Groover M.P. (2001). Industrial Robotics-Technology, Programming and Applications. McGraw Hill.

PRODUCTION PLANNING AND CONTROL

Course Code: **ME40068**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The current competitive business environment is forcing the organizations to adopt the latest tools, techniques and strategies for managing their resources in the most effective and efficient manner. The topics of the course deals with the management of resources and activities that lead to production of goods of right quality, in right quantity, at right time and place in the most cost-effective manner. The course focuses on the basic concepts, issues, and techniques adopted worldwide for efficient and effective operations. The topics include operations strategy, product design and development, work study, facility planning and layout, aggregate production planning, inventory and quality management.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Describe the various components that make up the manufacturing planning and control system and the interaction among them,
CO 2: Understand line balancing method and time study method,
CO 3: Articulate the factors affecting plant location and the techniques used for plant layout,
CO 4: Analyze the models that are applicable for inventory management, including those for quantity discounts, safety stocks, and order quantity and reorder point interactions,
CO 5: Estimate economic order quantity, and
CO 6: Develop the algorithms that are appropriate for solving single-machine, two-machine, parallel-machines and flow shop scheduling problems.

COURSE DETAILS

Overview of Operations Management
Introduction, Responsibilities of Production Manager, Strategic Decisions in Operations, Manufacturing Vs. Service Operation, and Types of Production processes (Project/Job, Batch, Mass/Line, Continuous).

Concept of FMS
Flexible Manufacturing System, Role of Production, Planning & Control (PPC), and New Product Development & Process Design.

Work Study and Aggregate Planning
Introduction of Work Study, Method study Procedure, Principles of Motion Economy, Stop Watch Time Study Procedure, Importance of Rating & Allowances in Time Study, Aggregate Planning: Relevant cost, and Evaluation of strategic alternatives (Level, Chase and Mixed).

Facility Location and Layout, Scheduling
Importance & Factors affecting the Plant Location, Single and Multi-facility location Techniques (Centroid and Minimax method), Plant Layout & its classification, Relationship Diagram & Block Diagramming, and Assembly Line of Balancing.

Inventory Control

Inventory Control: Relevant Costs, P & Q Systems of Inventory, Basic EOQ Model, and Model with Quantity discount, Economic Batch Quantity, Safety Stock, Reorder Point, ABC Analysis, and Material Requirement Planning.

Textbook

1.Paneerselvam R.(2013). Production and Operation Management. Third Edition.

Reference Books

1. Aswathappa K., Bhat S. Production and Operation Management.
2. Charry S.N. Production and operations management, TMH

MECHATRONIC SYSTEMS

Course Code: ME40070
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Mechatronic systems course encompassing mechanical engineering, electronic engineering and software engineering. This course is presented to cover all of these critical aspects including analog interfacing, digital logic, real-time computation tasks, and power amplifiers, measurement and sensing, controllers, and pneumatics and hydraulic actuation systems. Through the course, students will be able to analyze and develop electro-mechanical systems, and techniques through extensive and systematic research.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Select and apply the knowledge, techniques, skills and modern tools in mechatronics engineering technology,
CO 2: Understand the circuit analysis, analog and digital electronics, automation and controls, motors, electric drives, power systems, instrumentation, and concept of CNC machining appliances,
CO 3: Apply the different drive systems for actuation of various parts and components of a system,
CO 4: Correlate different controllers used in industries, machines and industrial robots,
CO 5: Evaluate the role of computers to aid in design, characterization, analysis, and troubleshooting of mechatronics systems, and
CO 6: Develop the G for part programming.

COURSE DETAILS

Introduction

Definition of mechatronics, Need of mechatronics system, Examples of mechatronics systems in manufacturing, Products, Design. Review of fundamentals of electronics. Data conversion devices, Sensors and transducers, (pressure, velocity, level, light, accelerometers, gyros, compass, encoders, strain gauges, LVDT, potentio meter), Smart sensors, Micro sensors, Transducers, Signal processing devices, Relays, Contactors and timers. Signal conditioning basics, Filtering, Protection, Pulse width modulation, Opamps and their applications, Microprocessors (8085 and Arduino) micro controllers for sensing, actuation and control, and PLCs. Digital data, Analog data, AD-DA conversion,and Demonstration on data acquisition systems using NI LabVIEW)

Logic circuits

Digital logic, Logic gates, Application of logic gates, Sequential logic, Basic modelling of systems, First order systems, Second order systems, and Performance measure of second order systems

Drives

Switching, Solenoids, Stepper motors, Servo drives. Ball screws, Linear motion bearings, Cams, Systems controlled by camshafts, and Electronic cams. (Programming a servomotor using NI Labview)

Pneumatics and Hydraulic actuation systems

Flow, Pressure and direction control valves, Actuators, and Supporting elements, Hydraulic power packs, Pumps, Production, Distribution and Conditioning of compressed air, System components and graphic representations, and Design of systems.

Controllers

Close loop and open loop systems, Description of PD, PI and PID controllers, CNC machines and part programming, Introduction to Robotics, Forward and invers kinematics (Demonstration on programing robot and CNC part programming).

Textbooks

1. Bolton, W., (2015). Mechatronics: electronic control systems in mechanical and electrical engineering, 6th edition, Pearson Education.
2. HMT ltd., (2017). Mechatronics, Tata Mcgraw-Hill, New Delhi.
3. Rajput, R. K. (2007). A textbook of Mechatronics, S. Chand Publishing.

Reference Books

1. Deb, S. R., & Deb, S., (2010). Robotics technology and flexible automation. McGraw-Hill Education.
2. Computer automation in manufacturing - an Introduction, T. O. Boucher, Chapman and Hall, 1996.
3. Giurgiutiu, V., & Lyshevski, S. E. (2016), Micromechatronics: Modeling, analysis, and design with MATLAB. CRC Press.
4. Mahalik, N.P., (2017), Mechatronics: Principles, concepts and applications, N. P. TMH

ROBOTICS

Course Code: **ME40072**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course would encompass a comprehensive study of Definition of Robot, Robot kinematics, Robot Dynamics, Robotic control, Computer vision etc. Knowledge of the course will help the students to know about Robot configuration, classifications, description of position and orientation of Robot. At the end of the course the students will have the idea about how Robot perceive object and strategies for extracting information from Sensors.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Describe the relationship between mechanical structures of industrial robots and their operational workspace characteristics,
CO 2: Understand Robot control by different types of programming method,
CO 3: Apply spatial transformation to adopt forward kinematic equations of robot manipulators and solve inverse kinematics of simple robot manipulators,
CO 4: Select the best robotic applications and be able to justify the overall advantages to Industry,
CO 5: Explore the field of machine vision as a fundamental sensor technology in robotics, and
CO 6: Develop the Jacobian matrix and use it to identify singularities and also to generate joint trajectory for motion planning.

COURSE DETAILS

Introduction

Definition of a robot, Basic concepts, Robot configurations, Types of robot drives, Basic robot motions, Point to point control, and Continuous path control.

Components and Operation

Basic control system concepts, Control system analysis, Robot actuation and feedback, Manipulators, Direct and inverse kinematics, Coordinate transformation, Brief robot dynamics, Types of robot and effectors, and Robot/ End and effectors interface.

Sensing and Machine Vision

Range sensing, Proximity sensing, Touch sensing, Force and torque sensing. Introduction to Machine vision, Sensing and digitizing, Image processing and analysis.

Robot Programming Methods

Languages, Capabilities and limitation, Artificial intelligence, Knowledge representation, Search techniques in A I, and Robotics.

Industrial Applications

Application of robots in machining, Welding, assembly, Material handling, Loading and unloading, CIM, Hostile, and Remote environments.

Textbook

1. Klafter, R. D., Chmielewski, T. A., & Negin, M. (1993). Robotic Engineering: An Integrated Approach. Prentice Hall India Learning Private Limited.

Reference Books

1. Groover, M. P., Weiss, M. S., Nagel, R. N., N.G. Odrey, & Dutta A. (2017). Industrial Robotics: Technology, Programming, and Applications. McGraw Hill Education.
2. Yoshikawa, T. (2010). Foundations of robotics: analysis and control. MIT press.
3. Fu, K., Gonzalez, R. G., & Lee, C. (2017). Robotics: Control, Sensing, Vision, and Intelligence. McGraw Hill Education.

COMPUTER CONTROLLED MANUFACTURING SYSTEMS

Course Code: **ME40074**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course will offer awareness of historical development of automation, different automated machine tools, part programming, process planning, computer networks and future aspects in the manufacturing technology. With the knowledge of this course, the students are able to identify the suitable machine tool and can develop the part program to produce the part. Effective process plan can be developed to produce the job without delay in production. They can also through with computer networks while going through this course.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Describe the importance of automation in the Manufacturing Industry,
CO 2: Understand the sequence of operations leading to optimized time and cost,
CO 3: Apply the essentials of manufacturing automation with automated machine tools such as NC, CNC and DNC,
CO 4: Acquire the programming skills to produce various complex features with computer assisted part programming methodologies,
CO 5: Evaluate the need the computers network in manufacturing industries, and

CO 6: Visualize the futuristic advancements in the manufacturing technology.

COURSE DETAILS

Fundamentals of Manufacturing and automation
Types of production, Objectives of a manufacturing system, Production concepts and Mathematical models, and Automation strategies.

Process planning
Group Technology and Computer Aided Process Planning, Introduction-part families-parts classification and cooling - group technology machine cells benefits of group - technology, and Process planning function CAPP - Computer generated time standards.

Numerical Control Production System
Numerical control, Coordinate system and Machine motion, Types of NC system, Machine tool applications, Problems of conventional NC, CNC, and DNC.

Part Programming
Basics of NC programming, Mathematics of tool paths, Machining forces, Tool offsets, Programming steps, NC programming Languages, G-Code and M-Code, APT Programming, CAD/CAM NC programming, and Rapid prototyping.

Computer Networks for manufacturing
Hierarchy of computers in manufacturing, Local area networking, and Manufacturing automation protocol.

The Future Automated Factory
Trends in manufacturing, and The future automated factory.

Textbooks

1. Groover, M. P. (2016). Automation, production systems, and computer-integrated manufacturing. Pearson Education India.
2. Zeid, I, & Sivasubramanian, R. (2009) CAD/CAM : Theory and Practice: Special Indian Edition. McGraw Hill Education.

Reference Books

1. Ranky, P. G. (1986). Computer integrated manufacturing. Prentice-Hall, Inc..
2. Koren, Y. (1983). Computer control of manufacturing systems (Vol. 168). New York: McGraw-Hill.

THERMOFLUIDS LAB

Course Code: **ME49011**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This laboratory is designed to understand the basic concepts of thermodynamics, fluid mechanics, heat transfer and refrigeration through various experiments. Study of IC engines is useful to understand the basic principles of thermodynamics. Most common hydraulic machines like turbines and pumps are studied to understand principle of conversion of hydraulic energy to mechanical energy and vice versa. Measurement of thermal conductivity is introduced know the basic heat transfer process. Heat exchanger is very versatile device used in various industries like thermal power plant, refrigerator etc., and experiment on it helps the students to understand the means of heat transfer from one fluid to another. Experiment of refrigeration will help the students to know about the basic refrigeration process used in refrigerator. At the end of the course, students will be confident to face the challenges of industry problems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Describe the principle of Bernoulli's theorem,
CO 2: Understand and measure the flow fluid through pipes with the help of venturi meter,
CO 3: Apply thermodynamic law and calculate the COP of Vapour Compression refrigeration system,
CO 4: Illustrate performance characteristics of 4 stroke single cylinder petrol and diesel engines,
CO 5: Determine thermal conductivity of metal bars of different materials, and
CO 6: Develop the characteristic curves for Pelton turbine, Francis turbine and centrifugal pump.

COURSE DETAILS

- Pressure drop calculation by Bernouli's apparatus
- Coefficient of discharge in Flow through pipes
- Venturimeter calibration
- CoP calculation of Vapour compression refrigeration system
- Petrol and Diesel Engine performance
- Thermal conductivity measurement
- Pelton turbine performance
- Francis turbine performance
- Centrifugal pump characteristic curve

Textbook

1. Ballaney P.L., (1994) Thermal Engineering (Engineering Thermodynamics & Energy Conversion Techniques), Khanna Publisher

Reference Books

1. Cengel Y.A., Boles M.A., Thermodynamics An Engineering Approach, (2011) McGraw Hill Education, 7th Edition
2. C. P. Arora, (2017) Refrigeration and Air Conditioning, McGraw Hill Education, 3rd Edition

METROLOGY AND INSTRUMENTATION LAB

Course Code: ME49013
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This laboratory is intended to describe the fundamental concepts of measuring instruments. It provides the in-depth knowledge about different inspection gauges, measuring instruments, and their field of application. The students can able to know the suitability and applicability of the instruments in effectively and efficiently. It is a kind of training which helps them to utilize in industrial application.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the different inspection gauges and their applications,
CO 2: Understand the working principle of different measuring instruments and their applications.,
CO 3: Articulate the results from different measuring instruments,
CO 4: Inspect the bore diameter by using four ball and two ball method,
CO 5: Evaluate the dimensions of a specimen using Sine bar and slip gauge., and
CO 6: Justify the use of profile projector for specimen inspection.

COURSE DETAILS

Study of different types of inspection gauges and their methods of application

Determination of diameter and length of stepped shaft using Micrometer, Vernier Caliper and Vernier height gauge

Determination of angle of an angle gauge plate by using sine bar method

Determination of bore diameter by bore diameter by four ball and two ball method

Determination of the included taper angle, large end, smaller end diameter (DL and Ds) and check the outer roundness and uniformity of an externally tapered specimen

Determination of the chordal thickness of gear tooth using gear tooth Vernier caliper

Determination of external radius of specimen

Textbook

1. Raghavendra N.V., Krishnamurthy L., (2013) Engineering Metrology and Measurements, Oxford Publication

Reference Book

1. Sawhney A. K., Sawhney P., (2017) A Course in Mechanical Measurement and Instrumentation & control, Dhanpat Rai and Co.

FOUNDATIONS OF MODERN MACROECONOMICS

Course Code: **HS30150**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to teach students the principles of economics of aggregates so they can apply these ideas to their own lives and the world in which they live.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Introduce themselves to the basic principles of macroeconomics,

CO 2: Explain the circular flow model and use the concepts of aggregate demand and aggregate supply,
CO 3: Understand the basic economic problems of inflation, unemployment, poverty and their remedies through macro insights,
CO 4: Evaluate the relevance of macro variables in policy making,
CO 5: Relate the corporate functioning to macroeconomic indicators, and
CO 6: Define fiscal and monetary policies and how these affect the economy.

COURSE DETAILS

National Income and its measurement
Introduction to National Income, Concepts of GDP, GNP, GDP Gap, GDP Deflator and national income, Comparison of GDP deflator with CPI, Rules and Methods of Measurement of GDP (Income, expenditure and Out Put method), Circular Flow of Income and expenditure both in close and open economy.

General Equilibrium
Introduction of AD & AS. Derivation of product market equilibrium (IS curve) and money market equilibrium (LM curve) – equilibrium in IS-LM Model, Effectiveness of Monetary and Fiscal Policy, Crowding-Out Effect.

Inflation and Unemployment
Measuring Inflation rate and Unemployment rate; The Phillips relation – The expectation augmented Philips curve – The natural rate of unemployment hypothesis The Relation between GDP Gap, Inflation rate and unemployment Gap, Okun's Law.

Theories of consumption and Investment

Keynesian and Post Keynesian**:** Consumption function, Marginal Efficiency of Capital, theories of consumption –Absolute, relative, permanent and life cycle income hypothesis.
Keynesian and Post Keynesian theories: The decisions to invest- Autonomous and Induced investment, MEI schedule. Multiplier and accelerator theories of Investment. Neo-classical theory of investment (Jorgensen)

Textbooks

1. N.Gregory Mankiw. Principles of Macroeconomics with course mate, 7th Edition, Cengage Publishers.
2. Andrew Abel and Ben Bernanke (2016), Macroeconomics, Publisher: Pearson.

Reference Books

1. Branson W.A., Macroeconomic Theory and Policy, Harper and Row New York.
2. Dornbusch, Fischer and Startz, Macroeconomics, McGraw Hill, 11th Edition, 2010.
3. Shapiro, E. (1996), Macroeconomic Analysis, Galgotia Publications, New Delhi.
4. Ackley, G. (1976), Macroeconomics: Theory and Policy, Macmillan Publishing Company.
5. S.N.V. Siva Kumar, Macro Economics and Policy for Managers: An Indian Perspective, Cengage publishers, 2019.

MONEY AND FINANCIAL MARKETS

Course Code: HS30152
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

To give the students a basic understanding of the Indian financial market, to familiarize students with Money Market and its sub markets and the regulatory framework in the Indian Financial system.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain why people hold money and why it is used in the trading process,
CO 2: Explain the impact of money multiplier and accelerator,
CO 3: Describe and explain the role of interest rate in an economy,
CO 4: Discuss the role of financial institutions in strengthening the economy,
CO 5: Describe and explain the main channels of the monetary transmission mechanism, through which monetary policy can have real effects on the economy, and
CO 6: Discuss the merits and disadvantages of different monetary policies used by Central Banks.

COURSE DETAILS

Money: concept, functions, measurement; theories of money supply determination. High Powered Money. Money multiplier and accelerator theory. Cryptocurrency

Financial institutions, markets, instruments, and financial innovations. Role of financial markets and institutions; problems of adverse selection and moral hazard; financial crises Money and capital markets: organisation, structure, and reforms in India; role of financial derivatives and other innovations

Interest rates Determination; sources of interest rate differentials; theories of term structure of interest rates; interest rates in India.

Banking System Balance sheet and portfolio management Indian banking system: changing role and structure; banking sector reforms. Central banking and monetary policy.

Textbook

1. Monetary Economics: Institutions, Theory & Policy, Suraj B Gupta. S. Chand

Reference Books

1. Baye, M., Jansen, D., 2006, Money, banking and financial markets, AITBS.
2. Bhole, L., Mahukud, J., 2017, Financial institutions and markets, 6th Edition, Tata McGraw-Hill.
3. Fabozzi, F., Modigliani, F., Jones, F., Ferri, M., 2010, Foundations of financial markets and institutions, 4th Edition, Pearson Education.
4. Jadhav, N., 2009, Monetary policy, financial stability and central banking in India. Macmillan.
5. Khan, M., 2015, Indian financial system, 9th Edition, Tata McGraw-Hill.
6. Mishkin, F., Eakins, S., 2017, Financial markets and institutions, 8th Edition, Pearson.
7. Mohan, R., 2011, Growth with financial stability: Central banking in an emerging market. Oxford University Press.
8. Various latest issues of RBI Bulletins, Annual Reports, Reports on Currency and Finance, and Reports of the Working Group, IMF Staff Papers.

POVERTY TO PROSPERITY

Course Code: **HS30154**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course includes poverty related issues from the economic perspective.

COURSE OUTCOME

After successfully completing the course, the students will be able to

CO 1: Gain contextual knowledge on concept of poverty,
CO 2: Understand Indicators and Issues related to poverty,
CO 3: Examine links between poverty and well-being,
CO 4: Understand the relation between Poverty and unemployment,
CO 5: Create sound knowledge about Poverty Alleviation Programmes and Policies, and
CO 6: Engage in critical thinking as a part of the analysis of economic problems, and problem-solving potentiality as well.

COURSE DETAILS

Introduction to the concept of poverty
Underdevelopment; Meaning and Indicators, Common Characteristics of Developing Countries, The Concept of Poverty and poverty Line, Determinants and indicators of poverty, Incidence of Poverty, Tools to Measure Poverty; Headcount Ratio, Poverty Gap Ratio & Sen Index.

Multidimensional poverty
Dimensions of Poverty, Multidimensional poverty, Measuring multidimensional poverty, Global Multidimensional Poverty Index, Multidimensional Poverty Index and SDGs.

Poverty and Unemployment
Problem of Unemployment, Nature and Estimates of Unemployment, Unemployment in Urban Areas, Agricultural Unemployment, Causes of Unemployment, Government Policy for Removing Unemployment, Major Employment Programmes.

Poverty and planning process
Poverty Alleviation Programmes and Policies: Meaning, Measuring BPL in India, Poverty Alleviation in India- Five Year Plans, Poverty Alleviation Programmes, Strategy of Poverty Alleviation.

Data analysis
Recent budgetary policies and programs relating to concepts of poverty; Analysis of Economic Survey data.

Textbook

1. S.K. Mishra, and V. K. Puri, Indian Economy, Himalaya Publishing House,2022, ISBN: 978-93-5596-423-6.

Reference Books

1. Gaurav Datt and Ashwani Mahajan, Indian Economy, GENERIC. Classic Edition, 2022, ISBN-10: 9352531299, ISBN-13: 978-9352531295.
2. Todaro, M., Smith, S. (2011). Economic development, 11th Edition, Pearson.
3. Abhijit Banerjee, Roland Benabou and Dilip Mookerjee, Understanding Poverty. Oxford University Press, 2006.
4. J. D. Sachs, The End of Poverty: Economic Possibilities for our Time, Penguin, 2006.
5. World Bank Group, A Measured Approach to Ending Poverty and Boosting Shared Prosperity: Concepts, Data, and the Twin Goals. World Bank, 2021, November 10, https://www.worldbank.org/en/research/publication/a-measured-approach-to-ending-poverty-and-boosting-shared-prosperity.

ORGANIZATIONAL CHANGE AND DEVELOPMENT

Course Code: **HS30250**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The primary objective of the course is to understand the importance of organizational change and the need to respond to the changes in the industry. It also focuses on imparting the knowledge of organization development concepts, tools and techniques that are meant for improving the functioning of individuals, groups and organizations. The aim of the course is to develop the application of behavioral science concepts to the functioning of the organization development.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Respond and anticipate the needs of change in a proactive way,
CO 2: Understand various levels and categories of change to develop appropriate intervention into the system,
CO 3: Apply the OD concepts, tools and techniques for improving the performance of individual, groups and organization in change process,
CO 4: Analyse and overcome the challenges in the change process,
CO 5: Explain the assumptions, beliefs and values of organizational development, and
CO 6: Implement behavioral science knowledge to bring changes in organizational strategies, structures, and processes.

COURSE DETAILS

Organizational Change

Organizational Change: Concept and Significance; Managing Change; Concept of Analyzing the Environment; Perspectives on Change: Contingency; Resource Dependence; Population Ecology; Implications of Change.

Types of Change

Types of Change: Continuous or Incremental Change; Discontinuous or Radial Change; Participate Change and Directive Change; Change Levers; Levels of Change: Knowledge Changes; Attitudinal Changes; Individual Behaviour Changes and Organizational Performance Changes.

Implementation of Change

Implementing Change: Steps-Assembling a Change; Management in establishing a new direction for the organization; Setting up of change teams and promoting innovation; Aligning structure; Systems and resources; Removing Road blocks; Absorbing changes into organization; keys to create a cultural change.

Organizational Growth and Development

Introduction to organizational growth and development; Historical Overview of OD (Laboratory Training, Survey Research, Action Research, Socio-technical systems); OD Values, Beliefs and Assumptions for individuals, Groups and Organizations; Role of OD Consultants – Styles, relation with client, entry strategies.

Organizational Development Interventions
OD Interventions: Overview, characteristics of effective Interventions, Individual Level , Team & Group Interventions; Human Resource Interventions (Performance Management, Reward Systems, Career Planning); Techno-Structural Interventions (Restructuring Organizations, Downsizing Employee Involvement, Work Redesign , Total Quality Management); Strategic Interventions (Mergers and Acquisitions, Strategic Alliances and Joint Ventures, Organization Transformation); Indian Experiences of OD in Public and Private Enterprises.

Textbooks

1. Organization Development and Change by Thomas Cummings and Christopher Worley - Cengage Publications, 2015.
2. Organizational Change and Development by Dipak Bhattacharya, Oxford Publishing House, 2011.
3. Managing Organizational Change- a multiple perspective approach by Ian Palmer, Richard Dunford, David A, Buchanan, Mc Graw Hill, 2016.

Reference Books

1. Organization Development: Behavioral Science Interventions for Organizational Improvement, by Wendell L French, Cecil H Bell - Pearson publications.
2. Organizational Change and Development, Kumkum Mukherjee, Pearson Publications, 2015.

INDIAN LITERATURE IN TRANSLATION

Course Code: **HS30050**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **English (HS10001)**

COURSE OBJECTIVE

The course aims to create awareness among the students, of the rich and diverse literary cultures of ancient, medieval and modern India. It would enable the students to appreciate the Indian classical literature, discuss Indian society post partition and understand the importance of devotion and dedication in human life.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Record the masterpieces in Indian classical literature,
CO 2: Explore images in literary productions that express the writers' sense of their society,
CO 3: Imbibe the virtue of sacrifice, passions, integrity, tolerance and selflessness,
CO 4: Compare English literature and Indian classical literature,
CO 5: Appraise the richness of Indian culture and the quality of the translated works, and
CO 6: Familiarize with the mechanism of translation.

COURSE DETAILS

Translation
A Brief Overview: What is translation? Types of translation.

Epics

- A short section from The Mahabharata – Draupadi's humiliation
- A short selection from Kamba Ramayana – Sita's humiliation

Short Story

- A story from Panchatantra
- A story from Jataka
- Premchand – a story
- Sadat Manto – Toba Tek Singh

Poetry

- Sections from Meghadutam, Kalidasa
- Bhakti poems – Mira Bai, Kabir, Bhima Bhoi
- Urdu tradition – Ghalib, Bahadur SahaZaffar
- Gitanjali – a few poems

Biography

- A selection from Harshacharita
- A short selection from Akbarinama

Play

- Bhasa – Urubhanga (short play – linked to section from Mahabharata)
- Mohan Rakesh – a section of his play (AdheAdhure)

Reference Books

1. Buck, W. (2019). Mahabharata. University of California Press.
2. Chakraborty, P. (2009). Stories from the Panchatantra.
3. Fazl, Abu'l (1877). Akbarnamah (Persian). Asiatic Society, Calcutta.
4. Francis, H. T., & Thomas, E. J. (Eds.). (2014). Jataka tales. Cambridge University Press.
5. Jeremy, Munday, Introducing Translation Studies, London: Oxford University Press, 2001.
6. Kane, Pandurang Vaman, ed. The Harshacarita of Banabhatta:(text of Uchchhvasas I-VIII). Motilal Banarsidass Publ., 1986.
7. Rajan, Chandra. Kalidasa: The loom of Time, New York, Penguin Books, 1989
8. Rakesh, Mohan. Halfway House. Worldview Publications, 2006.
9. Ray P , Yajnaseni, the story of Draupadi. Translated by P Bhattacharya. New Delhi: Rupa & Co., 1995.
10. Saadat Hasan Manto (2006). Arif, Iftikhar; Khan, Mohammad Anwar; Siddiqui, Khurram Khiraam (eds.). Frances W. Pritchett (trans.). "Toba Tek Singh". Pakistani Literature. Islamabad: The Pakistan Academy of Letters. **11** (2): 83.
11. Saadat Hasan Manto (2008), ٹوبہ ٹیک سنگھ(Toba Tek Singh), Four Corners, 2008, ISBN 978-81-907633-5-6.
12. Sreenivasan, R. (1993). Kamba Ramayanam.
13. Tagore, Rabindranath. Gitanjali. Courier Corporation, 2000.
14. Wilson, Horace Hayman (1813). The Mégha Dúta, Or, Cloud Messenger: A Poem, in the Sanskrit Language. Calcutta: College of Fort William.
15. School, B. (2016, August 24). Draupadi Humiliated, Mahabharata. World History Encyclopedia. Retrieved from https://www.worldhistory.org/image/5520/draupadi-humiliated-mahabharata/
16. https://allpoetry.com/Mirabai
17. https://allpoetry.com/Kabir
18. BHOI, B., & Rath, R. (1994). Three Songs. India International Centre Quarterly, 21(1), 23-25.
19. Beltz, J. (2008). Bhima Bhoi. Encyclopedia of hinduism, 775-775.
20. https://www.poemhunter.com/mirza-ghalib/poems/

21. https://allpoetry.com/Bahadur-Shah-Zafar
22. Gerow, E., & Bhāsa. (1985). Bhāsa's Ūrubhaṅga and Indian Poetics. Journal of the American Oriental Society, 405-412.
23. Paul, Samiran Kumar. The Complete Poems of Rabindranath Tagore's Gitanjali: Texts and Critical Evaluation. Sarup & Sons, 2006.
24. Sigi, R. (2006). Munshi Prem Chand. Diamond Pocket Books (P) Ltd.
25. https://archive.org/details/kamba-ramayana-english

CLIMATE CHANGE NARRATIVES

Course Code: HS30052
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of this course is to study climate fiction to demonstrate new ways of thinking about climate change and invoke opportunities for imagining more just and resilient futures. This course will enable skills for thinking, writing, and speaking critically about *both* literature *and* climate change. Moreover, it will enable the learners to analyze the specific formal and stylistic conventions of literary and cultural texts and situate those texts within broader debates and discourses—scientific, historical, and political—about climate change.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Draw on relevant political, historical, and scientific information to place literary and cultural texts within wider debates and discourses about climate change,
CO 2: Identify how literary and cultural texts complement or challenge understandings of climate change,
CO 3: Reflect on understandings of and feelings about climate change,
CO 4: Employ logic, creativity, and interpretive skills to produce persuasive and imaginative arguments about literature, culture, and climate change,
CO 5: Create a report on climate concerns, and
CO 6: Evaluate the impact of climate change on the local communities.

COURSE DETAILS

Introduction to Climate Change

- The New Climate War: The Fight to Take Back Our Planet, Michael E Mann
- Time Capsule Found on the Dead Planet, Margaret Atwood
- The Drowned World, JG Ballard
- Environmental Crisis and Hindu Religion, O.P. Dwivedi and B.N. Tiwari.

Impacts of Climate Change

- "Evidence for Climate Change,": Explore the CEEW project (Blog)Research present or future climate change impacts in your own community.
- "Diary of an Interesting Year," Helen Simpson "The Tamarisk Hunter," Paolo Bacigalupi
- "The Weatherman," Holly Howitt
- Living Mountain: The Fable of our times "Amitav Ghosh

Language of Climate Communication in Literature

- I'm not a plastic bag, Rachel Hope Alison
- Leila, Prayag Akbar

Textbooks

1. Rachel Hope Alison, I'm Not a Plastic Bag. New York: Archaia, 2012. ISBN-10: 1936393549.
2. Prayag Akbar. Leila. Simon and Schuster, 2017. ISBN: 978-0-571-34133-7.
3. Ed. by Mark Martin (Editor), Bill McKibben (Introduction), Margaret Atwood (Contributor), Paolo Bacigalupi (Contributor), T.C. Boyle (Contributor), I'm With the Bears: Short Stories from a Damaged Planet. Verso, 2011. ISBN-10 : 9781844677443.
4. J.G. Ballard, The Drowned World. Reprint Fourth Estate: United Kingdom. ISBN-0007221835.
5. Amitav Ghosh, Living Mountain: The Fable of Our times. India: Fourth State India. 9354898874
6. Michael E Mann, The New Climate War: The Fight to Take Back Our Planet. USA: Public Affairs. 1541758234.
7. O.P. Dwivedi and B.N. Tiwari, Environmental Crisis and Hindu Religion, New Delhi: Gitanjali Publishing House, 1987.

Reference Books

1. Maslin, Mark, Climate Change: A Very Short Introduction, Third Edition. Oxford: Oxford UP, 2014. ISBN: 9780198719045.
2. Rich, Nathaniel, Odds Against Tomorrow. New York: Farrar, Straus and Giroux, 2013. ISBN: 9781250.

INTRODUCTION TO SCIENCE FICTION

Course Code: **HS30054**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Introducing students to science fiction literature, both classic and contemporary. The aim is to nurture an interest in literature for those who already have it, and to create interest for those who do not, through a genre of literature that may be more relevant and exciting to them than old classics. Texts will deal with fictional representations of dystopia, artificial intelligence, theories of technology, cyberpunk, and alternative reality.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the concept of genre literature,

CO 2: Acquire knowledge of the important concepts of science fiction,

CO 3: Learn methods of textual analysis and critique,

CO 4: Recognize the role of popular and commercial literature in everyday life,
CO 5: Identify the role of technology and ethics in real-life future, and
CO 6: Analyse an issue from multiple perspectives.

COURSE DETAILS

Early Science Fiction, Emergence through 1917
Text: Jules Verne & Michel Verne, 'In the Year 2889' (1889)
Definition of science fiction, timeline of science fiction, categories of science fiction
Supplementary reading: H. G. Wells, 'The Chronic Argonauts' (1888)

Science Fiction between the Wars, 1918-1939
Text: E. M. Forster, 'The Machine Stops' (1928)
Science fiction as expression of potential; eutopia and dystopia
Supplementary reading: Murray Leinster, 'Proxima Centauri' (1935)
Supplementary viewing: Fritz Lang, *Metropolis* (1927)

The Golden Age and the Atomic Age 1940-1963
Text: C. L. Moore, 'No Woman Born' (1944)
Science fiction exploring alienness and mutation
Supplementary reading: Isaac Asimov, 'Nightfall' (1941), Judith Merrill, 'That Only a Mother' (1948)
Supplementary viewing: Ishiro Honda, *Godzilla* (1954)

New Wave and Reaction, 1963-1983
Text: Philip K. Dick, 'We Can Remember It for You Wholesale' (1966)
Humanity and human-machine division, beginnings of artificial intelligence, gender and its social implications in science fiction.
Supplementary reading: James Tiptree Jr., 'The Girl Who was Plugged In' (1974)
Supplementary viewing: Ridley Scott, *Blade Runner* (1982)

Cyberpunk, 1984 and Onwards
Text: William Gibson, 'Johnny Mnemonic' (*Burning Chrome*, 1986)
Exploring artificial intelligence, alternate self, and alternate reality
Supplementary reading: Douglas Adams, 'Young Zaphod Plays it Safe' (1986)
Supplementary viewing: Barry Sonnenfeld, *Men in Black* (1997), Mamoru Oshii, *The Ghost in the Shell* (1995)

Contemporary Trends
Text: Manjula Padmanabhan, 'Flexi-time' (2019)
Science fiction in contemporary times, Indian science fiction, science fiction as series
Supplementary reading: Ruhan Zhao, 'My Left Hand' (2017)
Supplementary viewing: Charlie Brooker, *Black Mirror* (2016-present), Choi Hangyong, *The Silent Sea* (2021), Chris Renaud & Pierre Coffin, *Despicable Me* (2010)

Textbooks

1. Jules Verne, Selected Short Stories, Maple Press, 2019.

2. E. M. Forster, The Eternal Moment & Other Stories, Mariner Books, 1970.
3. Philip K. Dick, The Short Story Collection, Createspace Independent Publishers, 2014.
4. William Gibson, Burning Chrome, Gollancz Publishers, 2017.
5. Tarun Saint & Manjula Padmanabhan eds. The Gollancz Book of South Asian Science Fiction vol. 1, Hachette India, 2019.
6. Lucas K. Law & Derwin Mak eds. Where the Stars Rise: Asian Science Fiction & Fantasy, Laksa Media Groups Inc., 2017.

Reference Books

1. Adam Roberts, The History of Science Fiction, Palgrave McMillan, 2nd Edition, 2016.
2. Brian Aldiss & David Wingrove, Trillion Year Spree, Gollancz, 1986.
3. Carl Freedman, Critical Theory and Science Fiction, Wesleyan University Press, 1st Edition, 2000.
4. Darko Suvin, Metamorphoses of Science Fiction, Peter Lang AG, updated edition, 2016.
5. Edward James & Sarah Mendlesohn, The Cambridge Companion to Science Fiction, Cambridge University Press, 1st Edition, 2003.

ECONOMETRICS FOR BUSINESS DATA ANALYTICS

Course Code: **HS40151**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Econometrics is a set of research tools used to estimate and test economic relationships. The methods taught in this course can also be employed in the business disciplines of accounting, finance, marketing and management and in many social science disciplines. SPSS provides data analysis for descriptive and bivariate statistics, numeral outcome predictions and predictions for identifying groups. The software also provides data transformation, graphing and direct managing features.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the usage of econometric tools in business,
CO 2: Describe BLUE and various types of distribution,
CO 3: Forecast future values using correlation and regression using SPSS,
CO 4: Check the relation between variables using causality, factor analysis and SEM using SPSS,
CO 5: Estimate and predict using dummy variables using SPSS, and
CO 6: Gain working knowledge on SPSS.

Nature and scope of Econometrics. Specification Analysis. Omission of a relevant variable. Inclusion of irrelevant variable, Tests of specification. Estimation of parameters, Testing of hypotheses , Defining statistical hypotheses, Distributions of test statistics, Testing hypotheses related to population parameters, Type-I and Type-II errors; Power of a test.

Properties of estimators, Best Linear Unbiased Estimator, Goodness of fit- R^2 and Adjusted $R^{2.}$ Scaling and units of measurement, Confidence intervals, Gauss Markov Theorem. Normal distribution; chi-sq, t-and F-distributions, , Tests for comparing parameters from two samples. Data analysis using SPSS.

Correlation- Partial and multiple. Estimation of model by method of ordinary least squares. Causality test, Granger test and Sim's test. Forecasting. Violations of Classical Assumptions: Consequences, Detection and Remedies – Multicollinearity; Heteroscedasticity; Serial correlation. Data analysis using SPSS.

Individual and Joint Functional Forms of Regression Models. Qualitative (dummy) independent variables. Factor Analysis. Cluster analysis. Structural Equation Modeling. Data analysis using SPSS and AMOS.

Textbooks

1. Joseph F. Hair Jr., William C. Black, Barr y J. Babin, Rolph E. Anderson Multivariate Data Analysis, 8th Edition. Cengage Publication.

Reference Books

1. Gujarati, D.N., Basic Econometrics, Mc Graw Hill, New Delhi.
2. Wooldridge, Introduction to Econometrics, Cengage Publication.
3. Kmenta J., Elements of Econometrics, University of Michigan Press.
4. Johnston J., Econometric Methods (2nd edition), Mc Graw Hill, New Delhi.
5. Gupta S.C, Fundamental of Statistics. Himalaya Publishing House.
6. Gupta S.C and Kapoor V.K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi.
7. G.S. Maddala- An Introduction to Econometrics.
8. Landau, S., & Everitt, B.S. A handbook of statistical analyses using SPSS. Chapman and Hall/CRC, , 2003.

FINANCIAL ECONOMICS

Course Code: HS40153
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Financial economics analyzes the use and distribution of resources in markets. It employs economic theory to evaluate how time, risk, opportunity costs, and information can create incentives or disincentives for a particular decision.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand theories of investment,
CO 2: Discuss portfolio analysis,
CO 3: Explain Efficient Market Hypothesis,
CO 4: Describe *Capital Asset Pricing Model,*

CO 5: Understand derivatives and options, and
CO 6: Discuss various types of contracts.

COURSE DETAILS

Investment theory and portfolio analysis: deterministic cash flow streams; basic theory of interest; discounting and present value; internal rate of return; evaluation criteria; fixed-income securities; bond prices and yields; interest rate sensitivity and duration; immunization; the term structure of interest rates; yield curves; spot rates and forward rates.

Single period random cash flows; mean-variance portfolio theory; random asset returns; portfolios of assets; portfolio mean and variance; feasible combinations of mean and variance; mean-variance portfolio analysis: the Markowitz model and the two-fund theorem; risk-free assets and the one-fund theorem. Efficient Market Hypothesis.

CAPM: the capital market line; the capital asset pricing model; the beta of an asset and of a portfolio; security market line; use of the CAPM model in investment analysis and as a pricing formula; the CAPM as a factor model, arbitrage pricing theory.

Futures, options and other derivatives: introduction to derivatives and options;
forward and futures contracts; options; other derivatives.

Textbook

1. Zvi Bodie, Alex Kane, Alan J. Marcus, Pitabas Mohanty. Investments, 11th Edition. Mc-Graw Hill.

Reference Books

1. Brealey, R., Myers, S., Allen, F., Mohanty, P., Principles of corporate finance, 10th Edition, Tata McGraw-Hill, 2013.
2. Hull, J., Basu, B., Options, futures, and other derivatives, 9th Edition, Pearson Education, 2017.
3. Luenberger, D., Investment Science. Oxford University Pres, 2013.

CORPORATE FINANCE

Course Code: HS40155
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Corporate financing manages financial activities by obtaining funds from the right sources. Corporate financing manages financial activities to maximize the return on investment. Corporate financing balances risk and profitability by properly structuring and budgeting the capital.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn about expected utility maximization – Risk aversion,
CO 2: Understand trade-off between risks and return,

CO 3: Know the principle of arbitrage; discrete processes and the binomial tree mode,
CO 4: Analyse the risk neutral valuation; stochastic process and the Markov property,
CO 5: Learn the idea underlying the Black- Scholes-Merton (BSM) differential equation, BSM pricing formulas; the Greek letters, and
CO 6: Understand the use of futures for hedging.

COURSE DETAILS

The Economic properties of utility functions – concept & measures to model attitudes towards risk – Expected utility maximization – Risk aversion – Motivation – First order stochastic dominance – Second order stochastic dominance – Stochastic dominance Vs dominance- risk: Risk versus return: Mean-variance analysis. Game Theory. The Prisoner's Dilemma. Nash Equilibrium.

Trade-off between risk and return (the Markowitz model) – Efficient frontier of risky assets – Value at risk of a portfolio – Computing VaR-Definition of VaR. Sharpe single index model.

The principle of arbitrage; discrete processes and the binomial tree model; risk neutral valuation; stochastic process (continuous variable, continuous time), the Markov property, Itô's lemma; the idea underlying the Black- Scholes-Merton (BSM) differential equation, BSM pricing formulas; the Greek letters.

The use of futures for hedging, stock index futures; forward and futures prices; interest rate futures and duration-based hedging strategies, option markets; call and put options; factors affecting option prices; put-call parity; option trading strategies: spreads; straddles; strips and straps; strangles.

Textbook

1. Westerfield, R.W., Jaffe, J., Ross, S. A., & Kakani, R.K. Corporate Finance (8^{th} Edition). The Mc-Graw Hill Companies.

Reference Books

1. D.G. Luenberger (1998), Investment Science, Oxford University Press, New York.
2. J. Cvitanic and Zapatero F (2004), Introduction to Economics and Mathematics of Financial Markets, MIT Press, Cambridge, London.
3. E. J. Elton and M.J. Gruber, Modern Portfolio Theory and Investment Analysis, Wiley, London.
4. Z. Bodie, A. Kane and A.J. Marcus (2004), Investments, Irwin McGraw – Hill, London.
5. R.A. Haugen (2001), Modern Investment Theory, Fifth Edition, Prentice Hall, New Jersey.
6. J.C. Hull (2004), Futures and Option Markets, Prentice-Hall, New Jersey.

PUBLIC ECONOMICS

Course Code: HS40156
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course is an overview of government finances with special reference to India. It aims to introduce students to the main concepts in public finance, taxation policy, management of public expenditure, public debt and budgetary techniques and practices. It will be useful for students aiming towards careers in the government sector, policy analysis, business.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand public finance and different roles played by the government in an economy,
CO 2: Learn about the interaction between the public and the private sector regarding several economic functions in an economy,
CO 3: Analyze the rationale behind different public sector activities by the government as suggested from the study of public finance,
CO 4: Differentiate between public goods and private goods,
CO 5: Understand the market failure and the role of the government, and
CO 6: Understand financial market in the light of the need to achieve efficiency and distribution goals.

COURSE DETAILS

Public Finance and private finance; public good vs. private good; Market failure and role of government; Criteria for public investment-Social Cost-Benefit Analysis; Maximum Social Advantage. Tax System: structure and reforms. Tax saving schemes.

Wagner's law of increasing state activities; Wiseman-Peacock hypothesis; Pure theory of public expenditure; Structure and growth of public expenditure; Criteria for public investment; Social cost-benefit analysis – Project evaluation.

Objectives of fiscal policy – full employment, anti-inflation, economic growth, redistribution of income and wealth; Interdependence of fiscal and monetary policies; Budgetary deficit and its implications; Fiscal policy for stabilization – Automatic vs discretionary stabilization; Alternative measures of resource mobilization and their impact on growth, distribution and prices; Balanced budget multiplier.

Challenges of financing small economic operators like moral hazard, adverse selection, high transaction cost and information asymmetry etc. Concept of microfinance: different models of microfinance operating in India; Self Help Group-Bank Linkage Programme (SBLP) in India. Subsidy-linked credit programmes and Non subsidy-link programmes of the Government of India for rural sector.

Textbook

1. Musgrave, R.A. and P.B. Musgrage, Public Finance in Theory and Practice, McGraw Hill, Kogakusha, Tokyo. 1976.

Reference Books

1. Goode, R., Government Finance in Developing Countries, TMH, New Delhi, 1986.
2. Jha, R., Modern Public Economics, Routledge, London, 1998.
3. Atkinson, A.B. and J.E. Siglitz, Lectures on Public Economics, TMH, New York. 1980.
4. Herber, B.P., Modern Public Finance, Richard D.Irwin, Homewood, 1967.

5. Stiglitz, J.E., & Rosengard, J.K., Economics of the public sector: 4th international student Edition. WW Norton & Company, 2015.
6. Jean Tirole, The Theory of Corporate Finance, Princeton University Press, 2006, ISBN: 9780691125565.

EMPLOYMENT, EMPLOYABILITY AND GROWTH

Course Code: **HS40157**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to Introduce the development economics, and then proceeds to study developmental policies to promote economic opportunity, and the future of work in the rapidly changing world, and to explain the link between environment and economic development, and globalization and economic development.

COURSE OUTCOME

After successfully completing the course, the students will be able to

CO 1: Learn about basics of development economics, with in depth discussions of the concepts of development and growth,
CO 2: Understand importance of human development and human capital for the economic Development,
CO 3: Understand the impact of globalization on economic growth,
CO 4: Learn about long run dynamic technology and future of work,
CO 5: Gain knowledge on policies and programmes to develop more sustainable economy, and
CO 6: Analyze the data related to growth and development.

COURSE DETAILS

Introduction to economic growth and development
Conceptualizing Development: Meaning of Economic development, Growth and Development; Growth accounting, Solow residual, A Contrast in Concepts, Measuring Economic Growth, Measuring Economic Development, The Development Gap; Human Development: What and Why Human Development, Essential Components of Human Development , Human Development Index

Labour force growth and occupational pattern; Labour relation and Social Security
Labour Force Growth in India, Occupational Structure and Economic Development Occupational Distribution of Labour Force in India; Magnitude of Industrial Disputes, Causes of Industrial Disputes, Industrial Relations: Policy of the Government, Social Security in India.

Globalization, Foreign aid and trade: Enable growth and development
Globalization and its impact: Meaning, steps, effects. Foreign Capital/Foreign Direct Investment (FDI), government policy, foreign aid, Foreign trade, Foreign trade of India, Foreign direct investment and trade: interlinkages and policy implications, Special Economic Zone (SEZ), International migration (FLO), Global value chain (GVC); concept as a model of growth.

Technology and future of work
Global value chain (GVC); Tradition and Technology, Transfer of technology, ICT and employment opportunities- agriculture, industry, service sector; social and economic development; ICT infrastructure and E-resilience, Skill development programmes of India.

Data analysis (Using software)
Recent budgetary policies and programs, Analysis of Economic Survey data pertaining to above concepts.

Textbook

1. Gaurav Datt and Ashwani Mahajan, *Indian Economy*, GENERIC. Classic Edition, 2022, ISBN-10: 9352531299 ISBN-13: 978-9352531295

Reference Books

1. S.K. Mishra, and V.K. Puri, Indian Economy, Himalaya Publishing House,2022, ISBN: 978-93-5596-423-6.
2. Uma Kapila, Indian Economy: Economic Development and Policy, Academic Foundation, 2022, ISBN-10: 9332705550 and ISBN-13: 978-9332705555.
3. Michael P. Todaro and Stephen C. Smith, Economic Development. Pearson Publications, 2015.
4. J. Drèze, R. Khera, Recent Social Security Initiatives in India. World Development, 98, 555–572, 2017. https://www.sciencedirect.com/science/article/pii/S0305750X17302097.

ADVANCED ECONOMETRICS

Course Code: **HS40158**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The primary objective of this course is to provide an advanced treatment of econometric methods for cross section and panel data including linear and non-linear models. EViews can be used for general statistical analysis and econometric analyses, such as cross-section and panel data analysis and time series estimation and forecasting.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn the regressions with Qualitative Independent Variables,
CO 2: Understand the theory and application of dynamic econometrics models,
CO 3: Know to estimate and interpret the Granger causality test results,
CO 4: Understand about Eviews software and import of data to Eviews,
CO 5: Learn the data analysis using Eviews, and
CO 6: Know the theory and application of cointegration, VAR and VECM with time series data.

COURSE DETAILS

Regressions with Qualitative Independent Variables

Dummy variable technique – Testing structural stability of regression models comparing to regressions, interaction effects, seasonal analysis, piece wise linear regression; The LPM, Logit, Probit and Tobit models – applications. Data analysis using Eviews.

Dynamic Econometric Model
Auto-regressive and distributed lag models – Koyak model, partial adjustment model, adaptive expectations; Instrumental variables, Problem of auto-correlation – application; Almon approach to distributed lag models. Data analysis using Eviews.

Ordinary Least Square Methods
OLS, FMOLS, DOLS. Estimating generalized least squares (GLS) equations using the Cochrane-Orcutt method. Data analysis using Eviews.

Volatility model(s)
ARCH, GARCH, GARCH-M, TGARCH, EGARCH. Cointegration, VAR and VECM. Data analysis using Eviews.

Textbook

1. Bhaumik, Sankar – Principles of Econometrics: A Modern Approach using EViews, OUP, 2015.

Reference Books

1. Koutsoyiannis, A., Theory of Econometrics, Macmillan Press, London, 1977.
2. Amemiya,T., Advanced Econometrics, Harvard University Press, London, 1985.
3. Mas-Colell,A., M.D. Whinston and J.R. Green, Microeconomic Theory, Oxford University Press, 1995.

ECONOMIC INEQUALITY

Course Code: **HS40162**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course studies inequality from the economic perspective.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn about various aspects of inequality,
CO 2: Analyse and Measuring Inequality,
CO 3: Understand food security and inequality,
CO 4: Understand about health and educational disparity,
CO 5: Learn about effectiveness of current government programs, and
CO 6: Analyze the data on economic inequality.

COURSE DETAILS

Introduction to inequality
Meaning of inequality; Global versus within-country inequality, growth and inequality; indicators of regional imbalance; cause of regional inequality; policy measures to remove regional inequality.

Measuring Inequality
Income Inequality, causes of income inequality; Axioms of inequality, Lorenz curve and Kuznets' inverted U hypothesis, Gini Coefficient, Decile dispersion ratio, Palma ratio, Gary S. Fields's Prediction.

Inequality and Food Security
Food and nutritional value; Global Hunger Index; Concept of food security, Global food security index; food self-sufficiency; Public Distribution System (PDS); Steps to reform PDS.

Inequality and Human Resource Development
Essential components of Human development, Human development Index (HDI), HDI ranking vs Income ranking, Inequality adjusted human development index, Gender inequality, Gender inequality index; Population stabilization; Health care infrastructure; Development of education sector in India, Equity and inclusion in education, policy measures to remove inequality.

Current Status of Inequality
Recent budgetary policies and programs relating to inequality; Analysis of Economic Survey data.

Textbook

1. Gaurav Datt and Ashwani Mahajan, Indian Economy, GENERIC. Classic Edition, 2022, ISBN-10: 9352531299, ISBN-13: 978-9352531295.

Reference Book

1. S.K. Mishra, and V.K. Puri, Indian Economy, Himalaya Publishing House,2022, ISBN: 978-93-5596-423-6.
2. Inequality Re-Examined. Amartya Sen. Oxford University Press. ISBN-10: 0198289286, ISBN-13: 978-0198289289.
3. Uma Kapila, Indian Economy: Economic Development and Policy, Academic Foundation, ISBN-10: 9332705550 and ISBN-13: 978-9332705555.

SUSTAINABLE ENERGY AND APPLICATIONS

Course Code: **EE30032**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Objective of this course is to inculcate in students an awareness of environmental issues and the global initiatives towards attaining sustainability. The student should realize the potential of technology in bringing in sustainable practices.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Understand the relevance and the concept of sustainability and the global initiatives,
CO2: Explain the different types of environmental pollution problems and their sustainable solutions,
CO3: Discuss the environmental regulations and standards,
CO4: Outline the concepts related to conventional and non-conventional energy,
CO5: Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles,and
CO6: Know the various methods for increasing efficiency in building.

COURSE CONTENT

Sustainability

Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM).

Environmental Pollution

Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Carbon credits, carbon trading and carbon foot print, legal provisions for environmental protection.

Environmental management standards

ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA), Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.

Resources and its utilisation

Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy.

Sustainability practices

Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport.

Smart and Intelligent Materials

Text Books

1. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
2. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning

Reference Books

1. Environment Impact Assessment Guidelines, Notification of Government of India, 2006
2. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998
3. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System

SOLAR ENERGY UTILIZATION

Course Code: EE30030
Credit: 3
L-T-P : 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

To provide a deep introduction about solar energy basics, principles, materials, theories and derivations about solar radiation, devices and its applications.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO1: Analyze the mathematical modelling of the solar radiation pattern,
CO2: Estimate solar radiations and its measurement methods,
CO3: Understand the construction features of various solar collectors,
CO4: Analyze the performance parameters of various solar collectors,
CO5: Explore the various applications of solar energy,and
CO6: Categorize the different forms of the energy storage units.

COURSE CONTENT

Solar Radiation

History of solar energy utilization - Solar radiation and modelling - Empirical equations for predicting the availability of solar radiation – Measurement of global, direct and diffuse radiation – Radiation computations on inclined surfaces – Angstrom's turbidity - Solar chart - Standard radiation scale.

Solar Radiation Measurement and Estimating

Measurement of solar radiation - Solar energy measuring instruments – Pyranometer – Pyrheliometer – Sunshine recorder - Estimation of average solar radiation - Ratio of beam and total radiation on tilted surface of that on horizontal surface.

Solar Collectors

Flat plate collector - Materials for flat plate collector and their properties - Thermal Analysis of Flat- plate Collector and Useful Heat Gained by the fluid - fin efficiency, collector efficiency, Heat Removal Factor, Focusing collectors, Types and applications of focusing collectors

Solar Energy Applications

Introduction and principle of operation of solar cooker, solar air heater, solar water heater, solar distillation, solar pond, solar thermal power generation, Greenhouse effect, Solar PV application

Storage of Solar Energy

Types of Energy Storage, Thermal Storage, Electrical Storage, Chemical Storage, hydro-storage

Text Books

1. Rai, G.D., Solar Energy Utilization, Khanna Publishers, N. Delhi, 2010.
2. Sukhatme S.P., Solar Energy, Tata McGraw Hills P Co.,3rd Edition, 2008

Reference Books

1. Jean Smith Jensen, Applied solar energy research: a directory of world activities and bibliography of significant literature, Volume2, Association for Applied Solar Energy, Stanford Research Institute, 2009.
2. Duffie, J.A., and Beckman, W.A. Solar Energy Thermal Process, John Wiley and Sons, NewYork, 2006. Jui Sheng Hsieh, Solar Energy Engineering, Prentice- Hall, 2007.

WIND AND BIOMASS ENERGY

Course Code: EE40013
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

To provide a deep introduction about wind energy basics, wind energy conversion Technologies, Various types of Biomass energy sources and Biomass to energy conversion technologies.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Know the basics of wind energy conversion and their operating characteristics,

CO2: Design the aerodynamics of wind rotor and wind turbine system,

CO3: Analyse the use of different power electronics converters and electrical machines used in stand alone wind energy conversion systems,

CO4: Analyze the nature and principles of bioenergy systems,

CO5: Prioritize the concept of waste management to energy production,and

CO6: Analyze the mechanism of different Biomass energy conversion technologies.

COURSE CONTENT

Wind Energy Basics and Types of Turbines

Sources of Energy: Renewable energy sources and features. Introduction to windenergy. Wind Turbine Sitting, General theories of wind machines: Basic laws and concept of aerodynamics, efficiency limit for wind energy conversion. Description and performances of horizontal axis wind turbine: Design of the blades and determination of forces acting on the wind power plant, power ~ speed and torque ~ speed characteristics of wind turbines, wind turbine control systems. Description and performances of vertical axis wind turbine

Wind Energy Power Conversion Technologies and applications

Conversion to electrical power: Induction and synchronous generators, grid connected and self-excited induction generator operation, generation schemes with variable speed turbines, constant voltage and constant frequency generation with power electronic control, Optimized control of induction generators and synchronous generators. Reactive power compensation, Types of converters, Type of wind energy conversion system, MPPT techniques for wind electrical systems.

Biomass Energy Source

Biomass energy sources, energy content of various Bio – fuels, Energy plantation, origin of Biomass photo synthesis process, Biomass Characteristics, Briquetting, Pelletization, Agrochemical, sustainability of Biomass.

Biomass Energy Conversion Technologies

Biomass Conversion Technologies, Urban Waste to Energy Conversion, Biomass Gasification: Types of gasifiers. Fixed bed gasifiers, Fluidized bed gasifiers. Biomass Liquefaction: Biomass to Ethanol

Production, Bio Diesel from edible & non-edible oils, Production of Bio diesel from Honge & Jatropha seeds, Blending of Bio diesel, Performance analysis of diesel engines using bio diesel, Biogas production from waste Biomass, classification of Biogas digester, floating gasholder & fixed dome type.(Working Principle with diagram), Calculations for sizing the Biogas plant.

Text books

1. S. N. Bhadra, D. Kastha, S. Banerjee, Wind Electrical Systems, Oxford Univ. Press , 2005
2. B. H. Khan, "Non – Conventional Energy Resources" Tata Mc Graw Hill, 2nd edition 2009.

Reference Books

1. Kothari D.P., "Renewable energy resources and emerging technologies", Prentice Hall of India Pvt. Ltd, 2006.
2. Rai G.D, "Non-Conventional Energy Sources", Khanna Publishers, 4th Edition 2000.
3. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.

INDUSTRIAL ECOLOGY AND DESIGN FOR SUSTAINABILITY

Course Code: **LS30002**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course will aim to cover the core concepts of sustainability, sustainable engineering, and how natural ecosystems function. The next objective would be to identify replicable natural systems from an engineering perspective, and how technological systems may be able to mimic nature. Modelling human made and natural systems and their dynamics, along with identifying key structural and functional nodes that can turn an industry to become fully automated while considering key environmental and social angles.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the basic nature of the course on offer,
CO 2: Comprehend and scrutinize the underlying network of every ecosystem,
CO 3: Apply ecological concepts to industries,
CO 4: Understand the sequence of events which lead to an environmental impact,
CO 5: Apply and visualize engineering knowledge to solve practical problems, and
CO 6: Learn an organized approach to manage environmental quality.

COURSE DETAILS

Introduction to Industrial Ecology
Fundamentals of sustainability, Sustainable Development Goals, Climate crisis, the promise of an ever-expanding global economy, industrial engineering, role of engineers, origin of IE, its definition, the

environment and the anthrosphere, industrial systems, material resources, societal factors and environmental equity. Link to sustainable development.

Ecosystem Functioning
Components, interactions, structuring, energy flow in different ecosystems, ecological pyramids, nutrient cycling, concept of niche.

Industries as Ecosystems
Components of an industrial ecosystem (Kalundborg example), zero waste industries, Material cycling, Resilience to stochastic events industrial symbiosis, role of government, community, developers, management, biomimetics, turning linear process cyclical, waste utilization (refusing, reducing, repurposing, recycling, and reuse)evaluating the success of eco-industrial development.

Life Cycle Assessments
Cradle to coffin following up on the origin and degradation of materials used in industries, how can one assess the fate of materials, waste products, and reduce industrial waste. Life cycles of products, processes and facilities; life cycle assessment (components, methodology, applications, difficulties), design for environment, efficient use of material (remanufacturing, recycling, reuse, etc.

Design for Sustainability
Product design, automating industries (drones, neural networks, IOT), conception of environmentally friendly products, carbon neutral industries, use of bamboo, mushrooms and alternative materials.

Environmental Management Systems
ISO, auditing, maintenance of EMS, ISO14001.

Textbook

1. Erkman S. and Ramaswamy R., Applied Industrial Ecology – A New Platform for Planning, Sustainable Societies, AICRA Publishers, Bangalore, India, 2003.

Reference Book

1. Edward Cohen-Rosenthal E. and Musnikow J. (edited) (2003) Eco-industrial Strategies, Sheffield, UK: Greenleaf Publishing.

WASTE MANAGEMENT AND ENERGY RECOVERY

Course Code: EE40018
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

To enable the students to learn the sources and types of waste generation as well as acquaint the methods of collection, transport, processing and generation technologies.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Know the various sources of waste and waste management methods,

CO2: Demonstrate proficiency in weast collection, transportation and processing techniques,

CO3: Analyze different weast treatment methods and its environmental implication,

CO4: Evaluate hazadeous weast sources potentioal environmental impacts and risk assessment techniques,
CO5: Compare various weast management techniques,and
CO6: Analyze environmental impact analysis to assess the weast management practice on air and water pollution.

COURSE CONTENT

Introduction

Sources, generation and estimation, types, compositions, Properties - physical, chemical and biological. Collection, Transfer stations, waste minimization, Recycling of municipal wastes, regulations.

Collection, Transportation And Processing Techniques

Onsite handling, storage, processing, types of waste collection mechanisms, Transfer stations - types and location, Manual component separation and other sepaation techniques.

Size Reduction

Aerobic Composting, Incineration for Medical /Pharmaceutical Waste. Land Fill Method- Types, Methods & siting consideration. Composition, characteristics, generation. Control of land fill leachate & gases, an environmental monitoring system for landfill gases.

Hazardous Waste

Definition, potential sources, impact on the environment, transportation regulations, risk assessment, remediation technologies. Private-public partnership, Government initiatives. Disposal of Hazardous Waste - Underground Storage Tanks Construction, Installation and Closure.

Managing wastes

Basics, types, working and typical conversion efficiencies of composting, anaerobic digestion, combustion, incineration, gasification, pyrolysis.

Environmental Impact Assessment

Production and assessment of impacts due to air and water pollution on the environment. Environment Impact Assessment in the land and biological environment. Environmental Effects due to Incineration.

Text books

1. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Prentice Hall 1999.
2. Barthwal, R. R., Environmental Impact Assessment, New Age International Publishers (P) Ltd 2012 3. Parker, Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985

Reference Books

1. Adaptive environmental assessment and Management Ed. C. S. Holling, John Wiley and Sons 2005
2. S.A. Abbasi and N. Abbasi, Renewable Energy Sources and Their Environmental Impact, Prentice Hall of India 2010
3. Environmental Impact Assessment L.W.Canter, McGraw Hill Book Company 1995
4. Barthwal, R. R., Environmental Impact Assessment, New Age International Publishers (P) Ltd 2012

ADVANCED NUMERICAL TECHNIQUES

Course Code: MA30002
Credit: 3
L-T-P: 3-0-0
Prerequisite: MA11001& MA11002

COURSE OBJECTIVE

The objective of this course is to equip the students with the advanced level of numerical computations to tackle the different mathematical models.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the error propagation in numerical computations,
CO 2: Know the concept of numerical techniques to find the root of non- linear equations and simultaneous equations,
CO 3: Find the interpolating polynomials and inverse interpolation,
CO 4: Apply the numerical techniques to approximate the definite single and double integrals,
CO 5: Know the concept of numerical solution of boundary value problems, and
CO 6: Use the finite difference method to solve partial differential equations.

COURSE DETAILS

Errors
Definition and sources of errors, Propagation of errors, Errors in summation.

Root finding for nonlinear equations and systems of equations
Muller's Method, Chebyshev Method, Solution of the system of non-linear equations using the Newton Raphson method.

Interpolation
Gauss forward and backward interpolation, Hermit's interpolation, Bivariate Interpolation and Inverse interpolation.

Numerical Integration
Rombergh Integration, Gauss-Legendre, Gauss-Chebyshev, Gauss-Laguerre, and Gauss-Hermite Integration Methods. Double Integration by Trapezoidal and Simpsonsmethods.

Numerical Solution of ODEs and PDEs
Milne' method, Shooting Method and Finite difference methods to solve parabolic and elliptic equations.

Textbooks

1. Singresu S Rao, The Finite Element method in Engineering, Elsevier, Butterworth Heinemann, 5th Edition.
2. M.K. Jain, S.R.K. Iyenger and R. K. Jain Numerical, Methods for Scientific and engineering computation by, New Age International Publisher, 6th Edition.

Reference Books

1 S. Rajasekharan, Finite Element Analysis in Engineering Design, S. Chand, 2nd Edition.
2 S.S Bhavikatti, Finite Element Analysis, New Age International Edn., 8th Edition.
P. Seshu, Textbook of Finite Element Analysis, PHI.

SUSTAINABLE ENERGY AND ENVIRONMENT

Course Code: CH30002
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course has been designed to make the learners understand principles of sustainable energy sources, their working principles, and their conversion systems. It also explores society's present needs; future energy demands and different energy conservation methods.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explore different renewable energy sources available in present scenario,
CO 2: Understand the mechanism of harvesting solar energy, its use and future prospective,
CO 3: Understand biomass energy generation and its technologies,
CO 4: Realize energy generation principles and techniques of hydrogen and hydro power,

CO 5: Explore energy generation from wind, wave and geothermal sources, and
CO 6: Apply the renewable energy technologies to solve various environmental problems.

COURSE DETAILS

Introduction of renewable energy
Introduction, Principles of renewable energy, Role of energy in economic development and social transformation, Energy Scenario (Classification of Energy Sources, advantages and disadvantages of conventional sources), Salient features of nonconventional energy sources, Energy efficiency and security, Energy and its environmental impacts, Importance of renewable energy sources, Standards and regulations, social implications.

Solar energy
Solar radiation and its nature, fundamentals of solar transmission, absorption and reflection, basics of solar thermal conversion, fundamentals of solar heating, principle and working of solar collectors, basics of solar photovoltaics, Solar photovoltaic energy conversion and utilization, materials and device design, P-N junction, Solar thermal applications to water desalination, refrigeration, and cooling, future prospects of solar energy.

Biomass energy
Basic principles of photosynthesis, photosynthesis and its mechanism at cellular level, Usable forms of biomass, Classification, Chemical composition, fuel properties of biomass, Concept of bio-refinery: Bio-fuels, Bio based chemicals and materials, Biomass conversion routes; biological (Aerobic and Anaerobic conversion, Fermentation), chemical (hydrolysis and hydrogenation) and chemical (Pyrolysis, Combustion, Gasification, and Liquefaction), production of biogas, alcohols, hydrogen, biodiesel and green diesels.

Hydrogen and hydro energy
Hydrogen as a renewable energy source, Sources of Hydrogen, Hydrogen Production: Direct electrolysis of water, thermal decomposition of water, biological and biochemical methods, Storage of Hydrogen: Gaseous, Cryogenic and Metal hydride, Principles of hydropower and types of turbines. Social and environmental aspects of hydrogen fuel and hydropower.

Alternate sources of renewable energy
Wind: Wind resources, characteristics of wind, classification of wind energy conversion systems. Ocean and tidal: Principle of tides and tidal power, ocean thermal energy conversion (OTEC), Energy and Power forms of waves, Wave energy conversion devices. Geothermal Energy: Geothermal Sources, Geothermal energy conversion and aquifer analysis, harnessing of geothermal resources, Social and environmental aspects of wind energy, wave energy and geothermal energy.

Textbook

1. John Twidell and Tony Weir,Renewable Energy Resources-3e, , Routledge-Taylor and Francis.

Reference Books

1. D.P. Kothari, K.C. Singal, Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies-3e, PHI Learning.
2. N.S Rathore and N.L. Panwar, Renewable Energy Sources For Sustainable Development-3e, New India Publishing Agency.

COMPOSITE MATERIALS AND STRUCTURES

Course Code: CH40001
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The main objective of this course is to increase student knowledge in design, manufacture and analysis of composite materials that can have better structural, thermal, electrical, mechanical, dielectric, magnetic, optical, electrochemical and biomedical properties.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Define and classify composites,
CO 2: Evaluate the relative merits of using composites with respect to conventional materials for important engineering and other applications,
CO 3: Quantify physical and mechanical properties of composite materials as a function of parameters such as volume fraction, orientation and arrangement,
CO 4: Design and prepare composite structures,
CO 5: Apply XRD, SEM and TEM in micro- structural analysis of composites, and
CO 6: Understand the concept of green composite and their processing techniques.

COURSE DETAILS

Classifications and Industrial Applications of Composite
General introduction, classification of composites, matrix materials (polymer, metal and ceramics) and reinforcement materials (fibres-glass, Aramid, Carbon, Boron), microstructure of composite, applications: in civil constructions, aerospace industries, automobile, packing industry, advantages and limitations of composite materials.

Performance of structural composites
Matrix/reinforcement interface, reinforcement mechanism, combination effects (law ofmixtures, weight fraction, volume fraction), effect of voids in composites, fracture mechanics of composites, strengthening mechanisms, stress-strain relations (generalized hooke's law), stress distribution in fibre and the matrix (shear stress and axial tensile stress in the fibre along its length), critical length of fibre for full strengthening, estimation of the critical amount of fibre to gain a composite strength.

Fabrication of composites
Fabrication of metal matrix composites, fabrication of polymer matrix composites, fabrication of ceramic matrix composites, selection of constituents, solidification processing of composites, synthesis of in situ composites, various techniques of vapor deposition, liquid phase method and hot pressing etc.
Characterization
Characterization methods of composites (x-ray diffraction (XRD), Electron microscopy (SEM, TEM) analysis of composites, Thermal Analysis, Fire retardancy test for polymer composites.

Green Composite

Introduction, Composition of green composite, bio-degradable reinforcement fibre (cellulose, starch, wool/silk, carbon nanotube, nano-clay, biodegradable matrix (cellulose, starch, chitin, protein), applications

of green composite.

Textbooks

1. Krishan K. Chawla, Composite Materials. 2nd Edition, Springer Press, 2001
2. Deborah D. L. Chung, Composite Materials: Science and applications, Springer, 2004.

References **Books**

1. T.W. Clyne, and D. Hull, An Introduction to Composite Materials, Cambridge University Press, Cambridge, 1996
2. Bhagwan D. Agarwal, Lawrence J. Broutman and K. Chandrashekhar, *Analysis and* Performance of Fibre Composites, John Wiley And Sons. Inc., New York, 1995.
3. Susheel Kalia, Biodegradable Green Composites, John Wiley & Sons Inc., 2016, eBook.
4. Composite Materials Properties, Characterisation, and Applications, Ed. Amit Sachdeva, Pramod Kumar Singh, Hee Woo Rhee, CRC press, broken sound parkway NW, 2021.

QUANTUM COMPUTING

Course Code: **PH40001**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to open up and introduce quantum computation as well as its supremacy over classical computation to the students and technically trained professionals from the field of engineering and general science.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand and apply the mathematical background and principles of basic quantum mechanics needed for quantum computation,
CO 2: Understand and apply the principle of measurement in quantum theory on pure and composite systems,
CO 3: Know the architecture of quantum computers and apply them in handling quantum circuits,
CO 4: Understand some fast quantum search algorithms and evaluate certain simple problems,
CO 5: Understand quantum cryptography and know simple cryptography protocols, and
CO 6: Understand principles and working of practical quantum systems for physical realization of quantum computers.

COURSE DETAILS

Background mathematics and Framework of Quantum mechanics
Operators, Projectionra and Ket Vectors, Orthonormal Bases, Two Dimensional Hilbert Space, Qubit and

Quantum States, Linear Operators, Matrix Representations of Vectors and Linear Operators, Inner and Outer Products, Eigen Values and Eigen Vectors, Gram–Schmidt Procedure of Constructing an Orthonormal Basis Set, Completeness Relation, Hermitian Operators, Projection Operator, Unitary Operator, Normal operator, The Commutator and Anti-commutator, Change of Basis, Spectral Decomposition, Pauli Matrices, Tensor Products, The Postulates of Quantum Mechanics, Collapsing of Wave Function, Uncertainty Principle, State Space, Time Evolution of Quantum State, Stern-Gerlach Experiment, Spin as a Degree of Freedom, Representing Spin States using Spin Vectors. Bloch Sphere, Representation of Qubit on Bloch Sphere.

Density operator and Quantum Measurement theory
Density Operator for Pure and Composite Systems and its Key Properties, Partial Trace and Reduce Density Operator, Density Operator and Bloch Vector. Projective Measurements, Measurements on Composite Systems, Positive Operator Valued Measures (POVM).

Basic Quantum Logic Operations and Gates
Classical Irreversible and Reversible Gates, Reversible Computation.
Single Qubit Gates and Their Matrix Representations, Identity Gate, Pauli Gates, Square Root of NOT Gate, Phase Shift Gates, Hadamard Gate, Rotation Operator Gates. Limitations with These Gates.
Multiple Qubit Gates and their Matrix Representations: Controlled NOT (CNOT) Gate and its Matrix Representations, CNOT Basis Transformations, Entangled States and Their Visualization.
Universal quantum gates**:** Two-level Unitary Gates as Universal Gates, Single Qubit and CNOT Gates as Universal Gates, A Discrete Set of Gates for Universal Quantum Computation.

Quantum Algorithms
Matrix representation of serial and parallel Operations, Quantum Interference, Quantum Parallelism, Deutsch's-Jozsa Algorithm, Quantum Fourier Transform, Phase Estimation, Shor Factorization, Grover Search.

Quantum Cryptography
Classical Cryptography, Quantum Key Exchange: BB84 Protocol, B92 Protocol, EPR Protocol, Teleportation.

Quantum hardware
Goals and Challenges, Implementing Quantum Computers, Guiding Principles, Ion Traps, Linear Optics, Nuclear Magnetic Resonance (NMR) and Superconductors.

Textbook

1. Nielsen and Chuang, Quantum Information and Quantum Computation, Cambridge University Press, 2002.

Reference Books

1. David McMahon- Quantum Computing Explained, John Wiley & Sons, Inc. (2008)
2. G Benenti, G Casati, G Strini - Principles of quantum computation and information. Volume 1- World Scientific (2004).

COMPOSITE MATERIALS AND STRUCTURES

Course Code: CH40001
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The main objective of this course is to increase student knowledge in design, manufacture and analysis of composite materials that can have better structural, thermal, electrical, mechanical, dielectric, magnetic, optical, electrochemical and biomedical properties.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Define and classify composites,
CO 2: Evaluate the relative merits of using composites with respect to conventional materials for important engineering and other applications,
CO 3: Quantify physical and mechanical properties of composite materials as a function of parameters such as volume fraction, orientation and arrangement,
CO 4: Design and prepare composite structures,
CO 5: Apply XRD, SEM and TEM in micro- structural analysis of composites, and
CO 6: Understand the concept of green composite and their processing techniques.

COURSE DETAILS

Classifications and Industrial Applications of Composite
General introduction, classification of composites, matrix materials (polymer, metal and ceramics) and reinforcement materials (fibres-glass, Aramid, Carbon, Boron), microstructure of composite, applications: in civil constructions, aerospace industries, automobile, packing industry, advantages and limitations of composite materials.

Performance of structural composites
Matrix/reinforcement interface, reinforcement mechanism, combination effects (law ofmixtures, weight fraction, volume fraction), effect of voids in composites, fracture mechanics of composites, strengthening mechanisms, stress-strain relations (generalized hooke's law), stress distribution in fibre and the matrix (shear stress and axial tensile stress in the fibre along its length), critical length of fibre for full strengthening, estimation of the critical amount of fibre to gain a composite strength.

Fabrication of composites
Fabrication of metal matrix composites, fabrication of polymer matrix composites, fabrication of ceramic matrix composites, selection of constituents, solidification processing of composites, synthesis of in situ composites, various techniques of vapor deposition, liquid phase method and hot pressing etc.
Characterization
Characterization methods of composites (x-ray diffraction (XRD), Electron microscopy (SEM, TEM) analysis of composites, Thermal Analysis, Fire retardancy test for polymer composites.

Green Composite

Introduction, Composition of green composite, bio-degradable reinforcement fibre (cellulose, starch, wool/silk, carbon nanotube, nano-clay, biodegradable matrix (cellulose, starch, chitin, protein), applications of green composite.

Textbooks

1. Krishan K. Chawla, Composite Materials. 2nd Edition, Springer Press, 2001
2. Deborah D. L. Chung, Composite Materials: Science and applications, Springer, 2004.

References **Books**

1. T.W. Clyne, and D. Hull, An Introduction to Composite Materials, Cambridge University Press, Cambridge, 1996
2. Bhagwan D. Agarwal, Lawrence J. Broutman and K. Chandrashekhar, *Analysis and* Performance of Fibre Composites, John Wiley And Sons. Inc., New York, 1995.
3. Susheel Kalia, Biodegradable Green Composites, John Wiley & Sons Inc., 2016, eBook.
4. Composite Materials Properties, Characterisation, and Applications, Ed. Amit Sachdeva, Pramod Kumar Singh, Hee Woo Rhee, CRC press, broken sound parkway NW, 2021.

SOLID WASTE MANAGEMENT

Course Code: CH40002
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The uncontrolled consumption lifestyle is the root cause of the huge waste generation problem of our modern world. According to WHO report, world cities are producing 1.3 billion tonnes of solid waste per year and will be nearly double by the end of 2025. This course aims to cover different solid waste management techniques for sustainability and at the same time it also deals with the legal institutional framework for the same.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand integrated solid waste management concepts and its requirement,
CO 2: Understand waste prevention at different levels such as production, supply, consumption and disposal,
CO 3: Understand the importance of public engagement in sustainable waste management,
CO 4: Implement waste reduction and recycling policies,
CO 5: Explore modern treatment techniques for solid wastes, and
CO 6: Understand the legal and institutional framework for sustainable solid waste management.

COURSE DETAILS

Waste management and sustainability
Solid waste and types, source and characteristics of waste, toxic and hazardous waste, generations of wastes, waste testing and analysis. Environmental health, driving force for sustainability, integrated waste management and sustainability.

Waste storage, segregation, collection and prevention
Introduction, source segregation, waste storage, waste collection, waste separation, Health and Safety issue, waste prevention, The growing burden of waste, waste prevention in the context of sustainability, The policy context, waste prevention at the level of production and supply, Waste prevention at the level of consumption and household, Barriers to waste prevention, best practice in developed countries.

Public Engagement for Implementation of Waste Reduction and Recycling Policies
Introduction, Defining Public Participation, Public participation in waste management systems, Public participation policy in Global context, typical areas of Public participation in waste management systems, Key Ingredients in Public Participation, selected Examples of Public participation in Waste Reduction and Recycling in Asia.

Treatment Techniques
Incineration, Gasification, Pyrolysis, Aerobic and Anaerobic Digestion as well as co-digestion, Plasma Arch Gasification, Bio-hydrometallurgical Processing of Metallic Components of E-Wastes, s/s immobilization of toxic/hazardous wastes.

Legal and Institutional Framework
Introduction, Why Legal Framework Matters, Nature and Characteristics of Legal Framework, Scientific and policy judgments in risk assessment, Trajectory of US Experience, European Union's Legislative Effort, South Asia

Textbooks

1. Jonathan W. C. Wong, Rao Y. Surampalli, Ammaiyappan Selvam, Rajeshwar D. Tyagi, Tian C. Zhang; Sustainable solid waste management, American Society of Civil Engineers, 2016.
2. Freeman H.M. (1988) Standard Handbook of Hazardous Waste Treatment and Disposal, McGraw Hill. New York.

Reference Books

1. G., Theissen H., Eliassen R., Solid waste Engineering-Principles and Management, 1991.
2. McBean, Edward A., Frank A. Rovers, and Grahame J. Farquahar. Solid waste landfill; engineering and design. Prentice Hall, 1995.
3. Sharma, Hari D. Waste containment systems, waste stabilization, and landfills: design and evaluation. John Wiley & Sons, 1994.

Bruner, C. R., Hazardous Waste Incineration, 2nd Edition, McGraw-Hill, Inc., New York, 1993.

TRAINING & DEVELOPMENT

Course Code: BM30102
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Students must understand the inevitability of training. The elective shall focus on the importance of an effective training needs assessment to plan training more effectively. At the end of the session, the student

shall be able to link Strategy and T&D. The different kinds of training methods are covered in this course. In the present competitive and dynamic environment, it has become essential for organizations to build and sustain competencies that would provide them sustainable competitive advantage. Dynamic and growth-oriented organizations recognize training as an important aspect of managerial function in a rapidly changing economic and social environment. Training is a process which enhances and develops his/her capabilities and effectiveness at work. After studying this, one will be able to understand new training techniques and how training is evaluated**.**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Remember the importance of training,
CO 2: Understand the nature, concept, difference between training and other related concepts,
CO 3: Apply knowledge to understand the importance of training and its link with strategy,
CO 4: Analyze the various industry training and development practices,
CO 5: Evaluate the various industry training and development practices and identify the most effective methods aligned with the situation, and
CO 6: Develop the ability to evaluate the effectiveness of training.

COURSE DETAILS

- Introduction to Training & Development
- Relevance Of Training To Organizations
- Training & Competitive Advantage
- Linking Training to Business Goals
- Learning and theories of learning
- Training Need Identification: Assessing Current & Future Training Needs
- Methods & techniques of delivering training inputs
- Roles & competencies of trainer
- Training design
- Transfer of Training
- Training Evaluation

Text book

1. Raymond A Noe and Amitabh Doe Kodwani, Employee Training & Development Need, McGraw Hill Publication, Latest Edition.

Reference Books

1. Blanchard & James, Effective Training, Pearson Publication, 3rd Edition.
2. Devendra Agochiya, Every Trainers Hand Book, Sage Publication, 2nd Edition, 2009, ISBN: 978-8132100812.
3. B Janakiram, Training & Development, Biztantra, Latest Edition.

FINANCIAL MANAGEMENT

Course Code: **BM30202**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Financial management is an introductory course in finance area. This course includes the basic concepts of finance like the first principles, financial environment, time value of money, risk and return, investment evaluation estimated, etc. The other topics are covered in Financial Management II in the next semester.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Remember and comprehend importance of leverage in finance,
CO2: Understand long term investment evaluation techniques,
CO3: Apply principles of finance and how they work,
CO4: Analyze the worth of time value of money in financial decision making,
CO5: Evaluate the risk and return perspective in finance, and
CO6: Delve deep into financial decisions after an overview of the financial environment.

COURSE DETAILS

Introduction to Finance and Financial Management
Financial management functions; role of a CFO, Wealth Vs Profit maximization principles; agency theory.

Financial System
Overview of Indian Financial System – Financial Intermediaries, Financial Markets, Financial Instruments and Regulators of the Financial System.

Time value of money
Importance of Time value of money in financial decision making; Present value, Future value, Annuity estimations using excel; Loan amortization using excel.

Risk and Return
Concept of Risk and Return; Measurement of historical and expected return; Measurement of risk; Portfolio risk and return.

Long-term Investment Decision
Capital budgeting concepts; Methods of investment evaluation – NPV, IRR, BCR and other methods.

Cost of Capital Estimation
Cost of capital concepts; measurement of component costs, cost of capital – WACC estimation.

Leverage
Operating and Financial leverage; Combined leverage; EBIT – EPS relationship.

Textbook

1. M Pandey, Financial Management, Vikas Publication, 11th Edition, 2016, ISBN: 978-9325982291.

Reference Books

1. Damodaran, Corporate Finance: Theory and Practice, Wiley Publication, Latest edition.
2. Brealey, Myers and Allan, Principles of Corporate Finance, McGraw Hill Publication, 11th Edition, 2017, ISBN: 978-9332902701.
3. R.P. Rustagi, Fundamentals of Financial Management, Taxmann Publication, 18th Edition, 2023, ISBN: 978-9357780810.

MARKETING MANAGEMENT

Course Code: **BM30302**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course would provide an understanding of the basic concepts, philosophies, processes and techniques of managing marketing operations of the organization with a greater emphasis on the process of value creation for customers.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Define Marketing and remember the core concepts of marketing,
CO2: Understand markets,
CO3: Apply the strategic frameworks in developing a marketing plan,
CO4: Analyze consumer buying behavior,
CO5: Evaluate the theories of consumer behavior in real life marketing, using analytics to uncover such behaviors, and
CO6: Craft the marketing positioning based on Segmentation and Targeting.

COURSE DETAILS

Introduction to Marketing
Why Marketing? Objectives and Definitions of marketing, Orientations to the market – Concepts, Fundamental Marketing concepts: Needs, Wants, Demand, and other essential fundamental concepts, The Marketing Mix elements, Decision making – SWOT and BCG matrix.

Marketing Environment
Macro Environment - components, Micro Environment – components, Differences between the two. Importance of environment scanning.

Consumer Buying Behavior
Consumer decision Processes - What influences Consumer Behavior? Key Psychological Processes, Buying roles, Consumer decision making Process, Business Market vs. Consumer Market, Stages in Buying Process.

Introduction to Marketing Research
Why Marketing Research? Types of MR, Quantitative and qualitative, The Marketing Research process.

Segmentation, Targeting, Positioning
Levels of Segmentation, Basis for Segmentation and methods, Segmentation Criteria and evaluation of Segments, Selection of Target Segment, Product differentiation, Differentiation strategies, Positioning stances, positioning strategies.

Contemporary Issues in Marketing
New trends in marketing, Consumerism, Rural Marketing, Social Marketing, Digital Marketing, Green Marketing.

Textbook

1. Kotler, Armstrong, Agnihotri, and Haque, Principles of Marketing, Pearson Publication, Latest Edition.

Reference Books

1. Kotler, Philip, Keller, Kevin Lane, Koshy, Abraham, Mithileshwar, Jha, M M – A South Asian Perspective, Pearson Publication, Latest edition.
2. Paul Bains, Chirs Fill, Kelly Page & Piyush K. Sinha, Marketing, Oxford University Press, 1st Edition, 2013, ISBN: 978-0198079446.

BASICS OF MANAGEMENT INFORMATION SYSTEM

Course Code: **BM30602**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Students should have hands-on experience to students in using computers for data organization and addressing business needs.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Remember the types of IS and basic concepts,
CO2: Understand the application of various IS in business domains,
CO3: Apply the principles of financing,
CO4: Analyze how firm decides between debt and equity, dividend payments,
CO5: Evaluate the tactical usage of IS in particular, and
CO6: Develop an ability to understand application of Integrated enterprise systems.

COURSE DETAILS

The Information Age

Purpose of IS, Types of IS, IS in Business function, Career in IS

Strategic Uses of Information Systems
Jet Blue Success Story and Ford on the Web Failure Story Summary:

Business Function& Supply Chains
Effectiveness and efficiency, Accounting, Finance, Engineering, SCM, CRM, ERP

IT in Business
Business Hardware, Business software, Business Networks and Telecommunications, Business Data Bases

Types of IS
TPS, MIS, EIS and ERP, Web Enabled Commerce, Challenges of Global, SDLC, Case Study and Test on Indian IS Cases, Open Sources, Outsourcing Basics. Expert System and DSS

Risk Management
Security and Disaster Recovery

Textbook

1. Effy Oz, Management Information Systems, Cengage Publication, Latest Edition.

Reference Books

1. Murthy, C.S.V., Management Information Systems, Himalaya Publication, Latest edition, ISBN: 978-8184882759.
2. Laudon and Laudon, Management Information Systems, Pearson Publication, Latest Edition, ISBN: 978-9352865475.

ENTREPRENEURSHIP

Course Code: **BM30702**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Entrepreneurship has been the engine of economic growth and prosperity in any society. The entrepreneur transforms resources to useful and valuable products, services and solutions. S/he does so by sensing opportunities and seizing opportunities while transforming assets. Considering significance of entrepreneurship for the economy and society, large companies besides governments and Universities are promoting entrepreneurship. This is often known as Intrapreneurship. In fact, all early management education was centered around creating and supporting entrepreneurs. It is therefore essential for all management graduates to learn entrepreneurship.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Remember the basic tenets of entrepreneurship,
CO2: Understand key concepts such as opportunities, challenges, resources & capabilities, new product development, intellectual property rights, efficiency, quality, innovation and customer responsiveness,
CO3: Apply the learned concepts to sense and seize opportunities,
CO4: Analyze opportunities for key success factors and required capabilities to win in the market place,
CO5: Evaluate resource constraints & opportunities and select appropriate opportunities, and
CO6: Create a business plan.

COURSE DETAILS

Self-diagnosis and Understanding Entrepreneurship
What is Entrepreneurship, Test for an affinity for entrepreneurial work, Characteristics and skills of entrepreneurs, Age of an Entrepreneurial Firm, Types of Entrepreneurs.

Finding & Evaluating the opportunity
New Business Opportunity, Characteristics of genuine business opportunities, Where to look for profitable opportunities, The process of opportunity evaluation.

Intellectual Property
Trademarks, Copyright, Patents, Geographical Indication of Goods, Designs, Other IPR Laws, Trade Secrets and Confidential Information.

Family Business
Family Business in India, The Founder, The Next Generation, Entry of family Members, N0n-family Members, Succession, Best Practices.

Organizing the enterprise
Issues involved in Doing Business in India, The various forms of organization, Advantage & Disadvantage of each form, Determining the best form of an Organization, Legal Issues.

Entrepreneurial Support
Policies, Business Incubation, Business Clusters.

Buying a Business
Challenges in Buying a Business, The Search, Process of Buying, Scrutiny, valuation, negotiation, Franchising.

Financing the business
Angels & Venture Capitalists, Debt Finance.

Making a Business Plan and Strategy
Uses of Business Plan, Writing a Business Plan, Data Collection, Kinds of Business Plans, Importance of the Executive Summery, Description of the Business, The Management Team, The Industry and the Market, Marketing Plan, Finance, Risk and Contingencies.

New Product Development
Types of New Products, New Product Development Process, The Adoption Process, Barriers to New product Development

E-Business
E-Commerce and Marketing Strategies

Textbook

1. Rajeeb Roy, Entrepreneurship, Oxford University Press Publication, 2nd Edition, 2011, ISBN: 978-0198072638.

Reference Books

1. Richard Luecke, Entrepreneur's Tool Kit: Tools & Techniques to launch and grow your business, Harvard Business Review Press Publication, 2004 Edition, ISBN: 978-1591394365.
2. Robert D Hisrichis, Entrepreneurship, McGraw Hill Publication, 11th Edition, 2020, ISBN: 978-9390113309.

PRODUCTION & OPERATIONS MANAGEMENT

Course Code: **BM30802**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Students have to understand the production and operation functions and familiarize themselves with the techniques for planning and control.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Remember the basic concepts of production and operation functions,
CO2: Understand the principles of work method and motion study,
CO3: Apply the decision framework for deciding facility and location,
CO4: Analyze the quality dimensions and process for product and measurement processes,
CO5: Evaluate and differentiate different production systems, and
CO6: Develop their ability to appreciate the materials and production planning steps.

COURSE DETAILS

Introduction to Operations Management
Concept, Input-Output Model, System view, Interface with other functional areas.

Facility & Location Layout
Facility location, Facility layout, Selection, Feasibility, Economy, Types, Design of layout.

Materials Management
Introduction – Scope, Function, Planning (MRP), Purchasing, Inventory Management, Standardization, Simplification, Material Handling – principles, Equipment, Systems.

Production Planning & Control
Aggregate Planning, Capacity planning, MPS, MRP, ERP, JIT, Scheduling, Routing

Quality Management

Concept, Strategy, Factors, Dimensions, Cost of Quality, Quality Inspection & Assurance, Quality Performance & Conformance, Quality Control – SPC, SQC, Quality Circle, TQM, ISO 9000.

Motion & Time Study
Productivity, Method Study, Motion Study, Time Study, Ergonomics.

Maintenance Management
Breakdown and Preventive maintenance, Total Productive maintenance (TPM).

Waste Management
Managing Disposal, Salvage & Recovery of Waste.

Automation
Concept, Advantages, Disadvantages, AGVS, AS/RS

Textbook

1. S. Anil Kumar and N. Suresh, Production & Operations Management, New Age International Publication, 2nd Edition,2011, ISBN:978-8122421774.

Reference Books

1. Kaniska Bedi, Production & Operations Management, Oxford Publication, 3rd Edition, 2013, ISBN: 978-0198072096.
2. Everett E Adam Jr., and Ronald J Ebert, Production & Operations Management, Prentice Hall Publication, Latest Edition.
3. S.N. Chary, Production & Operations Management, McGraw-Hill Publication, 6th Edition, 2019, ISBN: 978-9353164812.
4. K. Ashwathappa, Production & Operations Management, Himalaya Publication, Latest Edition.

SUSTAINABLE RURAL DEVELOPMENT

Course Code: RM30152
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Sustainability has become an important aspect of our lives in the wider context of the United Nations' Sustainable Development Goals (SDGs). This course aims to provide the participants knowledge on how the rural communities can achieve sustainable form of development. Apart from discussing about the various concepts related to sustainable development of rural areas and three pillars of sustainability such as society, environment and economy, the course will also focus on building multi-stakeholder partnerships to achieve sustainable rural development. The Sustainable Development Goals 3, 4, 5, 6, 7, 8, 9, 12, 15, 16 and 17 are integrated in the course.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Have a comprehensive understanding on the need for sustainability in the rural areas,
CO2: Be knowledgeable on the relevance of social aspects of sustainable rural development,
CO3: Appreciate the importance of economic dimensions of sustainable rural development,
CO4: Be able to comprehend on the relationship between environment and other dimensions ,
CO5: Attain skills to build multi-stakeholders partnerships for sustainable rural development,and
CO6: Draw up a plan for achieving sustainable development in rural areas.

COURSE DETAILS

Understanding sustainable development

Concepts of rural, development, rural development, integrated rural development, sustainable development, equitable and inclusive development, sustainable rural development and three pillars of sustainability-social, environmental and economic dimensions, contemporary technology and sustainable rural development, possibilities and hindrances towards sustainable rural development and Sustainable Development Goals (SDGs)

Equitable and sustainable rural social development

Crosscutting issues such as rural poverty, its causes, dimensions and reduction, ethnicity, gender, quality education, health care and social services, people's participation for sustainable rural development, building the ability of households and communities to consistently meet the basic needs, social inclusion and inclusive development, people centered development, women and youth empowerment, Human Development Index (HDI), Human Poverty Index (HPI) and Gender Development Index (GDI)

Economy and sustainable rural development

Full and sustainable employment of rural population, improved quality of life, definition and meaning of rural livelihoods, sustainable rural livelihoods framework, financial security of individuals, building financial assets and sustaining adequate income throughout the life-span, concepts of rural nonfarm-off farm, role of off farm and non-farm in rural development, development of local Small and Medium Enterprises (SMEs) as a means to industrialize the rural areas and building a local economic system of agro-industrial integration

Environment and sustainable rural development

Sustainable agricultural systems, optimizing agricultural and non-farm sector production, environmentally harmonious/judicious use and sustainable management of land, water, forest, air and other natural resources, fair and transparent natural resources governance, restoration and conservation of natural ecosystems, environmentally sustainable technologies covering renewable energy, energy efficient technologies, sustainable waste management and biomass conversion, the application of technology in contemporary times and change with continuum in future and with regard to different inclusions, weather and market information, climate change and greenhouse gas emission.

Partnerships for sustainable rural development

Development of community in regards to the basic needs of human being and beyond, Community participation, community action, community mobilization, collaboration and partnership between various community networks such as Self Help Groups (SHGs), Community Based Organizations (CBOs), voluntary organizations, Panchayati Raj Institutions (PRIs) with special reference to the approaches of conventional development vs. contemporary development, rural cooperatives, farmer producer

organizations, youth clubs and women organizations to plan and participate in implementing sustainable rural development programmes, implement and contribute for policy making for sustainable rural development

Reference Book

1. A set of reading materials from various textbooks/research articles to be compiled.

FOOD SECURITY

Course Code: RM20152
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The major objective of the course is to understand the causes, consequences of food insecurity and learn how local communities, governments and international institutions have been combating food insecurity and hunger. The other objectives of the course are to enlighten the participants on what they can undertake as individuals, decision and policy makers to ensure food security.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Have a systematic understanding on various concepts and discussions related to food security from multiple perspectives,
CO2: Demonstrate a critical awareness of the local, regional, national and global challenges encompassing social, political, global and economical contexts related to achieving food security,
CO3: Exhibit a wide-ranging understanding on the global strategies to overcome food insecurity,
CO4: Comprehend the food (in)security in the Indian context ,
CO5: Critically analyze the India's policies and programmes to address food security ,and
CO6: Be capable of assessing the food security status of individuals, households, local areas, regions, countries and world and develop solutions to address food insecurity.

COURSE DETAILS

Concepts of Food Security

Food security and hunger in global, national, regional, local and household contexts, concepts of food and nutritional security, human right to food and adequate nutrition, food security and diet as a means of achieving global health targets, definition of food insecurity and its types-chronic and transitory food insecurity, four dimensions of food security - food availability and accessibility.

Challenges in Achieving Global Food Security

Uneven distribution of food and other basic resources in the world, sustainability of food production and consumption, competing uses – bio-fuels' competition for land, water and energy resources and implication for food security, co-existence of genetically modified food, organic and conventional food crops and food security; complex emergencies, disasters, Covid-19, conflicts, protracted crises, gender and racial/ethnical inequality, poverty and food security; food insecure sections in vulnerable situations, limited food resources, increasing world population, growing world food demands, liberalization of food markets, international trading, climate change and the food security systems.

Global Strategies to Overcome Food Insecurity and Hunger

Alternative methods to achieve food security, elimination of food waste at all levels, globalization of food supply, global movements for food justice, delivering food subsidy, public and private sector's roles in food production, regulation and supply, multidimensional nutrition programs, FAO food security policies, community, household and family food insecurity coping strategies, adaptive responses of food security systems for climate change, global early warning and emergency food monitoring and management systems

Food Security in the Indian Context

Availability and accessibility of food in India, post-Green revolution status of food security, lack of access to food in India, hunger and starvation deaths, data on per capita daily supply of calories, child malnutrition, undernourished, anemic, India's status on Global Hunger Index and Global Food Security Index, NFHS data and heat maps, provisions related to right to food in Indian Constitution, impact of Covid-19 on food supply chains and food security

India's Policies and Programmes to Eliminate Hunger and Food Insecurity

Food security systems in India, Food for Work, Integrated Child Development Services (ICDS) Schemes, Mid-Day Meal Scheme (MDMS), Public Distribution System (PDS), Targeted Public Distribution System (TPDS), Pradhan Mantri Garib Kalyan Anna Yojana (PMGKAY) and the Pradhan Mantri Poshan Shakti Nirman Yojana (PM POSHAN Scheme), diversifying PDS food basket, Aadhaar biometric identification system for food security, Antyodaya Anna Yojana (AAY) to reduce hunger among the poorest, National Food Security Mission, Right to Food Legislation in India, National Food Security Act, (NFSA) 2013, its norms and salient features, priority households (PHHs), promotion of fortified food products, millets for food security and nutrition, State Food Commissions, obligations of Central, State and Local governments for food security and role of cooperatives in India's food security.

Textbook

1. A set of reading materials from various text books/research articles to be compiled.

References Books

1. CFS, Coming to Terms with Terminology. Food Security. Nutrition Security. Food Security and Nutrition. Food and Nutrition Security, CFS document 2012/39/4, http://www.fao.org/docrep/meeting/026/MD776E.pdf

2. Drèze, J. et al. 2016, "Food Security Act: How are India's poorest states faring?", Ideas for India, https://www.ideasforindia.in/topics/governance/food-security-act-how-are-indias-poorest-states-faring.html

3. FAO, IFAD, UNICEF, WFP and WHO, In Brief to The State of Food Security and Nutrition in the World 2022. Transforming food systems for food security, improved nutrition and affordable healthy diets for all, Rome, FAO, https://www.fao.org/3/cc0639en/cc0639en.pdf

4. Global Network for the Right to Food and Nutrition, State of the Right to Food and Nutrition Report 2021, July 2021, https://www.fian.org/files/files/20210719_State-RtFN-Report_2021_ENG_v15.pdf

5. Ipe, BT, Shubham S and Satyasai KJS (2022), Food and Nutritional Security in India, Charting the way to a robust agri-food system, Department of Economic Analysis and Research, NABARD Research Study–35, November 2022

6. Second International Conference on Nutrition (2014), Outcome Document, Rome Declaration on Nutrition. Rome, 19-21 http://www.fao.org/3/a-ml542e.pdf

LAW OF PATENT

Course Code: LW30910
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Patents contribute, preserve and channelize value for enterprises ranging from the world's largest technological corporations to start-up entities. Apart from economic gain by rendering competitive and transactional advantage, Patents have a remarkable effect in spurring innovation, research and dissemination of knowledge. The student of this Course will develop a clear understanding of the law relating to Patent practice and procedure, and will imbibe skills for applying the law for patent prosecution and transactions.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the origin, development and significance of patent law and its significance in commercial transactions and value addition to enterprises,
CO 2: Apply preliminary advisory and negotiation skills useful for commercial transactions involving patents,
CO 3: Analyze better employability in this field of intellectual property law through skill oriented training,
CO 4: Evaluate the problem-solving skills for the topics learnt,
CO 5: Develop critical thinking to impart basic skills required in litigation involving patents, and
CO 6: Understand and analyze the remedies and defenses in case of patent litigation.

COURSE DETAILS

Patentability And Patent Eligibility
Novelty Requirement; Inventive Step Requirement; Industrial Applicability Requirement; Patentable and Non patentable subject matter and Product & Process patent.

Patent Prosecution
Application for patent, Publication and Examination, Specification - Provisional and Complete; Contents of specification; Objection and Pre-Grant and Post-Grant Opposition.

Patent Grant
Sealing and granting of patents; Withdrawal and abandonment of application; Duration of patent: Law and policy consideration and Rights and obligations of a patentee.

Compulsory licenses, revocation and surrender of patent
Abuse of Patent Rights; Compulsory Licenses; Grounds for granting compulsory licenses; Matters to be considered in granting compulsory licenses; Revocation of Patent- who may apply? And Different grounds for and modes of revocation.

Patent Enforcement and Defenses
Infringement- Meaning and the scope; Burden of proof; Modes of infringement; Doctrine of colourable variation; Doctrine of Pith and marrow; Doctrine of equivalents and Defenses in suits of infringement of patent.

Introduction To Patent Law And International Agreements
Definition, nature and object of granting patent; Development of Patent jurisprudence; Paris Convention and Patents; An overview of TRIPS (only relevant provisions for Patent); Patent Co-operation Treaty (PCT) and Budapest Treaty.

Textbooks

1. Feroz Ali Khader, The Law of Patents, Lexis Nexis, 1st Edition. (2009)

Reference Books

1. Elizabeth Verkey, Law of Patents, Eastern Book Company, 2nd Edition, 2012.
2. Merges & Duffy, Patent Law &Policy: Cases and Materials, Lexis Nexis 5th Edition, 2011.

LAW OF CONTRACT

Course Code: LW30904
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course is designed to enrich the basic knowledge of engineering students in the field of law and to support the engineering and research programs. To introduce the basic understanding of the General Principles of Law of Contract-I so that students develop an understanding in various features of contract. The course will also help the students to develop knowledge about Indian Contract Act to understand the nature of agreements and remedies for breach of contract.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn the basic concepts of Law of Contracts and principles of common law and how common law, provisions have been adopted in the Indian Contract Act, 1872,
CO 2: Understand the vitiating factors for contract which render them void or voidable,
CO 3: Understand the nature of agreements,
CO 4: Analyze different modes of discharge of contract,
CO 5: Understand the remedies for breach of contract, and

CO 6: Learn the different types of E-contract.

Fundamental Concepts & Formation of a Contract
Basic concepts of contract, offer and acceptance, certainty; intention to create legal relations, consideration, promissory estoppel, third parties.

Vitiating Factors
Duress and coercion, Undue influence, Misrepresentation, Non-disclosure and fraud, Mistake.

Nature of Agreement
Quasi-contracts and contingent contracts.

Discharge of Contracts
By performance, by agreement, by breach, by frustration.

Remedies For Breach of Contract
General concept of damages, Money damages, Restitution, Specific performance and Equitable relief.

Electronic Contract
How e-contracts are formulated, Basic genres of e-contract; the click wrap, the shrink wrap.

Textbook

1. Anirudh Wadhwa (Ed.), Mulla The Indian Contract Act, Lexis Nexis, 2015.

Reference Books

1. Anson, Law of Contract, 29th Edition, Oxford University Press, 2010.
2. Pollock & Mulla, Indian Contract Act and Specific Relief Act (Vol. 1 & 2), Lexis Nexis 14th Edition, 2012.
3. The Law of Contract, Butterworths Common Law Series, 3rd Edition, 2007.

INTELLECTUAL PROPERTY RIGHTS (IPR) LAW

Course Code: LW30908
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Keeping the fact in mind that the present course would be taught to the students as a general paper, the main object behind teaching this course is to make the students understand IPR as a concept and the different forms of IPR. The course would be more of informative in nature to help the students appreciate the whole idea of protecting human labour through exclusive rights in the form of intellectual property rights and to help them to generate interest in the course for further research.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the origin, development and significance of intellectual property law and its significance in commercial transactions and value addition to enterprises,

CO 2: Equip with specific technical, legal and management skills related to protection, enforcement and commercialization of the various forms of intellectual properties,
CO 3: Analyze better employability in this field of intellectual property law through skill-oriented training,
CO 4: Evaluate the problem-solving skills for the topics learnt,
CO 5: Develop critical thinking to impart basic skills required in issues pertaining to intellectual Property rights, and
CO 6: Understand and analyze the remedies and defenses in case of Intellectual Property litigation.

COURSE DETAILS

Law of Copyright
Introduction; Nature of Copyright; Basic features of copyright; Originality, Idea-expression dichotomy and Authorship ownership and Works in which copyright subsists.

Law of Patents
Introduction to Patent, Nature of Rights, Patentability standards - Patentable subject matter; Patent Registration; Patent term and enforcement.

Trademarks
Basic concept of trademarks; Conceptual Analysis; Need for trademark protection; Registration of Trademarks, Registration of Trademark- who may apply? Enforcement of Registered Trademarks.

Geographical Indications
Introduction, Geographical Indications and Trademarks, Procedure for registration of Geographical Indications; Effect of Registration; Enforcement of registration of Geographical Indications.

Designs
Definition, nature and object of granting designs; Procedure for registration of designs; Effect of Registration; Enforcement of registration of Designs.

Textbook

1. V.K. Ahuja, Law relating to Intellectual Property, Lexis Nexis, 3rd Edition, 2017.

Reference Books

1. Hustin Pila, The subject matter of Intellectual Property, Oxford University Press, 1st ed. (2017)
2. Merges & Duffy, Patent Law &Policy: Cases and Materials, Lexis Nexis 5th ed. (2011)

ENVIRONMENTAL LAW

Course Code: LW30914
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The basic objective is to familiarize the concept and scope of environmental law and also of its particular dominant issues so as to become a value addition in learning and to ignite academic/research interest,

eventually.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the Jurisprudence behind the development of Environmental law and the underlying principles behind the development of such law,
CO 2: Understand the Constitutional obligations over the Government as well as the citizen in regard to improvement and protection of environment,
CO 3: Understand the origin, evolution and expansion of international environmental law and will be able to identify and critically analyse international environmental law instruments,
CO 4: Analyze the various environmental pollution and pollutants as provided under the National legislation vis-a-vis the international approach in defining the above,
CO 5: Provide an insight on the objectives of the Environment Protection Act, the role of governmental authorities, and
CO 6: Understand and analyze the legal precaution and remedies in case of Environmental hazards.

COURSE DETAILS

Introduction & Fundamental Principles of Environmental Protection
Concept of Environment – Meaning and Scope; Development vs. Environment; Sustainable Development – Meaning, Definition, Object and Scope; Environmental Ethics; Inter-generational and Intra-generational Equity; Precautionary Principle, Polluter Pays Principle, Public Trust Doctrine.

Constitutional Perspective of Environmental Laws
Right to Healthy Environment & Public Interest Litigation; Fundamental Rights & Duties - Right to Wholesome Environment; Directive Principles of State Policy.

International Environmental Law
International environmental law - Nature and scope, Stockholm declaration & Rio declaration, UNFCCC & recent developments

Water Pollution & Air Pollution

The Water (Prevention and Control of Pollution) Act, 1974 & The Air (Prevention and Control of Pollution) Act, 1981; Water Pollution & Air Pollution – Meaning, Causes and Effects; Central and State Pollution Control Boards –Constitution, Powers and Functions; Offenses & liabilities of Companies; Future usage of alternative energy.

Environmental Protection

The Environment (Protection) Act, 1986; Meaning of "Environment" and Environmental Pollutant"; Powers and Functions of the Central Government; Environmental Impact Assessment (EIA); National Green Tribunal Act.

Textbook

1. P. Leela Krishnan, Environmental Law in India, 5th Edition, 2019.

Reference Books

1. Divan Shyam and Rosencranz Armin, Environmental Law and Policy in India, Oxford University Press, 2019.
2. P. Leelakrishnan – Environmental Law Case Book, Lexis Nexis Butterworths Wadhwa, 2019.

COPYRIGHT LAW

Course Code: LW30918
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Copyright is a right given by the law to the creators of literary, dramatic, musical and artistic works and producers of cinematograph films and sound recordings. In the wake of technological developments and growth of digital communication, the concept of Copyright which was mainly restricted to Literary works has expanded to cover 'Neighbouring Rights' consisting of rights of performers, producers of phonograms and broadcasting organizations. The main motivation of law relating to copyright is to encourage and reward authors, composers, artists, designers, film producers and other creative people by providing protection through economic rights over their works.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the origin, development and significance of copyright law and its significance in commercial transactions,
CO 2: Apply preliminary policies derived from critical-analytic reasoning over selected portions of the Copyright Act, International Treaties and relevant case laws decided by National and Foreign Courts,
CO 3: Analyze better employability in this field of copyright law through skill-oriented training,
CO 4: Evaluate the problem-solving skills for the topics learnt,
CO 5: Develop critical thinking to impart basic skills required in litigation involving copyright law, and
CO 6: Understand and analyze the remedies and defenses in case of Copyright litigation.

COURSE DETAILS

Copyright and International Legal Instruments Relating to Copyright Protection

Concept of Copyright as a protection under the Intellectual Property law regime, Berne Convention for the Protection of Literary and Artistic Works, 1886, Universal Copyright Convention, 1952, Rome Convention for the Protection of Performers, Producer of Phonograms and Broadcasting Organizations, 1961: Neighbouring Rights, Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS), 1994: Background, Enforcement and Impact, WIPO Copyright Treaty, 1996, WIPO Performances and Phonograms Treaty, 1996;

Historical Development of Copyright as IPR

Development of Copyright Law in India, Development of Copyright Law in U.K., Development of Copyright Law in U.S.A, Concept of Copyright and Copyleft with respect to Copyright protection;

Subject-Matter of Copyright and Rights Conferred

Concept of Originality in U.S.A, U.K. and India, The Idea and Expression Dichotomy, Copyright in Original and Derivative Works, Moral Rights of the Authors, Assignment, License and Registration.

Protection of Copyright in Cyberspace

Concept, Acts and Uses in the Internet and their Copyright Implications, Right of Reproduction of work on the Internet, Liability of Internet Service Providers, Copyright in the Music Industry, Concept of Copyright Protection in U.S.A.-Digital Millennium Copyright Act: Fair Use and Safe Harbor.

Infringement and Defenses of Copyright Liability

Infringement under Indian Law and tests for determining Copyright Infringement, Fair Dealing, Copyright law and Education: Concept of Copyright in Academics and Research in India;

Enforcement of Copyright
TRIPS Agreement and the Mandate on Enforcement, Judicial Remedies in India: Civil and Criminal.

Textbook

1. P. Narayanan, Law of Copyright and Industrial Designs (4th ed. Eastern Law House, 2010)

Reference Books

1. Melville B. Nimmer and David Nimmer, Nimmer on Copyright Law (LexisNexis, Indian reprint 2010).
2. Lal's Commentary on The Copyright Act, 1957 (4^{th} Edition, Delhi Law House, 2010).

INFORMATION TECHNOLOGY LAW

Course Code: LW30920
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE
The first and foremost object of the course is to introduce the student to the general principles of Information & Communication Technology Law and then help them in understanding the nuances and its application. In other words, the chief object of the course is learning & understanding the fundamental principles of Internet Law.

COURSE OUTCOMES
After successfully completing the course, the students will be able to

CO 1: Learn different national and international principles that are involved in regulating the jurisdiction of Cyberspace,
CO 2: Develop knowledge and understanding of the different cyber contraventions and adjudication process,
CO 3: Understand the interface between ICT law and commercial law and practice in that it examines in detail the closed sub-set of online transactions which are clearly commercial in nature,
CO 4: Develop a critical approach and will introduce students to techniques and technologies for monitoring cybercrime and the legal regulatory framework.
CO 5: Understand the various aspects of electronic signature and digital signature, and
CO 6: Understand and analyse the remedies and defences in case of cybercrimes.

COURSE DETAILS

Introduction to Cyber Law

Need and scope of cyber law, Growing concerns relating to cyberspace and cyber technology, Important

definitions under Information Technology Act (IT Act), Theories of jurisdiction in cyberspace.

Civil liabilities and adjudication under Information Technology Act 2000
Cyber torts and contraventions, Adjudication under the Information Technology Act 2000, Judicial and Quasi-Judicial bodies under IT Act, Dispute Resolution under IT Act.

Cyber Crimes
Introduction to Cyber Crimes, Cyber Crimes vs. Conventional Crime. Classification of Cyber Crimes, Cyber Crimes under IT Act- Sec 65- Tampering with the Source Code, Sec 66- Computer related crimes, Sec 67,67A & 67 B- Pornography, Sec 69- Decryption of Information, Sec 70- Protected System, Cyber Crimes not listed under IT Act- Hacking, Email Spoofing and Email bombing, Online Defamation, Cyber Stalking, Phishing, Viruses, Denial of service attacks.

Regulation of E-Commerce
Legal recognition of electronic records under IT Act, Validity of digital contracts.

Electronic Signature and Digital Signature
Electronic Signatures, Cryptography, Public and Private Key, Verification of Digital Signature, Public Key Infrastructure, Electronic Signature and Information Technology Act, 2000.

E-Governance
Components of E Governance, Types of interactions in E Governance (Interactive Models like G2G, G2B, G2C), Benefits of E Governance, E Governance challenges specific to India, Legal Frame work for E Governance under IT Act,2000, Various E-Governance Projects in India.

Textbook

1. Sharma, Universal Law Publishing, An imprint of Lexis Nexis, 5th Edition, 2016.

Reference Books

1. Vakul, Information Technology Law and Practice- Cyber Laws and Laws Relating to E-Commerce.

HEALTH AND WELLBEING

Course Code: PE30002
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course is designed for non-health science students to sensitize them about health and well-being which is very important to lead a socially and economically productive life. The course will help the student to assess their own health and well-being status as well as those of others.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Recognize concepts of health, disease and wellbeing,
CO 2: Differentiate between health and wellbeing,
CO 3: Analyze the factors affecting health and wellbeing,
CO 4: Identify tools for measurement of wellbeing,
CO 5: Apply the tools to measure their wellbeing, and
CO 6: Design an intervention to ensure their health and Wellbeing.

COURSE DETAILS

Concept of Health, Disease & Wellbeing
Definition of health, disease & wellbeing; evolving concepts and dimensions of health, Individual health vs community health, Community Diagnosis, Health and well-being of the vulnerable.

Factors Affecting Health & Well-being
Social & behavioral determinants of health & wellbeing; vicious cycle of disease & poverty, enabling environment for health, Role of the health system and health services in ensuring health & wellbeing.

Approaches to Positive Health and Wellbeing
Theoretical models of health promotion and their relationship with the concept of wellbeing, Health Behavior Change models to understand and improve the health and well-being of people, Importance of mental health & wellbeing.

Measurements of Health, Disease, and Wellbeing
Morbidity, mortality, health-status assessment (incidence, prevalence, cumulative incidence, incidence rate), Newer measures of health and disease: QALY, DALY, HYL etc., Vital health indicators at the population level (Life expectancy, CBR, CDR, IMR, MMR, CPR, etc), Measures of functioning (physical, cognitive, emotional, and social), Concept of social capital, measures of satisfaction with Life: Satisfaction With Life Scale (SWLS).

Textbook

1. K. Park, Text of Preventive and Social Medicine, M/s. Banarsidas Bhanot, 27th Edition, 2023

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