Minor Degree in Computer Science and Engineering (offered to other branches students):

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501CS13	Operating Systems	IC	2		1	3	50	50	100	-
2501CS07	Computer Networks	IC	2		1	3	50	50	100	-
2501IT07	Agile Software Engineering	IC	2		1	3	50	50	100	PPSC
2501AI03	Data Mining	IC	1		2	3	50	50	100	-
2501CS08 2501IT06	Object Oriented Programming through C++ (or) Java Programming	IC	2		2	4	50	50	100	PPSC
2501CS16	Introduction to MERN Stack Development(or) Information Security Analysis & Audit	IC			2	2	50	50	100	JP
2501CS30			2			2	50	50	100	-
2501CS18	Advanced MERN Stack Development (or) Flutter Fundamentals	AC			2	2	50	50	100	IMSD
2501IT12					2	2	50	50	100	-
	Total		**11**		**9**	**20**				

Operating Systems

	L	T	P	C
Course Code: 2501CS13	**2**	**0**	**1**	**3**

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

- **CO1:** Describe basic concepts of operating systems and its structure.
- **CO2:** Analyse various issues related to inter process communication like process scheduling, resource management and deadlocks.
- **CO3:** Interpret the issues and challenges of memory management.
- **CO4:** Illustrate concepts of Disk management and file system implementation.
- **CO5:** Explain issues related to protection and security mechanisms.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1:	3								1		
CO2:	1	3		1					2		1
CO3:	1	3		1					2		1
CO4:	1	3		1					1		1
CO5:	2	2							1		

UNIT – I

Operating Systems Overview: Operating system functions, Operating system structure, Operating systems operations, Computing environments, Open-Source Operating Systems. System Structures: Operating System Services, User and Operating-System Interface, systems calls, Types of System Calls, system programs, operating system structure, System Boot.
Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Basic Linux commands
2. Implementation of System calls
3. Multiprogramming-Memory management-Implementation of fork (), wait (), exec() and exit (), System calls

UNIT – II

Process Concept: Process scheduling, Operations on processes, Inter-process communication. Process Scheduling: Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling, Thread scheduling.
Multithreaded Programming: Multithreading models, Thread libraries, Threading issues
Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Simulate the following CPU scheduling algorithms: FCFS and SJF
2. Simulate the following CPU scheduling algorithms: Priority and Round Robin

UNIT – III

Inter-process Communication: Race conditions, Critical Regions, Mutual exclusion with busy waiting, Sleep and wakeup, Semaphores, Mutexes, Monitors, Message passing, Classical IPC Problems - Dining philosophers problem, Readers and writers problem.
Deadlocks: Resources, Conditions for resource deadlocks, Ostrich algorithm, Deadlock detection and recovery, Deadlock avoidance, Deadlock prevention.
Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Simulate Bankers Algorithm for Dead Lock Avoidance
2. Write a C program that illustrates two processes communicating using shared memory.
3. Write C program to create a thread using pthreads library and let it run its function.
4. Write a C program to illustrate concurrent execution of threads using pthreads library

UNIT – IV

Memory-Management Strategies: Introduction, Swapping, Contiguous memory allocation, Paging, Segmentation.
Virtual Memory Management: Introduction, Demand paging, Copy on-write, Page replacement, Frame allocation, Thrashing, Memory-mapped files, Kernel memory allocation.
File Systems: Files, Directories, File system implementation, management and optimization.
Case Study: The above topics are discussed as case study in Windows/ Unix OS

Practice:

1. Simulate the Multiprogramming with a fixed number of tasks (MFT)
2. Simulate the Multiprogramming with a variable number of tasks (MVT)
3. Simulate the FIFO page replacement algorithm
4. Simulate the LRU page replacement algorithm
5. Simulate the following File allocation strategies: Sequenced, Indexed and Linked

UNIT – V

Secondary-Storage Structure: Overview of disk structure, and attachment, Disk scheduling, RAID structure, Stable storage implementation.
System Protection: Goals of protection, Principles and domain of protection, Access matrix, Access control, Revocation of access rights.
System Security: Introduction, Program threats, System and network threats.

Practice:

1. The above topics are discussed as case study in Windows/ Unix OS

Text Books:

1 Operating System Concepts, Abraham Silberschatz, Peter B Galvin and Greg Gagne, John Wiley and Sons Inc., 12th Edition. ISBN: 978-0470128725
2 William Stallings, Operating Systems: Internals and Design Principles. Prentice-Hall, 7th Edition.ISBN: 978-9332518803

Reference Books:

1 Modern Operating Systems, Tanenbaum A S, Pearson Education, 3rd Edition.ISBN: 978-0136006633
2 Operating Systems A Concept Based Approach, Dhamdhere D M, Tata McGraw-Hill, 3rd Edition.ISBN: 978-1259005589
3 Operating Systems, Nutt G,Pearson Educatio, 3rd Edition,. ISBN: 978-8131723593

Web Links:

1 https://archive.nptel.ac.in/courses/106/106/106106144/
2 https://archive.nptel.ac.in/courses/106/105/106105214/
3 https://www.coursera.org/learn/iot/lecture/MrgxS/lecture-3-1-operating-systems
4 https://in.udacity.com/auth?next=/course/introduction-to-operating-systems--ud923

Computer Networks

Course Code: 2501CS07	L	T	P	C
	2	0	1	3

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

- **CO1:** Describe network topologies, reference models and media for data transmission
- **CO2:** Analyze error and flow control issues in data link layer
- **CO3:** Classify MAC protocols and channelization techniques
- **CO4:** Apply routing algorithms and congestion control techniques for effective data transmission
- **CO5:** Analyze protocols Transport and Application Layers

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1									
CO2		2									
CO3		2							1	1	
CO4	1	2	2						2		1
CO5		1			1						1

UNIT – I

Network Overview: interfaces, protocols and services, connection-oriented and connectionless services, OSI & TCP/IP Reference Models. Local Area Networks: Topologies - star, bus, ring, media access control - deterministic and probabilistic, IEEE 802.x. wireless networking.

Practice:
1. Study of Network devices in detail and connect the computers in Local Area Network

UNIT – II

Data Link Protocols: framing and data transparency, error detection & correction, flow control.

Practice:
1. Write a Program to implement the data link layer farming methods such as i) Character stuffing ii) bit stuffing.

UNIT – III

Media Access Control: Random Access: ALOHA, Carrier sense multiple access (CSMA), CSMA with Collision Detection, CSMA with Collision Avoidance, Controlled Access: Reservation, Polling, Token Passing, Channelization: frequency division multiple Access (FDMA),
time division multiple access (TDMA), code division multiple access (CDMA).

Practice:

1. Write a Program to implement Sliding window protocols

UNIT – IV

Routing Algorithms: The Optimality principle, Shortest path, Flooding, Distance vector, Link state, Hierarchical
Congestion Control algorithms: General principles of congestion control, Congestion prevention polices, Approaches to Congestion Control, Traffic Aware Routing, Admission **Control, Traffic Throttling:** Load Shedding
Traffic Control Algorithm: Leaky bucket & Token bucket.

Practice:

1. Programs to implements routing protocols like shortest path.

UNIT – V

IP Protocols: IP Addressing, IP & ICMP.
Transmission Control Protocol: UDP & TCP.
Application Layer: World Wide Web, HTTP, Electronic mail, Architecture, web based mail, email security, TELENET, local versus remote Logging, Domain Name System: Name Space, DNS, SNMP.

Practice:

1. NS2 Simulator i. NS2 Simulator-Introduction ii. Simulate to Find the Number of Packets Dropped iii. Simulate to Find the Number of Packets Dropped by TCP/UDP

Capstone Project:

Simulate and implement data link layer protocols and network routing strategies using NS2 (Network Simulator 2). It includes configuring network topologies, setting up routing protocols like AODV, DSDV, and OLSR, and analyzing their performance through metrics such as throughput, delay, and packet delivery ratio. Additionally, explore the simulation of data link layer functionalities, including MAC addressing and error detection. You may use NS2's capabilities, that insights into the behaviour of network protocols, aiding in the design and optimization of efficient communication systems.

Text Books:

1	Computer Networks — Andrew S Tanenbaum and David J Wetherall, Pearson Education, 5th Edition. ISBN: 978-0132126953
2	Data Communications and Networking – Behrouz A.Forouzan, McGraw Hill Education, 5th Edition ISBN: 978-1259064753

Reference Books:

1	Data Communications and Networks- Achut S Godbole, AtulKahate, McGraw-Hill Education (India) Pvt Limited, 2nd Edition. ISBN: 978-0-07-123110-7

2 Computer Networks, Mayank Dave, CENGAGE India, 6th Edition ISBN: 978-8131509869

Web Links:

1 https://nptel.ac.in/courses/106105081
2 https://www.coursera.org/learn/fundamentals-network-communications

Agile Software Engineering

Course Code: 2501IT07	L	T	P	C
	2	0	1	3

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

CO1: Apply software engineering practices and evaluate different software development models to design and manage the life cycle of a Student Management System (SMS).
CO2: Analyze the principles of Agile methodologies and compare them with traditional models by transitioning a retail software company from Waterfall to Agile.
CO3: Evaluate the impact of Agile processes on requirements engineering and manage unstable requirements for a social media platform project.
CO4: Design and implement a comprehensive testing strategy using TDD and test automation tools in an Agile project.
CO5: Apply Agile design principles and execute refactoring techniques to develop maintainable and scalable software systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1			2						
CO2	3	2	1	1				2	2	2	1
CO3	2	1	1							2	1
CO4	3	2	2	1				2	2	2	1
CO5	1	2									

UNIT – I

Introduction to Software Engineering: Define Software Engineering, The Software Process, Software Engineering Practice, Software Myths
Software Life Cycle models and Processes: Software Process, Process Classification, Phased Development Life Cycle, Software Development Process Models – The Waterfall, Spiral and Evolutionary Models, Software Project Management Process, Project Planning and Estimation, Gathering Requirements, Software Design, Software Testing, Software Quality and Reliability.

Case Study: Developing a Student Management System (SMS)

UNIT – II

Fundamentals of Agile Methodology: Theories for Agile Management, Agile Software Development, Traditional Model Vs. Agile Model, Classification of Agile Methods, Agile Manifesto and Principles, Agile Project Management, Agile Team Interactions, Ethics in Agile Teams, Agility in Design, Testing, Agile Documentations, Agile Drivers, Capabilities and Values.
Case Study: Implementing Agile Methodology in a Software Development Project

UNIT – III

Agile Processes: Lean production - SCRUM, Crystal, Feature Driven Development, Adaptive Software Development, and Extreme Programming: Method overview – lifecycle – work products, roles and practices.
Agility And Requirements Engineering: Impact of Agile Processes in RE, Current Agile Practices, Overview of RE Using Agile, Managing Unstable Requirements, Requirements Elicitation
Case Study: Agile Processes and Requirements Engineering in a Healthcare Software Project

UNIT – IV

Agile Testing: The Agile lifecycle and its impact on testing, Test-Driven Development (TDD), xUnit framework and tools for TDD, Testing user stories - acceptance tests and scenarios, Planning and managing testing cycle, Exploratory testing, Risk based testing, Regression tests, Test Automation, Tools to support the Agile tester.

Case Study: Implementing Test-Driven Development (TDD) for a Healthcare Application

UNIT – V

Agile Software Design and Development: Agile design practices, Role of design Principles including Single Responsibility Principle, Open Closed Principle, Liskov Substitution Principle, Interface Segregation Principles, Dependency Inversion Principle in Agile Design, Need and significance of Refactoring, Refactoring Techniques, Continuous Integration, Automated build tools, Version control.
Case Study: Refactoring an E-Commerce Backend Using Agile Design Principles

Capstone Project:
1.Students shall choose a real-time software application (e.g., e-commerce backend, SMS, food delivery app) and apply Agile design principles, perform refactoring, implement TDD, and use version control and CI tools. This project should be implemented as a mini project and submitted at the end of the course.

Text Books:

1. Software Engineering – Concepts and Practices: Ugrasen Suman, Cengage Learning, ISBN: 9789390555475.
2. Agile Software Development, Current Research and Future Directions‖, Springer-Verlag Berlin Heidelberg, Dingsoyr, Torgeir, Dyba, Tore, Moe, Nils Brede (Eds.), ISBN-10. 3642125743.

Reference Books:

1. Software Engineering, Lan Sommerville, Pearson, Tenth Edition, ISBN: 978-9332582699.
2. Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results‖, Prentice Hall, David J. Anderson; Eli Schragenheim, ISBN: 978-0131424609

Web Links:

1 https://www.tutorialspoint.com/software_engineering/
2 https://www.sciencedirect.com/science/article/pii/S0950584916303329

Data Mining

Course Code: 2501AI03	L	T	P	C
	1	0	2	3

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

CO1:	Illustrate data warehousing architectures and mining concepts for knowledge discovery.
CO2:	Apply preprocessing techniques to prepare data for mining algorithms.
CO3:	Build classification model using Decision tree induction.
CO4:	Analyze association rule generation using Apriori and FP growth algorithms.
CO5:	Apply Clustering algorithms on given data to find similarity between classes.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	2		1			1	1		2
CO2	2	2	2		2			1	1		2
CO3	2	2	3		1			1	1		2
CO4	2	2	3		1			1	1		2
CO5	2	2	3		1			1	1		2

UNIT – I

Data Warehousing and Online Analytical Processing:
Data Warehouse: Basic Concepts, Data Warehouse Modeling: Data Cube and OLAP, Data Warehouse Design and Usage, Data Warehouse Implementation, Data Generalization by Attribute-Oriented Induction.
Data Mining: What Is Data Mining, Why Data Mining, Data Mining Functionalities, Technologies Are Used, Major Issues in Data Mining, Architecture Of Data Mining Systems Classification Of Data Mining Systems.

Practice:
1. Illustrate KDD process and explore the Data Mining tool WEKA/KNIME
2. for Data Preprocessing, Classification and Clustering.
3. Explain ETL process important for moving data in the data warehouse.

UNIT – II

Know Your Data : Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Data Visualization, Measuring Data Similarity and Dissimilarity.
Data Preprocessing : An Overview, Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization

Practice:
1. Apply Statistical Descriptions and Measures of Similarity and Dissimilarity on given data

2. Apply PreProcessing for training data set related to Weather data

UNIT – III

Classification and Prediction: Classification: Basic Concepts, General Approach to Solving a Classification Problem, Decision Tree Induction, Model Overfitting, Evaluating the Performance of a Classifier, Issues Regarding Classification and Prediction

Practice:

1. Demonstrate classification rule process on given data set using id3 algorithm.
2. Demonstrate classification rule process on Student's Academic Performance Data using j48 algorithm.

UNIT – IV

Mining Frequent Patterns, Associations and Correlations: Basic Concepts and Methods, Frequent Itemset Mining Methods, Which Patterns Are Interesting?—Pattern Evaluation Methods, Association Mining to Correlation Analysis.

Practice:

1. Demonstrate Association rule generation on credit card data using apriori algorithm.
2. Demonstrate Association rule process on contactlenses.arff using FPGrowth Algorithm

UNIT – V

Cluster Analysis: Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Evaluation of Clustering, Mining Spatial, Multimedia, Text and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web.

Practice:

1. Demonstrate clustering process on given dataset using simple k-means
2. Apply Hierarchical clustering process on dataset

Additional Practice:

1. Write a program of cluster analysis using DB SCAN algorithm Python programming language
2. Demonstrate Web/Text Mining using WEKA/KNIME Tool

Capstone Project:

Implement a data mining application involving data preprocessing and various data mining tasks can be achieved by focusing on a specific domain, such as retail, sales and customers, and then applying different techniques to analyse the data. This project would involve data cleaning, transformation, and various data mining tasks like clustering and association rule mining of your own data set, potentially leading to valuable insights into various area of data mining Applications.

Text Books:

1	Data Mining Concepts and Techniques, Jiawei Han, Micheline Kamber and Jian Pei Third Edition, Elsevier, ISBN: 978-9380931913
2	Introduction to Data Mining, PangNing Tan, Michael Steinbach and Vipin Kumar Pearson Education, ISBN: 978-1-292-02615-2

Reference Books:

1	Data Mining: Introductory and Advanced Topics, Margaret H. Dunham, 1st Edition Pearson Edn, ISBN: 978-8177587852
2	Data Mining Techniques and Applications An Introduction, Hongbo Du, 1st Edition, Cengage India, ISBN: 978-8131519554
3	Data Warehousing, Data Mining and OLAP, Alex Berson,.Stephen J. Smith, McGrawHill series, ISBN: 978-0070062726

Web Links:

1	https://nptel.ac.in/courses/106105174/
2	https://www.kdnuggets.com/
3	https://www.import.io/post/datascientistsvsdataanalystswhythedistinctionmatters/

Object Oriented Programming through C++

	L	T	P	C
Course Code: 2501CS08	**2**	**0**	**2**	**4**

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

- **CO1:** Make use of programming constructs of C and C++
- **CO2:** Summarize OOPS concepts.
- **CO3:** Develop applications using constructor and destructor.
- **CO4:** Apply C++ features for problem solving.
- **CO5:** Apply inheritance concepts and file I/O to solve a given problem.
- **CO6:** Design C++ classes using templates and STL.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	2					1	1		
CO2	2	1	2					1	1		
CO3	1	2	2					1	1		
CO4	1	1	1					1	1		
CO5	1	1	2					1	1		
CO6	2	1	2					1	1		

UNIT – I

Introduction to C++: Differences between C and C++, Disadvantages of Conventional Programming, Evolution of C++, Key Concepts of Object Oriented Programming, Structure of C++ program , Advantages of OOP, scope resolution Operator, Namespace.

Practice:

1. Find the roots of a quadratic equation.
2. Find factorial of a given number using recursion
3. Implement scope resolution and namespaces.
4. Illustrate the use of default arguments and access specifiers

UNIT – II

Classes and Objects: Declaring Objects- Access Specifiers and their Scope,Defining Member Function, Rules for Inline Functions, static Member Variable, static Member Function, Friend functions, overloading Member Function, Array of Objects, Object as Parameter, Object as return type, Nestedclass, Introduction to Constructors and Destructor,Characteristics of Constructor and Destructor, Application with Constructor, Constructor with Arguments, Copy Constructor, Anonymous Objects.

Practice:

1. Program to illustrate inline functions and function overloading.
2. Program to illustrate friend function
3. Program to illustrate the use of Constructors and Destructors.
4. Program illustrating Constructor overloading.
5. Program illustrating Copy Constructor.

UNIT – III

Operator Overloading: Introduction, The Keyword Operator,Rules for Overloading Operators,Overloading Unary Operator,Overloading Binary Operator, Overloading using friend function.
Inheritance: Introduction, Reusability, Types of Inheritance, Virtual Base Classes, Object as a Class Member, Abstract Classes, Advantages and Disadvantages of Inheritance. Pointer to Class- Pointer Object, this Pointer, Pointer to Derived Classes and Base Class.
Binding Polymorphisms and Virtual Functions: Introduction, Binding in C++,Virtual Functions, Rules for Virtual Function, Abstract classes, Virtual Destructor
Practice:

1. Overload Unary, and Binary Operators using member function.
2. Overload Unary, and Binary Operators using friend function.
3. Incorporate various forms of Inheritance i. Single Inheritance ii. Multiple Inheritances iii. Multi-level inheritance iv. Hierarchical Inheritance v. Hybrid inheritance
4. Order of execution of constructors and destructors in inheritance.
5. Illustrate the use of object as a class member,pointer to a class,this pointer and Virtual Base Class.
6. Illustrate virtual functions.
7. Implement pure virtual function and calculate the area of different shapes by using abstract class.

UNIT – IV

Generic Programming with Templates: Introduction, Need for Templates,Definition of class Templates, Normal Function Templates, Overloading of Template Function, Bubble Sort Using Function Templates, Difference between Templates and Macros, Linked list with templates
Practice:

1. Illustrate the use of function template.
2. Implement template class.
3. Implement class templates with multiple parameters.

UNIT – V

Exception Handling: Introduction, Principles of Exception Handling, The Keywords try throw and catch, Multiple Catch Statements.
Files: Stream I/O ,Reading and writing to Files.
Overview of Standard Template Library: Introduction, STL Programming Model, Containers, Sequence Containers, Associative Containers, Algorithms, Iterators, Vectors, Lists, Maps
Practice:

1. Implement Exceptions handling.
2. Illustrate the use of multiple catch statements.
3. Implement List,Vector and its Operations.
4. Implement Deque and its Operations.
5. Implement Map and its Operations.

Additional Practice:
1.Develop a C++ program for flight booking system

2.Develop Qt application containing slider and spin box in which a slider responds to changes in the spin box.

3.Develop a Qt application for creating a text pad.

4. Develop a C++ program with maximum of 20 characters, that your user will be guessed and will show
only asterisks (*) on the screen. The user will input or enter one character at a time. And for every correct character, the asterisk will be replaced by that character until all the characters or the mystery word/s will reveal. Your program will accept a maximum three (3) errors or mistakes in entering/inputting character otherwise the mystery word/s will be viewed. Sample Output: Output: ******* Enter your character: e
Output: ***e**e
Enter your character: a Output: sorry! the character is not existing. you still have 2 chances
Enter your character: s Output: s**e**e
Enter your character: c Output: sc*e*ce
Enter your character: i Output: scie*ce
Enter your character: n Output: science

Text Books:

1	The Complete Reference C++, Herbert Schildt, Fourth Edition, TMH ISBN-13:978-0070532465, and the ISBN-10 is 007053246X.
2	The C++ Programming Language, Bjarne Stroustrup, Fourth Edition, Pearson ISBN 978-0321563842

Reference Books:

1	A First Book Of C++, Gary Bronson, Fourth Edition, Cengage Learning ISBN-10. 8131532712 and ISBN:. 978-8131532713
2	C++ Primer Plus By Stephen Prata, Sixth Edition, Pearson ISBN: 978-0321776402
3	C++ Programming:From Problem Analysis To Program Design, Ds Malik,Eighth Edition, Cengage Learning ISBN: 9781337102087

Web Links:

1	http://nptel.ac.in/courses/106105151/
2	http://www.geeksforgeeks.org/c-plus-plus/
3	https://infyspringboard.onwingspan.com/web/en/viewer/html/lex_auth_013501572848615424101 01
4	https://www.udemy.com/course/beginning-c-plus-plus-programming/

Java Programming

Course Code: 2501IT06	L	T	P	C
	2	0	2	4

Course Outcomes:

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

CO1: Apply Java features for problem solving.
CO2: Build applications using principles of OOPs, interfaces and Packages.
CO3: Develop programs using Exception Handling to handle run-time errors.
CO4: Develop applications using multithreading for inter thread communication.
CO5: Build JDBC applications for performing CRUD operations using MySQL.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	1		1				1	2	1
CO2	2	1	3		1				1	2	1
CO3	2	3	2		1				1	2	1
CO4	2	2	2		1				1	2	1
CO5	2	2	3		1				1	2	1

UNIT – I

Introduction to Java: History of Java, Features of Java Language, JVM Architecture, Java source file structure. Building Blocks of Java, Control Statements, Operators, Type Conversion, Command Line Arguments, Arrays.

Practice:

1. **Control Statements**
   a. Select all the prime numbers within the range of 1 to 100.
   b. Find the sum of all even terms in the Fibonacci sequence up to the given range N.
   c. Check whether a given number is Armstrong or not.

2. Arrays
   a. Sort an array of integers in ascending order.
   b. Find the maximum and minimum element in an array.
   c. Remove duplicate elements from an array.

UNIT – II

Concepts of Class: Class, Object, Method, Constructor, Overloading- Method and Constructor Keywords: this, static and final, String Class and its Methods, StringTokenizer, StringBuffer and StringBuilder.

Practice:

1. Class Mechanism

a. Display the details of a person. Personal details should be given in one method and the qualification details in another method.
b. Implement constructor and constructor overloading.
c. Implement method overloading.

2.Strings

a. Check if a given string is a pangram (contains every letter of the alphabet at least once).
b. Find the most frequently occurring character in a string.
c. Find all permutations of a given string.
d. Check if a given string is a anagram (Ex: CAT and ACT).

UNIT – III

Inheritance: Inheritance, Types of Inheritance, super and super( ), Method Overriding, Using final with inheritance, abstract with Class and Method, Dynamic Method Dispatch. Interfaces: Introduction to interface, Multiple inheritance.

Practice:

1. Inheritance & interface

a. Implement multi level Inheritance.
b. Implement multiple Inheritance.
c. Find the areas of different shapes using abstract classes.

UNIT – IV

Packages: Introduction, Importing Packages and Classes, path and classpath, Access Specifiers, java.util: Collection Framework (related interfaces and classes), java.io: FileReader, FileWriter, FileInputStream, FileOutputStream, BufferReader and BufferWriter, Wrapper Classes.

Practice:

1. Packages & java.io

a. Import and use user defined package.
b. Illustrate the use of protected members in a package.
c. Copy Even numbers into Even.txt file and Odd Numbers into Odd.txt file.

2. Collection Framework

a. ArrayList and LinkedList
b. Iterator and Iterable
c. Comparator and Comparable
d. HashMap and TreeMap
e. HashSet and TreeSet
f. HashTable

UNIT – V

Exception Handling: Introduction, Keywords: try, catch, throw, throws and finally, Multiple Catch Clauses, Checked and Unchecked Exceptions, User Defined Exceptions.

Multithreading: Introduction, Thread Life Cycle, Creation, Priorities, Synchronization, ITC.

Java Database Connectivity: Introduction, JDBC Architecture, Types of Drivers, JDBC Environment Setup, JDBC Steps, CRUD Operations.

Practice:

1. Exception Handling

a. Illustrate exception handling mechanism using multiple catch clauses.
b. Make use of Built-in and user-defined Exceptions in handling a run time exception.

2. Multithreading

a. Creates threads by extending Thread class. First thread display "Good Morning "every 1 sec, the second thread displays "Hello "every 2 seconds and the third display "Welcome" every 3 seconds, (Repeat the same by implementing Runnable).
b. Solve Producer-Consumer problem using synchronization.

3. JDBC

a. CRUD operations.

Additional Practice:

1. Student Management
2. Inventory Management
3. Phone book Management

Capstone Project:

Develop a console-based quiz application in Java where questions are fetched from a database. The app should handle user login, score calculation, timer using threads, exception handling, and store results in both files and database.

*** Note: The student must Complete & Submit a Java Programming Certificate Course offered by Oracle Academy at the end of the Practice Session.**

Text Books:

1. The Complete Reference Java, Herbert Schildt, TMH ,8th Edition, ISBN 978-1260440232.

2. Java one step ahead, Anita seth, B.L.Juneja, Oxford, First Edition. ISBN: 9780199459643.

Reference Books:

1. Introduction to java programming, by Y Daniel Liang, Pearson, Seventh Edition. ISBN: 978-8131729588

2. Core Java: An Integrated Approach, R.Nageswara Rao, Dream tech press.ISBN: 978-9351199250

Web Links:

1. https://academy.oracle.com/pages/coursedescription/Oracle%20Academy%20Java%20Programming%20Course%20Description.pdf

2. https://nptel.ac.in/courses/106/105/106105191/

3. http://java.sun.com/docs/books/tutorial/

Introduction to MERN Stack Development

Course Code: 2501CS16	L	T	P	C
	0	0	2	2

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

- **CO1:** Make use of HTML elements and their attributes for designing static web pages.
- **CO2:** Build a web page by applying appropriate CSS styles to HTML elements.
- **CO3:** Experiment with JavaScript to develop dynamic web pages and validate forms.
- **CO4:** Build a basic web server using Node.js and also working with Node Package Manager (NPM)
- **CO5:** Make use of Typescript to optimize JavaScript code using strict type checking

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	3		2			1	2		2
CO2	2	3	2		2			1	2		2
CO3	2	2	3	1	2			1	2		2
CO4	2	3	2	2	2			1	2		2
CO5	2	2	3	1	2			1	2		2

Practice:

1. Lists, Links and Images

a. Write a HTML program, to explain the working of lists.
Note: It should have an ordered list, unordered list, nested lists and ordered list in an unordered list and definition lists.

b. Write a HTML program, to explain the working of hyperlinks using <a> tag and href, target Attributes.
Note: Use text to link, https://www.aec.edu.in/
Use image to link, https://www.aec.edu.in/?p=Gallery

c. Create a HTML document that has your image and your friend's image with a specific height and width. Also when clicked on the images it should navigate to their respective profiles.

d. Write a HTML program, in such a way that, rather than placing large images on a page, the preferred technique is to use thumbnails by setting the height and width parameters to something like to 100*100 pixels. Each thumbnail image is also a link to a full sized version of the image. Create an image gallery using this technique.

2. HTML Tables, Forms and Frames

a. Write a HTML program, to explain the working of tables. (use tags: <table>, <tr>, <th>, <td> and attributes: border, rowspan, colspan)

b. Write a HTML program, to explain the working of tables by preparing a timetable. (Note: Use <caption> tag to set the caption to the table & also use cell spacing, cell padding, border, rowspan, colspan etc.).

c. Write a HTML program, to explain the working of forms by designing Registration form. (Note: Include text field, password field, number field, date of birth field, checkboxes, radio buttons, list boxes using <select> & <option> tags, <text area> and two buttons ie: submit and reset. Use tables to provide a better view).
d. Write a HTML program, to explain the working of frames, such that page is to be divided into 3 parts on either direction. (Note: first frame image, second frame paragraph, third frame hyperlink. And also make sure of using "no frame" attribute such that frames to be fixed).

3. HTML 5 and Cascading Style Sheets, Types of CSS

a. Write a HTML program, that makes use of <article>, <aside>, <figure>, <figcaption>, <footer>, <header>, <main>, <nav>, <section>, , tags.
b. Write a HTML program, to embed audio and video into HTML web page.
c. Write a program to apply different types (or levels of styles or style specification formats) - inline, internal, external styles to HTML elements. (identify selector, property and value).

4. Selector forms

Write a program to apply different types of selector forms

i. Simple selector (element, id, class, group, universal)
ii. Combinator selector (descendant, child, adjacent sibling, general sibling)
iii. Pseudo-class selector
iv. Pseudo-element selector
v. Attribute selector

5. CSS with Color, Background, Font, Text and CSS Box Model

a. Write a program to demonstrate the various ways you can reference a color in CSS.
b. Write a CSS rule that places a background image halfway down the page, tilting it horizontally. The image should remain in place when the user scrolls up or down.
c. Write a program using the following terms related to CSS font and text:
i. font-size ii. font-weight iii. font-style iv. text-decoration
v. text-transformation vi. text-alignment
d. Write a program, to explain the importance of CSS Box model using
i. Content ii. Border iii. Margin iv. padding

6. Applying JavaScript - internal and external, I/O, Type Conversion

a. Write a program to embed internal and external JavaScript in a web page.
b. Write a program to explain the different ways for displaying output.
c. Write a program to explain the different ways for taking input.
d. Create a webpage which uses prompt dialogue box to ask a voter for his name and age. Display the information in table format along with either the voter can vote or not.

7. Javascript Pre-defined and User-defined Objects

a. Write a program using document object properties and methods.
b. Write a program using window object properties and methods.
c. Write a program using array object properties and methods.
d. Write a program using math object properties and methods.
e. Write a program using string object properties and methods.

f. Write a program using regex object properties and methods.
g. Write a program using date object properties and methods.
h. Write a program to explain user-defined object by using properties, methods, accessors, constructors and display.

8. Javascript Conditional Statements and Loops

a. Write a program which asks the user to enter three integers, obtains the numbers from the user and outputs HTML text that displays the larger number followed by the words "LARGER NUMBER" in an information message dialog. If the numbers are equal, output HTML text as "EQUAL NUMBERS".
b. Write a program to display **week** days using switch case.
c. Write a program to print 1 to 10 numbers using for, while and do-while loops.
d. Write a program to print data in object using for-in, for-each and for-of loops

9. Javascript Functions and Events

a. Design a appropriate function should be called to display
   i. Factorial of that number
   ii. Fibonacci series up to that number
b. Design a HTML having a text box and four buttons named Factorial, Fibonacci, When a button is pressed an appropriate function should be called to display
   i. Factorial of that number
   ii. Fibonacci series up to that number
c. Write a program to validate the following fields in a registration page
   i. Name (start with alphabet and followed by alphanumeric and the length should not be less than 6 characters)
   ii. Mobile (only numbers and length 10 digits)
   iii. E-mail (should contain format like xxxxxxx@xxxxxx.xxx)

10. Node.js

a. Write a program to show the workflow of JavaScript code executable by creating web server in Node.js.
b. Write a program to transfer data over http protocol using http module.
c. Create a text file src.txt and add the following content to it. (HTML, CSS, Javascript, Typescript, MongoDB, Express.js, React.js, Node.js)
d. Write a program to parse an URL using URL module.
e. Write a program to create an user-defined module and show the workflow of Modularization of application using Node.js

11. Typescript

a. Write a program to understand simple and special types.
b. Write a program to understand function parameter and return types.
c. Write a program to show the importance with Arrow function. Use optional, default and REST parameters.
d. Write a program to understand the working of typescript with class, constructor, properties, methods and access specifiers.

Additional Practice:

1. Write a CSS program, to apply 2D and 3D transformations in a web page

2. Design a Web page with new features of HTML file and CSS3.
3. Design a to-do list application using Javascript.

Note: The student must Complete & Submit a HTML5, JavaScript, TypeScript & NodeJs Certificate Courses offered by Infosys Spring board at the end of the Practice Session.

Text Books:

1 Programming the World Wide Web, Robet W Sebesta, Pearson, 7th Edition. ISBN 13 9789332518827

2 Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Vasan Subramanian, APress, O'Reilly, 2nd edition. ISBN 9781484226520.

Web Links:

1 https://infyspringboard.onwingspan.com/en/app/toc/lex_17739732834840810000_shared/overview (HTML5)

2 https://infyspringboard.onwingspan.com/en/app/toc/lex_18109698366332810000_shared/overview (Javascript)

3 https://infyspringboard.onwingspan.com/en/app/toc/lex_32407835671946760000_shared/overview (Node.js)

4 https://infyspringboard.onwingspan.com/en/app/toc/lex_9436233116512678000_shared/overview (Typescript)

Information Security Analysis & Audit

	L	T	P	C
Course Code: 2501CS30	2	0	0	2

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

CO1: Demonstrate fundamental concepts of information security and systems auditing
CO2: Analyze latest trend in management control framework
CO3: Identify security operations in management control framework.
CO4: Distinguish data evidence collection techniques.
CO5: Analyze data evidence evaluation in audit.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1									1
CO2	2	2					2				2
CO3	1	3		1		1		1			2
CO4	1	2					1	1		1	1
CO5	1	3		2	1		2	2			

UNIT – I

Overview of Information System Auditing: Effect of Computers on Internal Controls, Effects of Computers on Auditing, Foundations of information Systems Auditing, Conducting an Information Systems Audit.

UNIT – II

The management Control Framework-I: Introduction, Evaluating the planning Function, Leading Function, Controlling Function, Systems Development Management Controls, Approaches to Auditing Systems Development, Programming Management Controls, Data Resource Management Controls.

UNIT – III

The Management Control Framework-II: Security Management Controls, Operations management Controls Quality assurance Management Controls, Case Studies

UNIT – IV

Evidence Collection: Audit Software, Code Review, Test Data, and Code Comparison, Concurrent Auditing techniques, Interviews, Questionnaires, and Control Flowcharts. Performance Management tools- Case Studies.

UNIT – V

Evidence Evaluation: Evaluating Asset Safeguarding and Data Integrity, Evaluating System, Effectiveness, Evaluating System Efficiency, Information Systems Audit and Management: Managing the Information Systems Audit Function.

Text Books:

1 Information Systems Control and Audit, Ron Weber, Pearson Education, 1st Edition.ISBN : 978-8131704721
2 Cryptography Engineering: Design Principles and Practical Applications ,Niels Ferguson, Bruce Schneier, and Tadayoshi Kohno, John Wiley & Sons.ISBN: 978-0470474242

Reference Books:

1 Information System Audit and Assurance, D P Dube, TMH, New Delhi. ISBN: 978-0070585690
2 Computer Forensics, Computer Crime Investigation by John R. Vacca, Firewall Media, New Delhi.ISBN: 978-8170083412

Web Links:

1 https://www.coursera.org/learn/introduction-cybersecurity-cyber-attacks
2 https://computersecurity.stanford.edu/free-online-video[Free Online Videos]
3 CERT-In Guidelines- http://www.cert-in.org.in/

Advanced MERN Stack Development

Course Code: 2501CS18	L	T	P	C
	0	0	2	2

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

CO1:	Make use of router, template engine and authentication using sessions to develop application in ExpressJS.
CO2:	Build a single page application using RESTful APIs in ExpressJS.
CO3:	Make use of components, props, stats and render data in ReactJS.
CO4:	Apply router and hooks in designing ReactJS application.
CO5:	Make use of MongoDB queries to perform CRUD operations on document database.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	3		2			1	2		2
CO2	2	3	2		2			1	2		2
CO3	2	2	3		2			1	2		2
CO4	2	3	2		2			1	2		2
CO5	2	2	3		2			1	2		2

PRACTICE:

1. **ExpressJS – Routing, HTTP Methods, Middleware.**
   a. Write a program to define a route, Handling Routes, Route Parameters, Query Parameters and URL building.
   b. Write a program to accept data, retrieve data and delete a specified resource using http methods.
   c. Write a program to show the working of middleware.

2. **ExpressJS – Templating, Form Data**
   a. Write a program using templating engine.
   b. Write a program to work with form data.

3. **ExpressJS – Cookies, Sessions, Authentication**
   a. Write a program for session management using cookies and sessions.
   b. Write a program for user authentication.

4. **ExpressJS – Database, RESTful APIs**
   a. Write a program to connect MongoDB database using Mangoose and perform CRUD operations.
   b. Write a program to develop a single page application using RESTful APIs.

5. **ReactJS – Render HTML, JSX, Components – function & Class**
   a. Write a program to render HTML to a web page.
   b. Write a program for writing markup with JSX.

c. Write a program for creating and nesting components (function and class).

6. ReactJS – Props and States, Styles, Respond to Events

a. Write a program to work with props and states.
b. Write a program to add styles (CSS & Sass Styling) and display data.
c. Write a program for responding to events.

7. ReactJS – Conditional Rendering, Rendering Lists, React Forms

a. Write a program for conditional rendering.
b. Write a program for rendering lists.
c. Write a program for working with different form fields using react forms.

8. ReactJS – React Router, Updating the Screen

a. Write a program for routing to different pages using react router.
b. Write a program for updating the screen.

9. ReactJS – Hooks, Sharing data between Components

a. Write a program to understand the importance of using hooks.
b. Write a program for sharing data between components.

10. ReactJS Applications – To-do list and Quiz

a. Design to-do list application.

11. MongoDB – Installation, Configuration, CRUD operations

a. Install MongoDB and configure ATLAS
b. Write MongoDB queries to perform CRUD operations on document using insert(), find(), update(), remove()

12. MongoDB – Databases, Collections and Records

a. Write MongoDB queries to Create and drop databases and collections.
b. Write MongoDB queries to work with records using find(), limit(), sort(), createIndex(), aggregate().

Additional Practice:

1. Design a to-do list application using NodeJS and ExpressJS.
2. Design a Quiz app using ReactJS.
3. Complete the MongoDB certification from MongoDB University website.

Note: The student must Complete & Submit a Express Js, React Js & MongoDB Certificate Courses offered by Infosys Spring board at the end of the Practice Session.

Reference Books:

1 Programming the World Wide Web, 7th Edition, Robet W Sebesta, Pearson. ISBN 13 9789332518827
2 Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Vasan Subramanian, APress, O'Reilly, 2nd edition. ISBN 9781484226520.

Web Links:

1 https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_013843290195951616350733_shared/overview (Express Js)
2 https://infyspringboard.onwingspan.com/web/en/app/toc/lex_10648877150323546000_shared/overview(ReactJs)
3 https://infyspringboard.onwingspan.com/en/app/toc/lex_auth_013177169294712832113_shared/overview (MongoDB)

Flutter Fundamentals

Course Code: 2501IT12	L	T	P	C
	0	0	2	2

Course Outcomes:

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

CO1: Identify the steps to set up the Flutter development environment and recall the purpose of basic widgets and layout structures

CO2: Demonstrate the use of fundamental Flutter widgets including images, buttons, icons, lists, and forms.

CO3: Design and develop user interfaces using responsive layouts and implement navigation, gestures, and animations

CO4: Integrate state management techniques (like Provider, BLoC, Riverpod) and handle real-time user input and data changes effectively

CO5: Develop a complete Flutter application using backend integration with Firebase and REST APIs, demonstrating optimization, testing, and deployment skills.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2	1	3	-	-	-	-	-	2
CO2	3	2	3	1	2	-	-	-	-	-	2
CO3	3	2	3	2	3	-	-	-	-	-	2
CO4	3	3	3	2	3	-	-	-	-	-	2
CO5	3	3	3	3	3	-	-	-	-	-	3

Practice:

1.Introduction to Flutter

a. Setup Environment: Set up the Flutter development environment on both Windows and Mac OS.

b. First App: Create and run your first Flutter application in Android Studio.

c. Hello World: Create a simple "Hello World" Flutter application and run it on an Android emulator.

d. Understanding Structure: Modify the main Dart file to understand the structure of a Flutter app.

e. Hot Reload and Restart: Practice using the hot reload and hot restart features to see how changes reflect instantly.

2. Flutter Basics

a. Button Widgets: Create a Flutter app with various button widgets (Flat Button, Elevated Button, Icon Button).

b. Image Widget: Create an app that displays an image using the Image widget and customize its properties.

c. Icon Widgets: Use Icon widgets to display different icons in a Flutter app.

d. Counter App: Build a simple counter app that increases a number each time a button is pressed using set State.

e. Gesture Detector: Implement a gesture detector that changes the color of a container when tapped.

3.Flutter Basics Continued

a. List of Items: Create an app with a list of items where each item can be clicked to display a toast message.
b. Input Validation: Implement form input validation to ensure correct data entry.
c. Dialogs: Use Alert Dialog to show a dialog box when a button is pressed.

4.Introduction to Layouts

a. Basic Layouts: Create a layout using Column, Row, and Stack widgets.
b. Responsive Layout: Implement a responsive layout using the Flex widget.
c. Single and Multiple Child Widgets: Build a layout with a combination of single child and multiple child widgets.
d. Nested Layouts: Design a complex UI using nested layouts (e.g., rows inside columns).
e. Gesture Detection: Use Gesture Detector to detect various gestures (tap, double-tap).

5.Layouts Continued

a. Navigation: Implement navigation between two screens using the Navigator widget.
b. Grid View: Create a layout using Grid View to display items in a grid.
c. List View: Use List View to display a list of dynamic items.
d. Scrolling: Implement scrolling for a long list of items using List View and Scroll View

6.State Management (Basic)

a. Stateful and Stateless Widgets: Create a simple app to toggle between stateful and stateless widgets and observe the behavior.
b. Form Input and Display: Build an app with a form that takes user input and displays it on the same screen using set State.
c. Responsive Layout with Media Query: Create a responsive layout that adapts to different screen sizes using Media Query.
d. To-Do List App: Create a to-do list app where users can add and remove items dynamically.

7.Animation in Flutter

a. Animated Container: Create a simple animation using Animated Container.
b. Fade Transition: Implement a basic fade transition using Animated Opacity.
c. Physics-based Animation: Develop an app that uses a physics-based animation like Draggable.
d. Hero Animation: Implement a hero animation for navigating between screens.

8.Advanced Animations

a. Animated Builder: Use Animated Builder to create complex animations.
b. Animation Controller: Create animations with fine control using Animation Controller.
c. Staggered Animations: Implement staggered animations to animate multiple widgets in sequence.
d. Curved Animations: Use Curved Animation to create non-linear animations.

9.State Management (Advanced)

a. Provider Package: Use the Provider package for state management.

b. BLoC Pattern: Use the BLoC (Business Logic Component) pattern for managing state.

c. River pod: Explore and use the River pod package for state management.

10.Networking in Flutter

a. HTTP Requests: Use the http package to make GET and POST requests.

b. JSON Parsing: Parse JSON data received from an API.

c. Fetching Data: Fetch and display data from a remote API.

d. Handling Errors: Implement error handling for network requests.

e. REST API: Create an app that interacts with a REST API

11.Firebase Integration

a. Firebase Setup: Set up Firebase for a Flutter project.

b. Authentication: Implement user authentication using Firebase Auth.

c. Fire store: Use Fire store to store and retrieve data.

d. Firebase Storage: Upload and download files using Firebase Storage

12.Project Week

a. Project Planning: Plan a small project incorporating concepts learned.

b. Project Development: Develop the project with proper state management, layout, and networking.

c. Testing: Test the project for bugs and ensure all functionalities work as expected.

d. Optimization: Optimize the app for performance and responsiveness

Additional Practice:

1. Create a Flutter app that displays a list of items using List View. builder and allows users to add new items dynamically.
2. Develop a Flutter app that uses a Bottom Navigation Bar to navigate between different screens.
3. Create a Flutter app that implements basic form validation with input fields for name, email, and password.

Reference Books:

1	Beginning Flutter: A Hands-On Guide to App Development, Marco L. Napoli,ISBN: 1119550823
2	Flutter in Action, Eric Windmill, 2020, ISBN: 1617296147
3	Flutter for Beginners: An introductory guide to building cross-platform mobile applications with Flutter and Dart 2 by Alessandro Biessek,ISBN:1788996089

Web Links:

1	https://flutter.dev/docs
2	https://dart.dev/guides
3	https://codelabs.developers.google.com/?cat=flutter

Minor Degree in Civil Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501CE25	Repair & Rehabilitation of Structures	FC	3			3	50	50	100	-
2501CE43	Building Planning & Computer-Aided Drawing	FC			2	2	50	50	100	-
2501CE27	Green Buildings	FC	3			3	50	50	100	-
2501CE40	Fundamentals of Soil Behaviour	FC	2	1		3	50	50	100	-
2501CE54 2501CE47	Railway Engineering (or) Docks & Harbour Engineering	FC	3			3	50	50	100	-
2501CE36 2501CE37	Environmental Impact & Risk Management (or) Environmental Management	IC	3			3	50	50	100	-
2501CE56 2501CE49	Urban Transportation Planning (or) Intelligent Transportation Systems	IC	3			3	50	50	100	-
Total			**17**	**1**	**2**	**20**				

Repair and Rehabilitation of Structures

(Common to All, Except CE)

L T P C

Course Code: 2501CE25 **3 0 0 3**

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

CO1: Describe the concept of repair and its need.
CO2: Classify various causes of deterioration of concrete structure and Distresses monitoring techniques.
CO3: Identify the effect of corrosion on structures.
CO4: Assessing the techniques for repairing.
CO5: Apply the NDT techniques to assess the condition of the structures& explain seismic retrofitting and maintenance of heritage structures.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	3	1	-	2	-	-	-	-	-
CO2	2	-	2	2	-	2	-	-	-	-	-
CO3	2	1	2	2	-	2	-	-	-	-	-
CO4	2	-	2	2	-	2	-	-	-	-	-
CO5	2	-	2	2	-	3	-	-	-	-	-

UNIT – I

Introduction: Maintenance and Repair strategies - Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating a damaged structure.

UNIT – II

Deterioration of Structures: Introduction, Basic terminology – Causes of deterioration, physically induced deterioration, chemically induced deterioration, Quality assurance for concrete construction concrete properties- strength, permeability, thermal properties and cracking.

UNIT – III

Corrosion of structures: Corrosion mechanism - Effects of cover thickness and cracking - Methods of corrosion protection – Inhibitors - Coatings - Cathodic protection for reinforcements-design and construction errors - Effects of cover thickness and cracking.

UNIT – IV

Rehabilitation and Retrofitting methods: Repair: Gunniting, Shortcreting, Epoxy – Cement mortar injection, Crack ceiling
Rehabilitation Methods: Grouting, Imbalance of structural stability, Strengthening & Stabilization techniques, Design consideration – Beam shear capacity strengthening – Shear

transfer strengthening – Stress reduction techniques – Column strengthening, Flexural strengthening – Connection stabilization & strengthening.

UNIT – V

Damage Assessment: Repairs to Structures - Repair of structures distressed due to earthquake – Strengthening using FRP Strengthening and stabilization techniques for repair Non – Destructive testing methods – Rebound hammer, Ultrasonic pulse velocity, Rebar locator, Corrosion meter, Penetration resistance& Pullout tests. Seismic Retrofitting and Maintenance of Heritage Structures: Earthquake damages of buildings, their retrofitting and restoration. Effects of earthquakes. Methods of seismic retrofitting, restoration of buildings, Special care in repair and rehabilitation of heritage structures.

Text Books:

1. Maintenance Repair Rehabilitation & Minor works of Buildings- P.C. Varghese, PHI Publications. (ISBN: 978-81-203-4945-2)
2. Repair and Rehabilitation of Concrete Structures – P.I. Modi, C.N. Patel, PHI Publications. (ISBN : 9788120352148).

Reference Books:

1. Rehabilitation of Concrete Structures - B. Vidivelli, Standard Publishers Distributors (ISBN: 8180141101).
2. Rehabilitation of Concrete Structures - B. Vidivelli, Standard Publishers Distributors (ISBN : 9788180141102).
3. Concrete Repair and Maintenance illustrated - Peter H.Emmons (ISBN-13: 978-0876292860).

Web Links:

1. https://www.academia.edu/30633495/Repair_and_Rehabilitation_of_Structures
2. https://nptel.ac.in/courses/105/106/105106202/

Building Planning and Computer Aided Drawing
(Common to All, Except CE)

	L	T	P	C
Course Code: 2501CE43	**0**	**0**	**2**	**2**

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

- **CO1:** Discuss about CAD software and basic functions.
- **CO2:** Plan different types of buildings as per NBC regulations and building laws
- **CO3:** Sketch the various building components
- **CO4:** Evaluate plans of Single storied building & multistoried buildings
- **CO5:** Develop different sections at different elevations
- **CO6:** Detailing of building components like doors, windows and roof trusses etc.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	-	-	3	3	2	2	2	2	2
CO2	3	-	-	-	2	3	2	2	2	2	1
CO3	3	-	-	-	2	2	2	2	2	2	2
CO4	2	-	-	-	3	3	2	2	2	2	2
CO5	2	-	-	-	3	3	2	2	2	2	2
CO6	2	-	-	-	3	3	2	2	2	2	2

Practice:

1. Introduction to various CAD commands with simple examples
2. To understand about Principals of building planning and building bye-laws.
3. To draw the foundation details for the buildings.
4. To draw the stretcher and header bond.
5. To draw the English and Flemish bond.
6. To draw the plan section and elevation of different types of staircases
7. To draw the plan section &elevation of buildings using software a) Single storeyed b) Multi storeyed residential buildings
8. To draw the developed plan, elevation, section and site plan of public buildings (Hospital& or School buildings).
9. Detailing of building components like doors and windows.
10. To draw the elevation of roof structures like king post and queen post truss.

Additional Practice:

1. To draw the plan, elevation, section and site plan of Industrial buildings
2. To draw the plan and elevation of different types staircases.
3. To draw the plan, elevation, and section of two storied building.

Text Books:

1. Building Planning and Drawing, Dr. N. Kumara Swamy, A. Kameswara Rao, Charotar Publishing House Pvt. Ltd. 2019, 9th edition. (ISBN: 13. 978-9385039386).

2. Building Planning and Drawing by S.S. Bhavikatti, Dreamtech Press India Pvt. Ltd, 1 Edition 2019. (ISBN: 13. 978-9389307085

Reference Books:

1. Building, Planning and Drawing - Tech Knowledge Publications by Nishant A. Upadhye (ISBN: 978-93-89684-17-9)
2. Model Building Bye-laws 2016, Young Global Publications (ISBN-13:978-8188274475)
3. Planning, Designing and scheduling, Girescharan Singh &JagadishSingh, Published by Standard Publishers Distributors.(ISBN: 13. 978-8180140051)

Web Links:

1. http://www.bsiet.org/notes/BPD%20Theory.pdf
2. https://sites.google.com/a/mitr.iitm.ac.in/iitmcivil/ce2050
3. http://www.cadmatesoftware.com/

Green Buildings
(Common to All, Except CE)

Course Code: 2501CE27	L	T	P	C
	3	0	0	3

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

- **CO 1:** Define sustainability and a green building, along with its features and benefits.
- **CO 2:** Describe the methods used to maintain indoor environmental quality.
- **CO 3:** Describe the water efficiency methods
- **CO 4:** Design sustainable and energy efficient civil engineering projects.
- **CO 5:** Select materials for sustainable built environment & adopt waste management methods.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	2	-	-	-	2	-	1	-	-	-
CO2	3	3	-	-	-	2	-	1	-	-	-
CO3	3	3	-	-	-	2	-	1	-	-	-
CO4	2	2	-	-	-	2	-	1	-	-	-
CO5	3	3	-	-	-	2	-	1	-	-	-

UNIT I

Green Building Concept: Overview of green building movement; Concept of Green building and sustainable development; Issues and strategies of Green building and sustainable development; Objectives Principals and Benefits of Green building design; Introduction to High-performance building; integrated design process of high-performance building; Green project requirements and strategies; Overview of various green rating systems worldwide.

UNIT-II:

Green Building Materials and Indoor Environment Quality: Introduction; Low emitting materials; Building and material reuse; Construction waste management; Regional materials; Life cycle cost assessment of building materials and products; Factors affecting indoor environment quality; Ventilation and filtration; Building materials and finishes- Emittance level; Indoor Environment quality best practice.

UNIT-III:

Water: Reduce, Reuse and Recycle: Introduction; Wastewater strategy and water reuse/recycling; Water fixtures and water use reduction strategies.

UNIT-IV:

Energy Efficiency: Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy.
Methods to reduce operational energy: : Energy efficient building envelopes, Solar Heat Gain Coefficient, U-Values for facade materials, efficient lighting technologies, energy efficient and BEE rated appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of NET ZERO buildings.

UNIT-V:

Building materials: Methods to reduce embodied energy in building materials: (a) Local building materials. (b) Natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks. (c) Materials with recycled content such as blended cements, pozzolana cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. (d) Reuse of waste and salvaged materials.
Waste Management: Handling of construction & demolition waste materials, separation of household waste, handling e-waste, on-site and off-site organic waste management.

Text Books:

1. Alternative Building Materials and Technologies, K.S. Jagadeesh, B.V. Venkata Rama Reddy, and K.S. Nanjunda Rao,New Age International Publishers.(ISBN: 9788122433110)
2. Green Building Fundamentals, Mike Montoya, Pearson in the USA. (ISBN: 9780135066403)

Reference Books:

1. Green Buildings,Peter Gevorkian, published by McGraw-Hill. (ISBN: 9780071473590)
2. Green Building Handbook, Volume 1, Tom Woolley, Sam Kimmins, Paul Harrison, and Rob Harrison, E & FN Spon (an imprint of Thomson Science & Professional). (ISBN: 9780419236900)

Web Links:

1. https://www.igbc.in/
2. http://www.sbtmanual.in/
3. https://www.grihaindia.org/

Fundamentals of Soil Behaviour

(Common to All, Except CE)

L	T	P	C

Course Code: 2501CE40 **2 1 0 3**

Course Outcomes:

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

CO1: Identify the probable soil formation history
CO2: Evaluate the soil fabric by indirect and direct methods
CO3: Identify and solve soil water interaction problems
CO4: Evaluate the soil compressibility aspects and estimate probable settlements.
CO5: Asses the shear strength characteristics by conducting the most appropriate tests

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3	2	2	2	1	1	1	1	1	2
CO2	3	3	2	2	2	1	1	1	1	1	2
CO3	3	3	3	2	2	2	2	1	2	2	2
CO4	3	3	2	3	2	2	2	1	2	1	2
CO5	3	3	2	2	3	2	2	1	2	1	2

UNIT – I

Soil Formation and Composition : Origin, nature and distribution of soil, description of individual particle, clay mineralogy, clay-water electrolytes, soil fabric and structure.

UNIT – II

Effective Stress and Soil Permeability: Effective stress principle, steady state flow in soil, effect of flow on effective stress, determination of coefficient of permeability.

UNIT – III

Soil Consolidation: Consolidation in one, two, three and radial direction, variation of effective stress during consolidation, consolidation tests and determination of consolidation parameters.

UNIT – IV

Shear Strength of Soils: Stress path analysis, tri-axial and direct shear tests, shear behaviour of granular soils and Fine-Grained Soils, factors affecting shear behaviour, determination of shear strength parameters, pore pressure parameters, UU,CU, CD tests, total and effective shear strength parameters, factors affecting shear strength- determination of in situ undrained strength.

UNIT – V

Critical State Model: Introduction models and soil mechanics, use of models in engineering, elasticity, soil elasticity, plasticity and yielding, yielding of metal tubes in combined tension

and torsion, elastic-plastic model for soil, elastic volumetric strains, a particular elastic-plastic model.

Text Books:

1. Soil Mechanics and Foundation Engineering ,Arora K.R., Standard publisher, 2020. (ISBN: 13- 978-8180141126).
2. Soil Mechanics and Foundations , Punmia, B.C., Laxmi Publications Pvt. Ltd. New Delhi. (ISBN: 13- 978-8170087915).

Reference Books:

1. Text book in Fundamentals of Soil Behaviour , Mitchell, J. K., , John Wiley & Sons, New York, 2Ed. (ISBN: 13- 978-0471856405).
2. Soil Behaviour and critical State Soil Mechanics , Muir Wood , Cambridge University Press. (ISBN: 13- 978-0521337823).

Web Links:

1. https://nptel.ac.in/courses/105101084
2. https://archive.nptel.ac.in/courses/105/101/105101201/

Railway Engineering
(Common to All, Except CE)

L	T	P	C

Course Code: 2501CE54 **3 0 0 3**

Course Outcomes:

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

CO1: Explain different components of railway track
CO2: Design track gradients as per given requirements
CO3: Discuss various types of tracks turnouts and crossings
CO4: Explain interlocking and signaling systems
CO5: Describe purposes and facilities at Railway Stations
CO6: Explain track maintenance

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	-	-	-	-	-	-	-	-
CO2	2	2	3	-	-	-	-	-	-	-	-
CO3	-	2	3	-	-	1	-	-	-	-	-
CO4	-	1	3	-	-	2	-	-	-	-	-
CO5	1	-	-	-	-	2	-	-	-	-	-
CO6	1	-	-	-	-	2	-	-	-	-	-

UNIT – I

Components of Railway Engineering: Permanent way components – Railway Track Gauge - Cross Section of Permanent Way - Functions of various Components like Rails, Sleepers and Ballast –Rail Fastenings – Creep of Rails- Theories related to Creep – Adzing of Sleepers- Sleeper density – Rail joints.

UNIT – II

Geometric Design of Railway Track: Alignment – Engineering Surveys - Gradients- Grade Compensation- Cant and Negative Super elevation- Cant Deficiency – Degree of Curve – safe speed on curves – Transition curve – Compound curves.

UNIT – III

Turnouts & Controllers: Track layouts – Switches – Design of Tongue Rails – Crossings – Turnouts – Layout of Turnout – Double Turnout – Diamond crossing – Scissors crossing – Inspection and maintenance of Points and Crossings.

UNIT – IV

Signalling and Interlocking: Objectives of Signalling - Classification of Signals – Fixed Signals - Stop Signals Signalling Systems – Mechanical Signalling System - Electrical Signalling System - Systems for Controlling Train Movement – Interlocking - Modern Signalling Installations.

UNIT – V

Railway Stations and Yards: Purpose of a Railway Station - Selection of Site for a Railway Station - Facilities Required at Railway Stations – Requirements of a Passenger Station Yard - Classification of Railway Stations - Station Platforms - Types of Yards.

Text Books:

1. Railway Engineering, Satish Chandra and M.M. Agrawal, Oxford University Press, New Delhi,2020. (ISBN: 9780195687798).
2. Railway Engineering, Rangwala, Charotar Publishing House. (ISBN: 9788177643260).

Reference Books:

1. Roads, Railways, Bridges & Tunnel Engineering, T.D.Ahuja & G.S.Birdie. (ISBN: 9788189401337).

Web Links:

1. https://nptel.ac.in/courses/105/107/105107123/
2. http://www.nptelvideos.in/2012/11/transportation-engineering-ii.html
3. https://lecturenotes.in/subject/458

Docks & Harbour Engineering

(Common to All, Except CE)

	L	T	P	C
Course Code: 2501CE47	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Introduce history and classifications of harbors.
CO2: Explain the fundamentals of Harbor planning.
CO3: Explain the natural forces affecting ports and general design aspects of marine structures.
CO4: Describe various navigational aids and dock & repair facilities.
CO5: Describe maintenance and protection of port facilities.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	2	-	-	-	2	-
CO3	1	1	3	-	-	2	-	-	-	-	-
CO4	2	2	-	-	-	-	-	1	-	2	-
CO5	1	1	-	-	-	-	1	2	-	2	-

UNIT – I

Harbor Planning: Types of water transportation, water transportation in India, requirements of ports and harbors, classification of harbors, selection of site and planning of harbors, location of harbor, traffic estimation, master plan, ship characteristics, harbor design, turning basin, harbor entrances, type of docks, its location and number, Site investigations – hydrographic survey, topographic survey, soil investigations, current observations, tidal observations.

UNIT – II

Harbor Works: Design and construction of breakwaters, berthing structures - jetties, fenders, piers, wharves, dolphins, trestle, moles, navigational aids, requirements of signals, fixed navigation structures, the necessity of navigational aids, light houses, beacon lights, floating navigational aids, light ships, buoys, radar.

UNIT – III

Docks and Repair Facilities: Harbor docks, use of wet docks, design of wet docks, repair docks, lift docks, dry docks, keel and bilge blocking, construction of dry docks, gates for dry docks, pumping plant, floating docks, slipways, locks, size of the lock, lock gates, types of gates.

UNIT – IV

Port facilities: Port development, port planning, port building facilities, transit sheds, warehouses, cargo handling facilities, container handling terminal facilities, shipping terminals, inland port facilities.

UNIT – V

Dredging, Coastal Protection and Inland navigation: Classification, types of dredgers, choice of dredger, uses of dredged materials, coastal erosion and protection, sea wall, revetment, bulkhead, coastal zone, and beach profile. Inland waterways, Inland water transportation in India, classification of waterways, the economics of inland waterways transportation, national waterways

Text Books:

1. Dock and Tunnel Engineering, Srinivasan and S. C. Rangwala, Harbour, Charotar Pub House, Anan. (ISBN: 9788192869261).
2. Docks and Harbour Engineering, Bindra S.P. - Dhanpat Rai & Sons, New Delhi.(ISBN: 9788189928858).

Reference Books:

1. Transportation Engineering, Railways, Airports, Docks & Harbours, Srinivasa Kumar R, University Press, Hyderabad,2020. (ISBN: 9789389211160).
2. Port Design - Guidelines and recommendations, C. A. Thoresen, Tapir Publications,2018. (ISBN: 9788251908399).
3. Highway, Railway, Airport and Harbor Engineering, Subramanian K. P, Scitech Publications (India) Pvt Limited, Chenna. (ISBN:13- 9788195330591).

Web Links:

1. https://nptel.ac.in/courses/114106025
2. https://lecturenotes.in/s/1892-dock-harbour-and-airport-engineering/videos

Environmental Impact & Risk Management

(Common to All, Except CE)

	L	T	P	C
Course Code: 2501CE36	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Apply basic principles of EIA
CO2: Illustrate the necessity to study the impacts
CO3: Interpret different risks that will be caused by projects or industries
CO4: Identify methods to overcome these impacts
CO5: Demonstrate the concepts of the legal requirements of Environmental and Risk Assessment for projects.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	1	-	-	2	-	-	-	1	1
CO2	2	2	2	1	-	2	-	-	-	-	-
CO3	2	2	1	1	-	3	-	-	-	-	-
CO4	2	2	2	1	-	2	-	-	-	-	-
CO5	2	-	3	-	-	3	-	-	-	-	-

UNIT – I

Introduction : Historical development of Environmental Impact Assessment (EIA). EIA in Project Cycle. Legal and Regulatory aspects in India. – Types and limitations of EIA –.EIA process- screening – scoping - setting – analysis – mitigation. Cross sectoral issues and terms of reference in EIA – Public Participation in EIA.

UNIT – II

Impact Indentification and Prediction: Matrices – Networks – Checklists –Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA. Prediction tools for EIA – Mathematical modeling for impact prediction – Assessment of impacts – air – water – soil – noise – biological — Cumulative Impact Assessment.

UNIT – III

Social Impact Assessment and Eia Documentation: Social impact assessment - Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition Documentation of EIA findings – planning – organization of information and visual display materials – Report preparation.

UNIT – IV

Environmental Management Plan: Environmental Management Plan - preparation, implementation and review – Mitigation and Rehabilitation Plans – Policy and guidelines for planning and monitoring programmes – Post project audit – Ethical and Quality aspects of Environmental Impact Assessment- Case Studies.

UNIT – V

Environmental Risk Assessment and Management: Environmental risk assessment framework-Hazard identification -Dose Response Evaluation – Exposure Assessment – Exposure Factors, Tools for Environmental Risk Assessment– HAZOP and FEMA methods – Event tree and fault tree analysis – Multimedia and multipath way exposure modelling of contaminant- Risk Characterization Risk communication - Emergency Preparedness Plans –Design of risk management programs.

Text Books:

1. Environmental Impact Assessment , Canter, L.W., McGraw Hill, New York. (ISBN: 0070097674).
2. Environmental Impact Assessment – Practical solutions to recurrent problems, Lawrence, D.P., Wiley-Interscience, New Jersey. (ISBN: 978-0-471-72202-1).

Reference Books:

1. Environmental Risk and Hazards, Cutter, S.L., Prentice-Hall of India Pvt. Ltd., New Delhi, (ISBN: 0137538561)
2. Risk Assessment and Management Handbook, Kolluru Rao, Bartell Steven, Pitblado R and Stricoff , McGraw Hill Inc., New York. (ISBN: 13978-0070359871)
3. Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control Sam Mannan, Lees, 4th Edition, Butterworth Heineman. (ISBN: 978-0-7506-7555-0).

Web Links:

1. https://nptel.ac.in/courses/120108004
2. https://www.witpress.com/journals
3. https://www.researchgate.net/publication/235859306

Environmental Management

(Common to All, Except CE)

	L	T	P	C
Course Code: 2501CE37	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Understand the physical and chemical treatment processes
CO2: Knowledge on various unit operations e.g, sedimentation tank, coagulation and filtration tank.
CO3: Knowledge on biological treatment significance
CO4: Know the aerobic treatment of wastewater
CO5: Understand the anaerobic treatment of wastewater

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	-	-	-	2	2	-	-	-	1
CO2	2	2	1	-	2	3	2	-	-	-	2
CO3	3	2	3	-	-	3	-	2	-	-	2
CO4	3	-	-	-	-	3	-	3	-	-	1
CO5	2	-	-	-	-	3	3	1	-	-	2

UNIT – I

Principles of Environmental Management: Definition of Environmental Management - Principles of Environmental Management - Nature, Scope and Components of Environmental Management - Policies and Legal Aspect of Environmental Management.

UNIT – II

Sustainable Environmental solutions: Public Private Participation Model - ISO Certification - Environment Health & Safety (EHS) - Environment & Disaster Management (EDM) - Environmental organizations for planning and implementation of sustainable development.

UNIT – III

Environmental Management Plan: Preventive and reactive strategies for environmental pollution control - Life Cycle Assessment as Environmental Management Tool - Environmental Management Plan (EMP) - Components of EMP - Preparation of EMP - Case Study

UNIT – IV

Environmental Impact Assessment: Environmental Impact Assessment (EIA) - Need and Importance - Steps involved - Methods of EIA - Ad-hoc, checklist, network, matrix etc - Typical case studies of environmental impact assessment - Environmental impact statement and risk assessment

UNIT – V

Environmental Legislations: Environmental Legislation - Air, Water and Environmental acts - Preventive and reactive strategies for environmental pollution control - Environmental Audit.

Text Books:

1. Assessment and analysis of Environmental management, Shukla S. S.,Shrivastva P. R, commonwealth publishers New Delhi (ISBN: 8171692192).
2. An introduction to Environmental Management, Dr, Anand Bal, Himalaya Publishing House, (ISBN-13 978-8183183758).

Reference Books:

1. Environmental Impact Assessment, second edition, Larry W. Canter, McGraw-Hill International editions (ISBN-13 978-0070097643).
2. Environmental Management 2013, Vikas Khanna, D. R. & Chopra, A. K. & Matta, Gagan & Bhutiani, R. & Singh (ISBN-13 978-8170358220).

Web Links:

1. https://enviromicro-journals.onlinelibrary.wiley.com/journal/14622920.
2. https://link.springer.com/book/10.1007/978-94-017-9118-2

Urban Transportation Planning

(Common to All, Except CE)

	L	T	P	C
Course Code: 2501CE56	**3**	**0**	**0**	**3**

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

CO1: Design, conduct and administer surveys to provide the data required for transportation planning.

CO2: Explain the process of data collection about travel behavior and analyze the data for use in transport planning
CO3: Develop and calibrate modal split, trip generation rates for specific types of land use developments
CO4: Apply the mode choice behaviour and mode split models.
CO5: Adopt the steps that are necessary to complete a long-term transportation plan.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	3	-	-	2	1	-	-	-	-
CO2	2	2	1	1	-	2	1	-	-	-	-
CO3	2	-	3	-	-	2	1	-	-	-	-
CO4	2	-	-	-	-	2	2	-	-	-	-
CO5	2	-	-	-	-	3	1	-	-	-	-

UNIT – I

Introduction: Urbanization, urban class groups, transportation problems and identification, impacts of transportation, urban transport system planning process, modeling techniques in planning. Urban mass transportation systems: urban transit problems, travel demand, types of transit systems

UNIT – II

Data Collection: Types and Sources of Data Trip generation models - Trip classification - productions and attractions – Trip rate analysis - Multiple regression models - Category analysis - Trip distribution models – Growth factor models.

UNIT – III

Trip Generation: UTPS Approach, Trip Generation Analysis: Zonal Models, Category Analysis, Household Models, Trip Attraction models, Commercial Trip Rates; Trip Distribution by Growth Factor Methods. Problems on above.

UNIT – IV

Trip Distribution: Gravity Models, Opportunity Models, Time Function Iteration Models. Travel demand modeling: gravity model, opportunity models, Desire line diagram. Modal split analysis. Problems on above.

UNIT – V

Traffic Assignment: Land use transportation models – Urban forms and structures - Location models - Accessibility – Land use models - Lowry derivative models Diversion Curves; Basic Elements of Transport Networks, Coding, Route Properties, Path Building- Preparation of alternative plans - Evaluation technique.

Text Books:

1. Principles of Urban Transportation System Planning , Hutchinson B.G., McGraw Hill. (ISBN : 13. 978-0070315396).
2. Introduction to Transportation Planning , J. Hutchinson, London. (ISBN: 13: 9780090986200).

Reference Books:

1. Transportation Engineering , Kent Lall, Prentice Hall of India (ISBN-13: 978-9332569706).
2. Transportation Engineering and Planning, C.S. Papacostas and P.D. Prevedouros, Prentice Hall of India Pvt. Ltd (ISBN-13: 978-0130814197)
3. Highway Engineering, S.K. Khanna& C.E.G. Justo, Nemchand & Bros., 10th edition (ISBN-13: 978-8185240930)

Intelligent Transportation Systems

(Common to All, Except CE)

	L	T	P	C
Course Code: 2501CE49	**3**	**0**	**0**	**3**

Course Outcomes:

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

- **CO1:** Identify and differentiate ITS user services and their components.
- **CO2:** Study the telecommunications in ITS.
- **CO3:** Interpret ITS functional areas.
- **CO4:** Implement suitable ITS and services for effective transportation.

CO5: Applications of Automated Highway Systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	-	-	1	-	-	-	-	-	-
CO2	3	2	-	-	1	-	-	-	-	-	-
CO3	2	2	1	1	1	-	-	-	-	-	-
CO4	2	2	1	1	1	-	-	-	-	-	-
CO5	2	2	1	1	1	-	-	-	-	-	-

UNIT – I

Introduction: Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

UNIT – II

Telecommunications in ITS: Importance of telecommunications in the ITS system, Information Management, Traffic Management Centers (TMC). Vehicle – Roadside communication – Vehicle Positioning System.

UNIT – III

ITS functional areas: Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS).

UNIT – IV

ITS User Needs and Services: Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.

UNIT – V

Automated Highway Systems: Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.

Text Books:

1. Fundamentals of Intelligent Transportation Systems Planning, M.A. Chowdhury and A. Sadek, Artech House, First Edition. (ISBN: 9781580534702).
2. Intelligent Transport Systems, Sarkar, Pradip Kumar, and Amit Kumar Jain, PHI Learning, 2018, First Edition. (ISBN: 9788120353001).

Reference Books:

1. Economic Impacts of Intelligent Transportation Systems: Innovations and Case Studies, Bekiaris and Y.J. Nakanishi, Elsevier/JAI. (ISBN: 9780762310320).
2. Intelligent Transport Systems Standards, Bob Williams, Artech House Publishers. (ISBN: 9781607839324)
3. Intelligent Transport Systems: Cases and Policies, Roger Stough, Edward Elgar. (ISBN: 3. 978-1840644470).

Web Links:

1. https://www.civil.iitb.ac.in/tvm/nptel/591_ITS_1/web/web.html
2. https://www.civil.iitb.ac.in/tvm/nptel/592_ITS_2/web/web.html
3. https://archive.nptel.ac.in/courses/105/101/105101008/
4. http://digital-library.theiet.org/content/journals/iet-its

Minor Degree in Electrical and Electronics Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EE55	Operation &Control of Electric machines	FC	2			2	50	50	100	BEEE
2501EE56	Fundamentals of Power Electronics	FC	2			2	50	50	100	BEEE

2501EE13	Electrical Measurements & Instrumentation	FC	2	1	1	4	50	50	100	ENA-1/BEEE
2501EE53	Electric Power Generation, Transmission and Distribution Systems	IC	3			3	50	50	100	ENA-1/BEEE
2501EE34 2501EE27	Alternative Energy Sources (or) Utilization of Electrical Energy	IC	3			3	50	50	100	EPGDS / BEEE/ ISM
2501EE37 2501EE35	Hybrid Electric Vehicles (or) Special Electric machines	AC	3			3	50	50	100	FPE/ OCEM
2501EE43 2501EE30	Electrical Safety (or) Methods & Algorithms for Intelligent Control	AC	3			3	50	50	100	EPGDS/PSA
	Total		**18**	**1**	**1**	**20**				

Operation & Control of Electric Machines

(Common to All, Except EEE)

	L	T	P	C
Course Code: 2501EE55	**2**	**0**	**0**	**2**

Course Outcomes:

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

CO1 Explain the concepts of electromechanical energy conversion & operation of the DC machines.
CO2 Analyze starting methods & speed control of DC machines.
CO3 Analyze the performance of DC machines by conducting various tests on DC machines.
CO4 Analyze the performance of synchronous generator.
CO5 Analyze the Parallel operation of synchronous generators.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	-	-	-	1	1	-
CO2	2	3	2	-	-	-	-	-	1	1	-
CO3	3	2	2	-	-	-	-	-	1	1	-
CO4	3	2	-	-	-	-	-	-	1	1	-
CO5	2	3	2	-	-	-	-	-	1	1	-

UNIT – I

Electromechanical Energy Conversion & introduction to DC machines: Principles of Energy Conversion, singly excited & multi excited systems, torque production in rotating machines & general analysis of the electromechanical system.
DC Generator: Construction - the principle of operation - EMF equation – Types – Armature reaction - Characteristics – Applications.

UNIT – II

DC Motors: Principle of operation - Types- Back EMF - Torque equation – Characteristics – Losses - Efficiency – Commutation – Applications - 3 point starter - 4 point starter – Speed control methods.

UNIT – III

Single-phase Transformers: Types - constructional details – principle of operation – EMF equation – operation on no load & on load – lagging, leading & unity power factors loads – phasor diagrams of transformers – equivalent circuit.

UNIT – IV

Synchronous generator: Operation – Construction - type – Types of Armature windings – Distribution– Pitch & winding factors – E.M.F equation - armature reaction – Voltage regulation by synchronous impedance method– MMF method & Potier triangle method - Two reaction theory, Slip test.

UNIT – V

Parallel Operation of Synchronous Generators: Parallel operation with infinite bus & other alternators – Power flow equations - Synchronizing power – Load sharing– Control of real & reactive power.

Text Books:

1. Electrical Machinery by P.S. Bhimbra, R.C. Khanna & Vineet Khanna, 1st edition, 2021 ISBN: 9788174091734.
2. Electrical Machines by R. K. Rajput, Lakshmi publications, 5th edition ISBN: 9788131807460.

Reference Books:

1. Electrical Machines by D. P. Kothari, I. J. Nagarth, McGraw Hill Publications, 5th edition (ISBN: 9780070699670).
2. Electrical Machinery by Abijith Chakrabarthi & Sudhipta Debnath, McGraw Hill, 1st edition (ISBN: 9781259006456).

Web Links:

1. http://nptel.ac.in/courses/108106071
2. http://www.ncert.nic.in/html/learning_basket/electricity/electricity/machine/ma chine_content.htm
3. https://lecturenotes.in/subject/41/electrical-machine-1

Fundamentals of Power Electronics
(Common to All, Except EEE)

	L	T	P	C
Course Code: 2501EE56	**2**	**0**	**0**	**2**

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

CO1 Explain the different types of power semiconductor devices & their Characteristics.
CO2 Evaluate the performance of rectifiers.
CO3 Design DC-DC & AC-AC converter with given characteristics.
CO4 Explain the operation of Inverters.
CO5 Explain the operation of three phase Inverters & application of PWM techniques.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1	-	-	-	-	-	1	1	-
CO2	2	3	2	-	-	-	-	-	1	1	-
CO3	3	2	2	-	-	-	-	-	1	1	-
CO4	2	3	2	-	-	-	-	-	1	1	-
CO5	3	2	2	-	-	-	-	-	1	1	-

UNIT – I

Introduction to Power Electronics devices: Concept of power electronics, applications, types of power converters, operation & characteristics of Power IGBT, SCR, TRIAC, static & dynamic characteristics of SCR, protection of SCR, turn on methods of SCR & commutation of SCR, Thyristor Firing Circuits.

UNIT – II

Phase Controlled Converters: Principles of single-phase fully-controlled converter with R, RL, & RLE load, effect of freewheeling diode, Principles of single-phase half-controlled converter with RL & RLE load.

UNIT – III

DC-DC Converters: Introduction, Basic principles of step-down & step-up operation, chopper classification study of Buck, Boost & Buck-Boost regulators.
AC-AC converters: AC Voltage Controllers: Introduction, principle of operation of single-phase voltage controllers for R-L, R-L-E loads.

UNIT – IV

Inverters: Introduction, principle of operation, single phase bridge inverters with R, RL & RLC loads,
UNIT – V

3-phase bridge inverters: 180- & 120-degrees mode of operation, Voltage control of single-phase inverters –single pulse width modulation, multiple pulse width modulation, sinusoidal pulse width modulation.

Text Books:

1. Power Electronics – by P. S. Bhimbra, Khanna Publishers ISBN:9788174092793.
2. Power Electronics: Circuits, Devices & Applications – by M.H Rashid, Prentice Hall of India, 3rd Edition, ISBN: 9788120345317.

Reference Books:

1. Power Electronics: Essentials & Applications by L. Umanand, Wiley, Pvt. Limited, India , ISBN: 9788126519453.
2. Power Electronics, M. D. Singh & K. B. Kanchandhani, Tata McGraw – Hill Publishing Company, 2nd Edition, ISBN: 9780074633694.

Web Links:

1. https://nptel.ac.in/courses/108/101/108101038/
2. https://nptel.ac.in/courses/108/102/108102145/
3. https://nptel.ac.in/courses/108/102/108102145/

Electrical Measurements & Instrumentation

(Common to All, Except EEE)

	L	T	P	C
Course Code: 2501EE13	**2**	**0**	**2**	**4**

Course Outcomes:

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

CO1: Explain different types of instruments for measuring AC & DC quantities.

CO2: Explain different types of instruments for measurement of power & power factor.
CO3: Identify suitable bridges for measurement of R, L, & C
CO4: Analyze the effectiveness of Transducers.
CO5: Illustrate the principle of different types of Digital Meters.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-
CO4	2	3	1	-	-	-	-	-	-	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-

UNIT – I

Analog Ammeter & Voltmeters: Classification – deflecting - control & damping torques – PMMC - Moving Iron type & Electrostatic Instruments - Construction - Torque equation - Range extension - Errors & compensations. Instrument transformers – Current & Potential transformers- Construction-Working.

UNIT – II

Analog Wattmeters & Power Factor Meters: Electrodynamometer type wattmeter (LPF & UPF) - Power factor meters: Dynamometer & M.I type (Single phase & Three phase) - Single phase induction type energy meters- Construction - theory - torque equation - advantages & disadvantages. Measurement of active & reactive power in single phase & in three phase with balanced loads.
Potentiometers: Introduction to DC & AC Potentiometers – Construction-working.

Practice:

1. Calibration & Testing of single phase energy Meter.
2. Calibration of dynamometer wattmeter using phantom loading.
3. Calibration of PMMC ammeter & voltmeter using Crompton D.C. Potentiometer.
4. Measurement of 3 phase reactive power with single phase wattmeter for balanced Loading.
5. Measurement of 3 phase power with single wattmeter & using two C.Ts.
6. Calibration of LPF wattmeter by direct loading.

UNIT – III

Measurements of Electrical parameters: DC Bridges: Wheat stone's bridge - Kelvin's double bridge for measuring low resistance - Loss of charge method for measurement of high resistance - Megger – measurement of earth resistance.
AC Bridges: Measurement of inductance & quality factor: - Maxwell's bridge - Hay's bridge - &erson's bridge. Measurement of capacitance & loss angle - Desauty's bridge - Schering Bridge.

Practice:

1. Measurement of resistance & Determination of Tolerance using Kelvin's double Bridge.
2. Capacitance Measurement using Schering Bridge.
3. Inductance Measurement using &erson Bridge.

UNIT – IV

Transducers: Definition - Classification - Resistive - Inductive & Capacitive Transducer - LVDT - Strain Gauge - Thermistors - Thermocouples - Piezo electric & Photo Diode Transducers - Hall effect sensors.

Practice:

1. Determination of the characteristics of a LVDT.

UNIT – V

Digital meters : Digital Voltmeters – Successive approximation DVM - Ramp type DVM & Integrating type DVM – Digital frequency meter - Digital multimeter - Digital tachometer - Digital Energy Meter. CRO- measurement of phase difference & Frequency using lissajious patterns.

Additional practice:

1. Measurement of resistance using Wheatstone bridge.
2. Dielectric oil testing using H.T test Kit.
3. Measurement of Choke coil parameters & single-phase power using three voltmeter & three ammeter method.

Text Books:

1. Electrical Measurements & measuring Instruments by E.W. Golding & F.C.Widdis - Wheeler Publishing ,5th Edition, ISBN: 9780273402022.
2. Modern Electronic Instrumentation & Measurement Techniques by A.D. Helfrick & W.D. Cooper - PHI ,5th Edition, ISBN: 9788120307520.

Reference Books:

1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney Dhanpat Rai & Co.Publications, ISBN: 9786009578337.
2. Electrical & Electronic Measurements & instrumentation by R.K.Rajput, ISBN: 9788121929899.

Web Links:

1. Electrical Measurements by Buckingham & Price - Prentice – Hall
2. https://archive.nptel.ac.in/courses/108/105/108105153/
3. https://electricalbaba.com/different-types-of-transducers/

Electric Power Generation, Transmission & Distribution Systems
(Common to All, Except EEE)

	L	T	P	C
Course Code: 2501EE53	**3**	**0**	**0**	**3**

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

CO1: Identify the different components of various power plants.

CO2: Analyze the performance of short, medium and long transmission lines.
CO3: Identify various factors related to sag and corona.
CO4: Distinguish between AC/ DC distribution systems and also estimate voltage drops of distribution systems.
CO5: Analyze the different economic factors of power generation and tariffs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	-	-	2	-	-	-	-	-
CO2	2	3	1	-	-	-	-	-	-	-	-
CO3	2	1	3	-	-	1	-	-	-	-	-
CO4	2	3	1	-	-	1	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

UNIT – I

Power Stations: Principle of power generation, site selection and layout of Thermal, Nuclear, Hydro power plant, Components of Thermal and Nuclear power plant.

UNIT – II

Performance of Transmission Lines: Classification of Transmission Lines –Short, medium, long and their model representations –End condenser method, Nominal-T– Nominal-Pie, and A, B, C, D Constants, Surge Impedance and SIL of Long Lines.

UNIT – III

Corona and Sag: Corona – Description of the phenomenon–Factors affecting corona– Critical voltages and power loss –Radio Interference. Sag and Tension calculations with equal and unequal heights of towers–Effect of Wind and Ice on weight of Conductor.

UNIT – IV

Distribution Systems: Classification of distribution systems, design features of distribution systems, radial distribution, ring main distribution, voltage drop calculations: DC distributors for following cases - radial DC distributor fed at one end and at both ends (equal / unequal voltages), ring main distributor, stepped distributor and AC distribution, comparison of DC and AC distribution.

UNIT – V

Economic Aspects of Power Generation and Tariff Methods: Types of load, Load curve, load duration and integrated load duration curves, Important terms and factors in Load Curve. Costs of Generation and their division into Fixed, Semi-fixed and Running Costs, Characteristics and types of Tariff..

Text Books:

1. A Text Book on Power System Engineering by M. L. Soni, P. V. Gupta, U. S. Bhatnagar and, A. Chakrabarti, Dhanpat Rai AND Co. Pvt. Ltd ISBN:9788177000207.
2. Generation, Distribution and Utilization of Electric Energy by C. L. Wadhawa, Newage International (P) Limited, Publishers ISBN: 9789393159175.

Reference Books:

1. Principles of Power System by V. K. Mehta & Rohit Mehta, S Chand & Company Limited, Publishers (ISBN: 9788121924962).
2. Electrical Power Distribution Systems by V. Kamaraju, Tata McGraw Hill, New Delhi (ISBN: 9780070151413).

Web Links:

1. https://www.slideshare.net/ntpc-project-korbasuper-themal-power-plant
2. https://www.euronuclear.org/1-information/energy-uses.htm
3. https://www.slideshare.net/9anku/electrical-distribution-system

Alternative Energy Sources

(Common to All, Except EEE)

	L	T	P	C
Course Code: 2501EE34	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Describe the environmental aspects of Renewable Energy Resources.

CO2: Describe the use of Solar Energy & the various components used in the energy production.
CO3: Underst& the conversion principles of Wind & Biomass Energy Resources.
CO4: Acquire the basic knowledge of Ocean Thermal Energy
CO5: Acquire the basic knowledge of energy conversion & Hydrogen Energy.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3	2	-	-	2	-	-	-	-	-
CO2	3	3	2	-	-	2	-	-	-	-	-
CO3	3	3	2	-	-	2	-	-	-	-	-
CO4	3	3	2	-	-	2	-	-	-	-	-
CO5	3	3	2	-	-	2	-	-	-	-	-

UNIT – I

Introduction: Principles of renewable energy; energy & sustainable development, worldwide renewable energy availability, renewable energy availability in India, brief descriptions on solar energy, wind energy, tidal energy, wave energy, ocean thermal energy, biomass energy, geothermal energy, oil shale

UNIT – II

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal & inclined surfaces; Solar radiation Measurements- Pyrheliometers, Pyrometer, Solar Thermal systems: Flat plate collector; Solar distillation; Solar Pond electric power plant. Photovoltaic system for electric power generation.

UNIT – III

Wind Energy: Wind velocity & power from wind; major problems associated with wind power, Basic components of wind energy conversion system (WECS); Classification of WECS- Horizontal axis- single, double & multiblade system. Vertical axis- Savonius & darrieus types.
Biomass Energy: Biomass Resources; Biomass conversion technologies-fixed dome; Urban waste to energy conversion.

UNIT – IV

Tidal Power: Tides energy suppliers & their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, advantages & limitations.
Ocean Thermal Energy Conversion: Principle of working, OTEC power stations in the world, problems as

UNIT – V

Green Energy: Introduction, Fuel cells: Classification of fuel cells – H2; Operating principles, Zero energy Concepts. Benefits of hydrogen energy, hydrogen production

technologies (electrolysis method only), hydrogen energy storage, applications of hydrogen energy (contemporary cases).

Text Books:

1. Non-Conventional energy resources, Khan B.H, Tata Mc-Graw hill, New Delhi, 3rd Edition, ISBN: 9789352601882.
2. Non-conventional Energy Sources, G.D.Rai, Khanna Publications, New Delhi, 4th Edition, ISBN: 9788174090737.

Reference Books:

1. Renewable energy resources, Twidell, J.W. & Weir, A., BSP Books Pvt.Ltd, UK, 2nd Edition, ISBN: 9780415584388.
2. Renewable Energy Technologies, R.Ramesh, Uday kumar, Narosa Publishing House, New Delhi, 1st Edition, ISBN:9788173190674.

Utilization of Electrical Energy

(Common to All, Except EEE)

	L	T	P	C
Course Code: 2501EE27	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Identify various illumination methods produced by different illuminating sources.
CO2: Identify a suitable motor for electric drives & industrial applications
CO3: Identify most appropriate heating & welding techniques for suitable applications.
CO4: Distinguish various traction systems & determine the tractive effort & specific energy consumption.
CO5: Explain the necessity & usage of different energy storage schemes for different applications & comparisons.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-

UNIT – I

Illumination fundamentals & Methods: Illumination fundamentals Introduction - terms used in illumination–Laws of illumination–Polar curves–Integrating sphere–Lux meter Sources of light. Various Illumination Methods Discharge lamps - MV & SV lamps – Comparison between tungsten filament lamps & fluorescent tubes Basic principles of light control– Types & design of lighting & flood lighting–LED lighting - Energy conservation.

UNIT – II

Selection of Motors: Choice of Motor - Type of Electric Drives - Starting & Running Characteristics – Speed Control–Temperature Rise – Applications of Electric Drives–Types of Industrial Loads–Continuous Intermittent & Variable Loads–Load Equalization - Introduction To Energy Efficient Motors.

UNIT – III

Electric Heating & Welding: Advantages & methods of electric heating–Resistance heating induction heating & di electric heating. Electric Welding. Electric welding–Resistance & arc welding–Electric welding equipment–Comparison between AC & DC Welding.

UNIT – IV

Electric Traction: Traction & electrification– Special features of traction motor– Mechanics of train movement, Speed-time curves, tractive effort, Specific energy consumption, acceleration & retardation–Adhesive weight, coefficient of adhesion.

UNIT – V

Introduction to Energy Storage Systems: Need For Energy Storage - Types of Energy Storage-Thermal - Electrical - Magnetic & Chemical Storage Systems - Comparison of Energy Storage Technologies Applications.

Text Books:

1. Utilization of Electric Power – by Er.R.K Rajput – Lakshmi publications Third Edition , 2023, ISBN: 9788131808290.
2. Utilisation of Electric Power : Including Electric Drives & Electric Traction – by Suryanarayana N.V, New Age International (P) Limited - Publishers – Third edition 2024,ISBN: 9788122405460.

Reference Books:

1. Utilization Of Electric Energy: Including Electric Drives & Electric Traction -by Tarlok singh, ISBN: 9789380027845.
2. Utilization of Electric power & Electric Traction -by J.B.Gupta S.K.Kataria & Sons ISBN: 9789350142585.

Web Links:

1 https://nptel.ac.in/courses/108105060
2 https://onlinecourses.nptel.ac.in/noc23_ag06/preview

Hybrid Electric Vehicles

(Common to All, Except EEE)

	L	T	P	C
Course Code: 2501EE37	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO 1: Analyze the architectures of HEVs with various components.
CO 2: Illustrate the concept of Electric Vehicle & Hybrid Electric Vehicles.

CO 3: Explain the Plan concept of Plug-in Electrical Vehicles.
CO 4: Analyze the power electronics converters for HEVs.
CO 5: Apply various energy storage technologies in Hybrid Vehicles.

Mapping of course outcomes with program outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	2	-	-	-	-	-	-	-	-
CO2	2	3	3	-	-	-	-	-	-	-	-
CO3	1	2	3	2	-	-	-	-	-	-	-
CO4	2	3	3	3	-	-	-	-	-	-	-
CO5	3	3	3	-	-	-	-	-	-	-	-

UNIT-I

Introduction: History of hybrid vehicles, architectures of HEVs, series & parallel HEVs, complex HEVs.

UNIT-II

Hybridization of Automobile: Fundamentals of vehicle, components of conventional vehicle & propulsion load; Drive cycles & drive terrain; Concept of electric vehicle & hybrid electric vehicle; Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV & PHEV; Fuel Cell vehicles & its constituents.

UNIT-III

Plug-in Hybrid Electric Vehicle: PHEVs & EREVs blended PHEVs, PHEV Architectures, equivalent electric range of blended PHEVs; Fuel economy of PHEVs, power management of PHEVs, PHEV battery charging.

UNIT-IV

Power Electronics in HEVs: Rectifiers used in HEVs, voltage ripples; Buck converter used in HEVs, non-isolated bidirectional DC-DC converter, regenerative braking, isolated bidirectional DC-DC converter, PWM rectifier in HEVs, EV & PHEV battery chargers.

UNIT-V

Battery & Storage Systems: Energy Storage Parameters; Batteries; Ultra capacitors; Flywheels - Superconducting Magnetic Storage System; Pumped Hydroelectric Energy Storage; Compressed Air Energy Storage - Storage Heat; Energy Storage as an Economic Resource.

Text Books:

1. Advanced Electric Drive Vehicles by Ali Emadi, CRC Press , ISBN: 9781138072855.
2. Electric & Hybrid Vehicles: Design Fundamentals by Iqbal Hussein, CRC Press, ISBN: 9780367693930.

Reference Books:

1. Introduction to Hybrid Vehicle System Modeling & Control by Wei Liu, Wiley ,ISBN: 9788126556205.
2. Electric & Hybrid Vehicles Technologies, Modelling & Control: A Mechatronic Approach by Amir Khajepour, Saber Fallah& Avesta Goodarzi, John Wiley & Sons Ltd , ISBN: 9781118341513.

Web Links:

1. https://archive.nptel.ac.in/courses/108/103/108103009/
2. https://ndl.iitkgp.ac.in/he_document/nptel/nptel/

Special Electrical Machines
(Common to all, except EEE)

	L	T	P	C
Course Code: 2501EE35	**3**	**0**	**0**	**3**

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

CO1: Explain the operation & control of Stepper Motor.
CO2: Describe theory of operation & control of Switched Reluctance Motor.
CO3: Explain the operation & control of Synchronous Reluctance Motor.

CO4: Describe theory of operation & control of Permanent Magnet Brushless D.C. Motors.
CO5: Explicate the theory of PMSM & LIM & its applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	1	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-

UNIT – I

Stepper Motors: Constructional features – Types of Stepper Motors - permanent magnet (PM) type - Hybrid type Stepper Motor - Variable Reluctance Motor (VRM) - Single stack & multiple stack VRM – Characteristics, Modes of Operation & Applications of Stepper Motor.

UNIT – II

Switched Reluctance Motors: Constructional features, Principle of operation, Torque production, Power Converters & their controllers, Methods of Rotor position sensing, Sensor less operation, Closed loop control of SRM, Characteristics.

UNIT – III

Synchronous Reluctance Motor: Construction, Working, Torque Equation, control, Advantages & Applications Synchronous Reluctance Motor

UNIT – IV

Brushless D.C. Motors: Principle of Operation, Types, EMF & torque equations, Commutation, Motor characteristics & control, Torque/speed characteristics.

UNIT – V

Permanent Magnet Synchronous Motors: Construction, Principle of Operation, EMF Equation of PMSM, Torque Equation, Comparison of Conventional & PM Synchronous Motors, Application of PMSM
Linear Induction Motors: Linear Induction Motors (LIM)- Construction– principle of operation— Development of one-sided LIM with back iron equivalent circuit of LIM-Applications

Text Books:

1. Brushless Permanent magnet & reluctance motor drives, by T.J.E.Miller, Clarenden press, Oxford , ISBN:9780198593690.
2. Special electrical Machines, by K. VenkataRatnam, University press, New Delhi, ISBN: 9781439806463.

Reference Books:

1. Special electrical machines, E.G. Janardhanan, PHI learning private limited, ISBN: 9788120348806.
2. Permanent Magnet & BLDC Motor Drives, by Krishnan R, CRC Press ISBN:9780824753849.

Web Links:

1. https://nptel.ac.in/courses/108102156
2. https://www.monolithicpower.com/stepper-motors-basics-types-uses
3. https://epochautomation.com/synchronous-reluctance-motor-working/

Electrical Safety

(Common to All, Except EEE)

Course Code: 2501EE43	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- **CO 1:** Describe electrical hazards & safety equipment.
- **CO 2:** Analyze & apply various grounding & bonding techniques
- **CO 3:** Select appropriate safety method for low, medium equipment's & high voltage equipment.

CO 4: Participate in a safety team & Carry out proper maintenance of electrical equipment by underst&ing various St&ards.

CO 5: Analyze the safety method for high voltage equipment's.

Mapping of course outcomes with program outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-
CO5	1	3	1	-	-	-	-	-	-	-	-

UNIT-I

Hazards of Electricity & Electrical Safety Equipment: Primary & secondary hazards-arc, blast, shocks causes & effects-safety equipment flash & thermal protection, head & eye protection-rubber insulating equipment, hot sticks, insulated tools, barriers & signs, safety tags, locking devices- voltage measuring instruments- proximity & contact testers-safety electrical one line diagram- electrician's safety kit.

UNIT-II

Grounding of Electrical Systems & Equipment: General requirements for grounding & bonding- definitions grounding of electrical equipment-bonding of electrically conducting materials & other equipment connection of grounding & bonding equipment- system grounding- purpose of system grounding-grounding electrode system- grounding conductor connection to electrodes-use of grounded circuit conductor for grounding equipment-grounding of low voltage & high voltage systems.

UNIT-III

Safety Procedures & Methods: The six step safety methods- pre job briefings - hot-work decision tree-safe switching of power system- lockout-tag out- flash hazard calculation & approach distances-calculating the required level of arc protection-safety equipment, procedure for low, medium & high voltage systems- the one-minute safety audit

UNIT-IV

Safety Management & Organizing Structure: Electrical safety program structure, development- company safety team- safety policy program implementation- employee electrical safety teams- safety meetings- safety audit accident prevention- first aid- rescue techniques-accident investigation.

UNIT-V

Electrical Maintenance & Legal Safety Requirements & St&ards: Safety related case for electrical maintenance- reliability centred maintenance (RCM) - eight step maintenance program- frequency of maintenance- maintenance requirement for specific equipment & location- regulatory bodies- national electrical safety code st&ard for electrical safety in

work place- occupational safety & health administration st&ards, Indian Electricity Acts related to Electrical Safety

Text Books:

1. Electrical Safety Handbook by John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, Al Winfield, McGraw-Hill Education, 4th Edition , ISBN: 9780071745130.
2. Electric Safety Practice & Standards, Khaled Ismail, CRC Press, Taylor & Francis, ISBN: 9781138073999.

Reference Books

1. Electrical Safety- a guide to the causes & prevention of electric hazards, Maxwell Adams.J, The Institution of Electric Engineers, IET, ISBN: 9780852968062.
2. 'Electrical Safety in the Workplace', Ray A. Jones, Jane G. Jones, Jones & Bartlett Learning, ISBN: 9780877655800.

Web Links:

1. http://nptel.ac.in/courses/103106071/5
2. https://www.electricalsafetyfirst.org.uk

Methods & Algorithms for Intelligent Control

(Common to All, Except EEE)

	L	T	P	C
Course Code: 2501EE30	**3**	**0**	**0**	**3**

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

CO1: Design feedback controllers for complex dynamic systems using ANN.
CO2: Design fuzzy logic-based controller for dynamic systems.

CO3: Construct TS fuzzy models for complex dynamic systems.

CO4: Formulate hybrid controllers by combining the concepts of Genetic Algorithm and BioInspired algorithms with ANN.

CO5: Formulate hybrid controllers by combining the concepts of Genetic Algorithm and BioInspired algorithms with Fuzzy logic.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	3	1	2	-	-	-	-	-	-
CO2	2	2	3	1	2	-	-	-	-	-	-
CO3	2	2	3	1	2	-	-	-	-	-	-
CO4	2	2	3	1	2	-	-	-	-	-	-
CO5	2	2	3	1	2	-	-	-	-	-	-

UNIT – I

Introduction: Introduction to intelligent control, comparison study between conventional and intelligent control, intelligent supervisory control, intelligent adaptive control.

UNIT – II

Neural network based control: Introduction to Neural Network, theory of neural network for classification and function approximation, supervised and unsupervised learning rules, RBF neural network, Support vector machines, intelligent control using Neural Network, Approximation capabilities by feed-forward and recurrent neural network, Neuro-control based on back propagation algorithm, system identification with neural network.

UNIT – III

Fuzzy logic control: Introduction to fuzzy set theory and logic, application of fuzzy logic in control system, fuzzy quantization of knowledge, fuzzy controller design, Fuzzy T-S modelling for dynamic system and stability using Lyapunov theory.

UNIT – IV

Genetic algorithm and control: Basic theory and operations of Genetic algorithm, GA based control system, optimization problem using GA related to control and other engineering problems.

UNIT – V

Bio-inspired evolutionary algorithms: Bio-inspired evolutionary algorithms – like Particle swamp optimization (PSO), simulated annealing, Fire-fly optimization, bacterial foraging etc – only the concepts and case studies related control problems.

Text Books:

1. Neural Networks, Simon Haykin. Pearson Education Asia, ISBN: 9780023527616.

2. Genetic Algorithm in Search Optimization & Machine Learning, David E. Goldberg, Pearson Education, ISBN: 9780201157673.

Reference Books:

1. Fuzzy logic (intelligence control and information), J. Yen and R. Langari, Pearson, first Edition, ISBN: 9780135258170.
2. Methods and Applications of Intelligent Control, Spyros G. Tzafestas, Kluware academic publisher (ISBN: 9780792346241).

Web Links:

1. https://archive.nptel.ac.in/courses/108/104/108104049/
2. https://archive.nptel.ac.in/courses/106/106/106106126/

Minor Degree in Mechanical Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501ME74	Basic Mechanical Engineering	FC	2			2	50	50	100	-
2501ME04	Engineering Thermodynamics	IC	2	1		3	50	50	100	SSP/ MP
2501ME77	Introduction to Automobile Engineering (or) Mechanics of Solids	IC	3			3	50	50	100	SSP/ MP
2501ME78										
2501ME12	Heat Power Engineering (or) Refrigeration & Air Conditioning	IC	2	1		3	50	50	100	ETD
2501ME40										
2501ME75	Production Technology	IC	3			3	50	50	100	EWS

2501ME76	Metallurgy & Material Science	IC	3			3	50	50	100	SSP/ MP
2501ME79 2501ME80	Theory of Machines (or) Advanced Engineering Metrology	AC	3			3	50	50	100	SSP/ MP
	TOTAL		**18**	**2**		**20**				

Basic Mechanical Engineering

(Common to All, Except ME)

Course Code: 2501ME74

L	**T**	**P**	**C**
2	0	0	2

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

- **CO1:** Explain the basic concepts of thermodynamics and fluid mechanics
- **CO2:** Explain the engineering design principles and process
- **CO3:** Draw the velocity and acceleration diagrams analyzing machines and mechanisms
- **CO4:** Explain the different manufacturing techniques

CO5: Explain the fundamentals of vibrations in mechanical systems

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

UNIT – I

Thermodynamics: Basic concepts and definitions (system, surroundings, state, process, cycle) Zeroth, First, and Second Laws of Thermodynamics, Properties of pure substances, Energy analysis of closed systems and Control volumes, Applications
Fluid Mechanics: Properties of fluids, Pressure variation in a static fluid, Manometry, Bernoulli's equation, Continuity equation, Venturi meter, Orifice meter, Pitot tube, Laminar and Turbulent flow, Reynolds number

UNIT – II

Engineering Design: Definition and importance of engineering design, The role of design in engineering, Historical perspectives and case studies, Steps of the engineering design process, Principles of design thinking, Introduction to computer-aided design (CAD)

UNIT – III

Machines & Mechanisms: Machines: Definition and significance of machines and mechanisms, History and evolution of mechanical systems, Applications
Mechanisms: Types of mechanisms (linkages, cams, gears), Kinematic analysis of mechanisms, Velocity and acceleration diagrams, Gears and gear trains and applications.

UNIT – IV

Manufacturing Processes: Introduction to manufacturing techniques, Casting, Forging, Forming, Machining, Welding, Joining, Powder metallurgy, Plastic and Composite manufacturing, Introduction to Computer Numerical Control (CNC) machines, Additive manufacturing. Introduction to Robotics - Joints & Links, Configurations and Applications of Robotics

UNIT – V

Vibrations: Fundamentals of Vibration: Introduction to Free vibration of single-degree-of-freedom systems, Damped vibration, Forced vibration, Vibration isolation and transmissibility.
Vibration Measurement: Vibration measuring instruments, Basic concepts of vibration control.

Text Books:

1. Basic Mechanical Engineering, P.K. Nag, Tata McGraw Hill Education, 3rd Edition, **ISBN** : 9780070708389.
2. Manufacturing Engineering and Technology, Serope Kalpakjian and Steven Schmid, Pearson Education; 7th Edition, ISBN-13. 978-9332587908.

Reference Books:

1. Theory of Machines, S.S. Ratan, McGraw Hill Education India Private Limited, 4th Edition, **ISBN**-13. 978-9353166281.
2. Engineering Design - A Project-Based Introduction, CL Dym, John Wiley & Sons Inc, 4th Edition, **ISBN**-13, 978-1118324585.

Web Links:

1. https://nptel.ac.in/courses/112105123
2. https://archive.nptel.ac.in/courses/112/107/112107145/

Engineering Thermodynamics

(Common to All, Except ME)

Course Code: 2501ME04	L	T	P	C
	2	1	0	3

Course Outcomes:

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

CO1: Apply thermodynamic concepts to analysis of energy system.
CO2: Apply the first law of thermodynamics for closed and open systems.

CO3: Apply the second law of thermodynamics and principle of entropy for the engineering system.
CO4: Anlayse the properties of pure substances.
CO5: Explain the working of various refrigeration system and psychrometric process

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

UNIT – I

Introduction: System, boundary, Surrounding, control volume, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle – Reversibility – Quasi static Process, Irreversible Process, Causes of Irreversibility, Forms of energy, presure, work and heat transfer, temperature and the Zeroth Law of thermodynamics

UNIT – II

First Law of Thermodynamics: Energy analysis of closed and open system, energy analysis of steady flow devices – Nozzle, Diffusers, Turbine, Compressor, and Throttle. Limitation of first law of thermodynamics.

UNIT – III

Second Law of Thermodynamics: Heat engine and reversed heat engine, Statements of second law (Kelvin-Planck and Clausius Statement) and their equivalence, PMM-II, Carnot's principle, Carnot cycle and its specialties, Thermodynamic Temperature Scale, Thermodynamic scale of Temperature, Entropy, Clausius Inequality, The increase in entropy principles – Energy Equation, Reversibility and Irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations – Elementary Treatment of the Third Law of Thermodynamics.

UNIT – IV

Properties of Pure Substances: Pure Substances, P-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations – Triple point at critical state properties during change of phase, Dryness Fraction – Clausius – Clapeyron Equation Property tables. Mollier charts – Various Thermodynamic processes and energy transfer.

UNIT – V

Introduction to Refrigeration: Properties of the regrigerents Working of Air Refrigeration System, Vapour Compression Refrigeration System, Coefficient of performance (COP), Refrigerants.
Introduction to Air Conditioning: Psychrometric properties & Psychrometric process - adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing.

Text Books:

1. Engineering Thermodynamics, P.K. Nag, Tata McGraw Hill Publishers, 6th Edition, ISBN: 9789352606429.
2. Thermodynamics: An Engineering Approach, Cengal, Y.A and Boles, M.A, McGraw Hill, 5th Edition, ISBN: 0073107689.

Reference Books:

1. Treatises on Heat Engineering, V.P.Vasandhani & D.S Kumar, Metropolitan Book Depot, 4th Edition, ISBN: 9788120003507.
2. Engineering Thermodynamics, Mayhew and Rogers, Longman Green & Co Ltd., 4th Edition, ISBN: 0582045665.

Web Links:

1. https://archive.nptel.ac.in/courses/112/106/112106310/
2. https://archive.nptel.ac.in/courses/112/104/112104113/
3. https://ocw.mit.edu/courses/3-00-thermodynamics-of-materials-fall-2002/download/

Introduction to Automobile Engineering

(Common to All, Except ME)

Course Code: 2501ME77	L	T	P	C
	3	0	0	3

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

CO1: Summarize the Vehicle Chassis Layouts of 4-wheelers
CO2: Identify the different constructional features and working principles of Un-Sprung

components of the given vehicle

CO3: Identify the different constructional features and working principles Sprungcomponents of the given vehicle.

CO4: Summarize the functionalities of various Electrical systems of typical Automobile

CO5: Explain the different Active and Passive Vehicle Safety Systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	-	-	-	-	1	2	1	-	1
CO2	3	-	-	3	-	-	1	2	1	1	1
CO3	2	-	-	-	-	-	1	2	1	-	1
CO4	3	1	1	-	-	-	1	2	1	-	1
CO5	3	1	1	-	-	3	1	2	1	-	1

UNIT – I

Introduction: History of Automobile and introduction to Autombile Industry, Chassis Layouts : Components of four wheeler automobile - power transmission modes, Types and Homologation of Vehicles.

UNIT – II

Transmission: Clutches, Gear Box, Rear Axles and its Types, Differential and its applications. Steering System: Steering geometry – Types of of steering mechanism steering linkages of Independent and Conventional Suspension.

UNIT – III

Suspension System: Objectives of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system, Air Suspension, Rubber Suspension.
Braking System: Mechanical braking system, hydraulic braking system requirement of brake fluid.

UNIT – IV

Wheels and Tyres: Basic Requirements of Wheels and Tyres, Construction of Wheel Assembly, Tyre Construction, Types, Tyre Sizes and Designation, Aspect Ratio, Tyre Tread Pattern, Selection of Tyre under Different Applications.

UNIT – V

Electrical System: Charging circuit, generator, starting system, lighting, horn, wiper, fuel gauge, oil pressure gauge, engine temperature indicator.
Safety Systems: Introduction, safety systems - seat belt, air bags, anti-lock brake system (ABS), Electronic Brake force Distribution (EBD), Head restraints, seats with anti-submarine effects and fuel cut off switch.

Text Books:

1. Automobile Engineering, Kirpal Singh, Vol- I, Standard Publisher, New Delhi, 2020, ISBN: 9788180142420.
2. Motor Vehicles, Newton Steeds and Garret, Butterworth, 13th Edition, ISBN: 0750637633.

Reference Books:

1. Modern Vehicle Technology, Heinz Hazler, Butterworth, London, 2nd Edition, ISBN: 0750651318.
2. Automotive Chassis, Heldt P.M., Chilton Co., New York, 2012, ISBN: 1258386380.

Web Links:

1. https://archive.nptel.ac.in/courses/107/106/107106088/
2. https://www.udemy.com/course/automotive-engineering-automobile-fundamentals-and-advanced/?couponCode=LEADERSALE24A

Mechanics of Solids

(Common to All, Except ME)

Course Code: 2501ME78

L	T	P	C
3	0	0	3

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

CO1: Calculate stress and strain in bodies of varying cross-section and composite bars, principal stresses and strain energy.
CO2: Determine the shear force and bending moment diagrams for beams of various loads.

CO3: Analyse the variation of bending and shear stresses across a beam.
CO4: Compute the slope and deflection for beams of varying loads and support arrangements and torsional rigidity of a solid and hollow shaft.
CO5: Analyze the stresses and stability characteristics of thin, thick cylinders and columns.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3	2	-	-	-	-	-	-	-	-
CO2	3	3	2	1	-	-	-	-	-	-	-
CO3	3	3	2	1	-	-	-	-	-	-	-
CO4	3	3	2	1	-	-	-	-	-	-	-
CO5	3	3	2	1	-	-	-	-	-	-	-

UNIT – I

Simple Stresses & Strains: Elasticity and plasticity – Types of stresses & strains–Hooke's law – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Bars of varying section – composite bars – Temperature stresses- Complex Stresses - Stresses on an inclined plane under different uniaxial and biaxial stress conditions - Principal planes and principal stresses - Mohr's circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT – II

Shear Force and Bending Moment: Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed load, uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of abeam.

UNIT – III

Flexural Stresses: Theory of simple bending, Derivation of bending equation, Determination of bending stresses – section modulus of rectangular, circular, I and T sections– Design of simple beam sections.
Shear Stresses: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I and T sections.

UNIT – IV

Deflection of Beams: Bending into a circular arc – slope, deflection and radius of curvature - Differential equation for the elastic line of a beam – Double integration and Macaulay's methods - Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, UDL and UVL. Mohr's theorem and Moment area method - application to simple cases.
Torsion: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

UNIT – V

Thin and Thick Cylinders: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains – changes in diameter, and volume of thin cylinders– Thin spherical shells. Wire wound thin cylinders. Lame's equation – cylinders subjected to inside & outside pressures – compound cylinders.
Columns: Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula

Text Books:

1. Strength of materials, GH Ryder, Palgrave Macmillan publishers India Ltd, ISBN-13978-0333109281.
2. Strength of materials, B.C. Punmia, Lakshmi publications Pvt. Ltd, 10th Edition, New Delhi, ISBN - 978-8131809259.

Reference Books:

1. Mechanics of materials, Gere & Timoshenko, CBS publications, 2nd Edition ,ISBN: 978-8123908946.
2. Strength of Materials, Andrew Pytel and Ferdinand L. Singer, Longman Publications, 4th Edition, ISBN:9780060453138.
3. Mechanics of Solids, Popov, New Pearson Education, 2nd Edition, ISBN:978-9332550216.

Weblinks:

1. https://www.classcentral.com/course/swayam-strength-of-materials-iitm-184204
2. https://www.coursera.org/learn/mechanics-1

Heat Power Engineering
(Common to All, Except ME)

Course Code: 2501ME12	L	T	P	C
	2	1	0	3

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

CO1: Apply the various techniques to improve the performance of Rankine Cycle
CO2: Explain the working principle and performance of boiler and draught system
CO3: Analyse the performance of Steam nozzles
CO4: Analyse the performance of Impulse and Reaction Turbines
CO5: Analyse the performance of Steam Condensers and Gas Turbines.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

UNIT – I

Steam Power Cycles: Steam Power plant - Layout, Rankine cycle - Schematic layout, Thermodynamic analysis - Simple Cycle. Methods to improve cycle performance - Regeneration & Reheating cycle.

UNIT – II

Boiler: Classification, Working principles of low-pressure (LP) & high-pressure (HP) boilers with sketches, Boiler mountings and accessories. Performance of boiler - Equivalent evaporation - Efficiency.
Draught System: Classification – Natural and Artificial draught – Induced, Forced & Balanced draught - height of chimney for given draught and discharge - condition for maximum discharge and chimney efficiency

UNIT – III

Steam Nozzles: Function of a nozzle – applications – types, Flow through nozzles and thermodynamic analysis, assumptions, Velocity coefficient and condition for maximum discharge, Critical pressure ratio, Supersaturated flow and its effects, Degree of super saturation and Degree of undercooling, Wilson line.

UNIT – IV

Steam Turbines: Impulse turbine: Mechanical details - Velocity diagram - Effect of friction power developed, Axial thrust, Blade or diagram efficiency - condition for maximum efficiency.
Reaction Turbine: Mechanical details, principle of operation, Thermodynamic analysis of a stage, Degree of reaction velocity diagram, Parson's reaction turbine, Condition for maximum efficiency, Calculation of blade height. Compounding – Velocity, Pressure and Velocity Pressure compounding

UNIT – V

Steam Condensers: Classification - working principle, vacuum efficiency and condenser efficiency, air leakage, sources and their effects, air pump, cooling water requirement.
Gas Turbines: Simple gas turbine plant - Ideal cycle - Essential components - Actual cycle. Regeneration, Inter cooling and Reheating cycle, Merits and demerits.

Text Books:

1. Heat Engineering, V.P Vasandani and D.S Kumar, Metropolitan Book Company, 4th Edition, ISBN: 978-8120003507.
2. Thermodynamics and Heat Engines, R. Yadav, Central publishing house, 6th Edition, ISBN:978818544403.

Reference Books:

1. Thermodynamics: An Engineering Approach, Cengel, Y. A. and Boles, M. A., Tata McGraw-Hill, 7th Edition, ISBN:978-0-07-352932-5.
2. Thermal Engineering, P.L.Ballaney, Khanna publishers, 25th Edition, ISBN:978-81-7409-031-7

Web Links:

1. https://nptel.ac.in/courses/112/106/112106303/
2. https://nptel.ac.in/courses/112103262.

Refrigeration & Air Conditioning

(Common to All, Except ME)

Course Code: 2501ME40	L	T	P	C
	2	1	0	3

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

CO1: Explain the principle and applications of air refrigeration system.
CO2: Describe vapour compression refrigeration system.
CO3: Explain different types of vapour absorption refrigeration system.
CO4: Describe air-conditioning processes using the principles of Psychrometry.
CO5: Calculate loads in air-conditioning system and explain different heat pump circuits.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	1	-	-	-	-	1
CO2	3	2	-	-	-	1	-	-	-	-	-
CO3	3	2	-	-	-	1	-	-	-	-	-
CO4	2	3	-	-	-	1	-	-	-	-	1
CO5	3	2	-	-	-	1	-	-	-	-	-

UNIT – I

Introduction to Refrigeration: Necessity, application, unit and C.O.P of refrigeration, Reversed Carnot cycle, Bell Coleman cycle with its numerical problem, Air Refrigeration System (ARS), Open & Dense air system, Refrigeration system used in air crafts and its problem. Classification of Refrigerants & its Properties, Nomenclature, Ozone layer Depletion, Global Warming.

UNIT – II

Vapour Compression Refrigeration System (VCRS): Simple Vapour Compression Refrigeration Cycle, Comparison between ARS & VCRS, Representation of cycle on T-S and P-H charts, Effect of sub cooling & super heating, Actual cycle influence of various parameters on system performance, Brief description about Actual VCRS.

UNIT – III

Vapour Absorption Refrigeration System (VARS): Working principal of VARS, Comparison between VCRS & VARS, Description & working of principle of Ammonia-Water VARS, Lithium-Bromide water VARS, Principle & operation of three fluid absorption system. Salient features, working principle and basic components of Steam Jet Refrigeration System, Principle & operation of thermoelectric refrigeration system - Vortex tube.

UNIT – IV

Introduction to Air Conditioning: Psychometric properties & processes, Ventilation, Infiltration, Comfort conditions, Factors Affecting Human Comfort, Factors Affecting Optimum Effective Temperature, Requirements of human comfort and concept of effective temperature, comfort chart. Air Conditioning Systems: Working principle of comfort, industrial, winter, summer, year-round, unitary and central air conditioning system.

UNIT – V

Air-conditioning load calculations: Load concepts of Room Sensible Heat Factor, Grand Sensible Heat Factor and Effective Room Sensible Heat Factor. Classification of equipment used in an air conditioning system, Humidifier, filters, grills, registers, fans, and blowers. Air Handling Units, Heat pump – heat sources, Different types of heat pump circuits.

Text Books:

1. Refrigeration and Air-conditioning, Arora C.P., Tata Mc Graw –Hill, 4th edition, 2021, ISBN : 9789390385843.
2. Refrigeration and Air Conditioning, Khurmi R. S., S Chand, Revised edition, 2019, ISBN : 9788121927819.

Reference Books:

1. Refrigeration and Air Conditioning, Manohar Prasad, New Age International, Pvt Ltd, 3rd edition 2021, ISBN:978-8122436945.
2. A Course in Refrigeration and Air conditioning, S. C. Arora & S. Domkundwar, Dhanpatrai, ISBN: 9788120339156.

Data Book:

1. Refrigerant and Psychrometric Properties - Tables and Charts [SI Units], Mathur, M. L., and Mehta, F. S., Jain Brothers.

Web Links:

1. https://nptel.ac.in/courses/112105128.
2. https://www.udemy.com/course/water-cooler-dispenser-working-and-circuit-diagram/?couponCode=NVDPRODIN35.
3. https://bharatskills.gov.in/Home/StudyMaterial?var=06nHBys5P85EmOqtjA1wsA==&Default=YES.

Production Technology
(Common to All, Except ME)

Course Code: 2501ME75	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

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

CO1: Elaborate the fundamental principles of casting process.
CO2: Classify the various joining process with applications
CO3: Discuss the basic concepts of metal forming techniques
CO4: Explain the basic concepts of smithy and forging techniques.
CO5: Explain the basic concepts of plastic processing techniques and powder metallurgy

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	-	-	-	1	-	2	1	-	-
CO2	2	1	2	-	-	1	-	2	1	-	-
CO3	2	2	1	-	1	1	-	2	1	-	-
CO4	2	2	1	-	1	1	-	2	1	-	-
CO5	2	2	1	-	1	1	-	2	1	-	-

UNIT – I

Introduction: Introduction to manufacturing process, Classification and Overview of Manufacturing Processes. Introduction to Metal Casting, Casting design considerations, Sand casting process, Casting Terminology, Types of Patterns, Pattern Materials and Pattern Allowances, Sand casting, Classifications of Moulds, moulding materials and their properties, Core, Gating system and its Design, Riser and its design, Foundry - furnaces, Melting & Pouring, Fluidity, Solidification of pure metals and alloys, Casting defects, Advanced casting processes, advantages and applications.

UNIT – II

Metal Joining: Introduction, Classification of Welding Processes, Gas Welding & Cutting , Arc Welding-Theory of heat generation, Power Source Selection, Arc characteristics, Arc blow, ISI classification of coated electrodes, SMAW,GTAW,GMAW-CO2 12, SAW,LBW,EBW,UW, Resistance welding, Solid state welding processes, Hybrid Welding Processes, Brazing, Soldering and their applications, HAZ, characteristics of weldment, Welding Defects and Remedies.

UNIT – III

Sheet Metal Work: Standard Specifications for Sheets, Sheet Metal Operations, Yield criteria, Plastic deformation of metals, Tools and Equipment in SMW, Deep drawing.

Forming : Hot working and Cold working, Rolling, Hubbing, Embossing, Thread rolling, Tube Piercing, Hot spinning, Press Working, Defects in metal working, Wire Drawing, Tube drawing. High Energy rate Forming (HERF) processes.

UNIT – IV

Smithing And Forging: Forging & Forging dies, Smith Forging operations, Forging Process, Hand Forging, Power Forging, Impression Die Forging, Drop Hammers, Press Forging, Upset forging, Forging Defects and Remedies.

UNIT – V

Plastic Processing: Types of Plastics, Properties, Applications, and their processing methods, Blow molding and Injection molding.
Powder Metallurgy: Powder production methods, compaction, and sintering. Applications of powder metallurgy. Advantage and Disadvantage of Powder Metallurgy in comparison to Conventional Shaping process.

Text Books:

1. Manufacturing Engineering and Technology, Kalpakian S, Schmid S.R., Pearson Education, Delhi, 7th Edition 2018, ISBN 978-9332587908.
2. Fundamentals of Modern Manufacturing, Groover Mikell P, John Wiley and Sons Inc,7th Edition,2018, ISBN 978-1119722014.

Reference Books:

1. Manufacturing Science, A. Ghosh & A.K. Mallik, East West Press Pvt. Ltd Publication, 3rd Edition, ISBN 978-8176710633.
2. Manufacturing Processes, H.S. Shan, Cambridge University Publication, 2nd Edition, ISBN 978-1316638583.
3. Process and materials of manufacture, Lindberg, PHI Publications, 4thEdition, ISBN 978-8120306639.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc24_me16/preview
2. https://onlinecourses.nptel.ac.in/noc24_me51/preview
3. https://archive.nptel.ac.in/courses/113/106/113106098/

Metallurgy & Material Science
(Common to All, Except ME)

Course Code: 2501ME76	L	T	P	C
	3	0	0	3

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

CO1: Explain the concepts of structure of metals and equilibrium diagrams.
CO2: Analyse the ferrous and non-ferrous metals and alloys in industrial applications
CO3: Analyse the heat treatment on steels.
CO4: Explain the methods of making of metal powders and applications of powder metallurgy.
CO5: Summarize the properties and applications of ceramic and composite materials.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	-	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-

UNIT– I

Structure of Metals and Constitution of alloys: Crystallization of metals, Packing Factor SC, BCC, FCC& HCP-line density, plane density. Grain and grain boundaries, effect of grain boundaries– determination of grain size. Imperfections, Slip and Twinning. Necessity of alloying, types of solid solutions, Hume Rothery's rules, intermediate alloy phases, and electron compounds. **Equilibrium Diagrams:** Experimental methods of construction of equilibrium diagrams, Isomorphous alloy systems, equilibrium cooling and heating of alloys, Lever rule, coring miscibility gaps, eutectic systems, congruent melting intermediate phases, peritecticreaction. Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. Study of binary phase diagrams such as Cu-Ni and Fe-Fe_3C.

UNIT–II

Ferrous metals and alloys: Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheroidal graphite cast iron, Alloy cast iron. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, Hadfield manganese steels, tool and die steels. **Non-ferrous Metals and Alloys:** Structure and properties of copper and its alloys, Aluminium and its alloys, Titanium and its alloys, Magnesium and its alloys, Super alloys.

UNIT–III

Heat treatment of Steels: Effect of alloying elements on Fe-Fe3C system, annealing, normalizing, hardening, TTT diagrams, tempering, harden ability, surface - hardening methods, age hardening treatment, Cryogenic treatment.

UNIT–IV

Powder Metallurgy: Basic processes- Methods of producing metal powders- milling atomization-Granulation-Reduction-Electrolytic Deposition. Compacting methods – Sintering - Methods of manufacturing sintered parts. Secondary operations, Applications of powder metallurgical products.

UNIT– V

Ceramic and Advanced materials: Crystalline ceramics, glasses, cermets, abrasive materials, Classification of composites, manufacturing methods, particle reinforced composites, fiber reinforced composites, PMC, MMC, CMC and CCCs. Introduction toNano materials and smart materials.

.

Text Books:

1. Introduction to Physical Metallurgy, Sidney H Avner, TMH Publications, 2nd Edition
2. Materials Science and Metallurgy, V.D. Kodgire, Everest Publishing House, 39th Edition

Reference Books:

1. Materials Science and Engineering, An Introduction, William D. Callister, Wiley Publications, 9th Edition.
2. Mechanical Metallurgy George Ellwood Dieter, David Bacon. McGraw- Hill Book company.
3. Engineering Materials & Metallurgy, R.K. Rajput, S. Chand Publications, 2nd Edition.

Weblinks:

1. https://archive.nptel.ac.in/courses/113/106/113106032/
2. https://www.coursera.org/learn/fundamentals-of-materials-science
3. https://www.coursera.org/learn/material-behavior.

Theory of Machines
(Common to All, Except ME)

Course Code: 2501ME79	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

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

CO1: Apply the knowledge of mechanisms in real time applications
CO2: Construct the velocity and acceleration diagrams using relative velocity method and instantaneous centre method.
CO3: Calculate the velocity and acceleration of follower motions and construct the cam profile
CO4: Calculate the velocities of different components of a compound and epicyclic gear trains
CO5: Construct the turning moment diagram of engine and flywheel.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

UNIT – I

Elements of Kinematics: Classification of Mechanisms-Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain -Limit positions- Mechanical advantage- Description of common mechanisms- Inversions of 4-bar chain: Crank and Slotted Lever mechanism, Quick Return Motion mechanism, Davis and Ackermann Steering gear mechanisms, Hooke's joint.

UNIT – II

Velocity and Acceleration Analysis: Plane motion of a rigid body: Instantaneous centre of rotation, centrode and axode - Relative motion between two bodies – Kennedy's Theorem – Graphical determination of instantaneous centre for Four bar and Single Slider Crank chain mechanisms, Determination of Angular Velocity of points and links. Motion of a Link in Machine - Determination of Displacement, Velocity and Acceleration for a Four Bar Mechanism, Single Slider Crank chain mechanism, Double Slider Crank chain mechanism.

UNIT – III

Cams and followers: Definition and classification of Cams and Followers - Terminology - Types of follower motion: Uniform velocity, Simple harmonic motion and Uniform Acceleration

and Retardation, Cycloidal motion for Knife edge, Flat face and Roller follower and offset follower.

UNIT – IV

Power Transmission: Introduction –Modes of Power Transmission applications. Gears and Gear Trains- Classification, Terminology, Law of Gearing, Path of contact, Arc of contact. Interference, Methods of avoiding interferences. Simple gear train, Compound gear train, reverted gear train, epicyclic gear train and Differential. Table method to find velocity of components of a gear train.

UNIT – V

Turning Moment Diagrams: Static and dynamic force analysis of planar mechanisms, Dynamic force analysis of slider crank mechanism, Inertia Torque, Angular Velocity and Acceleration of connecting rod, Crank Effort and Turning Moment Diagrams – Fluctuation of energy – Fly Wheel design.

Text Books:

1. Theory of machines, S.S.Rattan, Tata Mc Graw Hill, 5th Edition, 2019, ISBN: 9789351343479.
2. Theory of machines, Thomas Bevan, CBS Publishers, 3rdEdition, ISBN: 9788123908748.

Reference Books:

1. Theory of machines: Kinematics and Dynamics , Sadhu Singh, 3rd Edition, Pearson Publisher, 2011, ISBN: 9788131760697.
2. Theory of machines, R.K.Bansal, J.S.Brar, Laxmi Publications, 6th Edition, ISBN: 9788131808054.

Web Links:

1. https://nitsri.ac.in/Department/Mechanical%20Engineering/MEC_403_Part_3_KINEMATICS_OF_MACHINERY.pdf
2. https://archive.nptel.ac.in/courses/112/104/112104121/

Advanced Engineering Metrology

(Common to All, Except ME)

Course Code: 2501ME80	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- **CO1:** Identify the generalized concept of measurement system.
- **CO2:** Summarize the concepts of DC and AC bridges used in measurement systems.
- **CO3:** Apply the fundamentals in measurements and calibration of instruments.
- **CO4:** Describe the working principles and operation of measuring instruments.
- **CO5:** Explain the basic physics of transducers and their operating principles.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	1
CO3	3	2	-	-	-	-	-	-	-	-	1
CO4	3	2	-	-	-	-	-	-	-	-	1
CO5	3	2	-	-	-	-	-	-	-	-	1

UNIT-I

Generalized Configuration of Measuring System: Functional elements of a basic measuring system, different types of measurands, description of functional elements, input-output configuration of a measuring system, linear and angular measurements, comparators, interferometry, form and finish measurement, alignment and testing methods, tolerance analysis in manufacturing and assembly, concepts of coordinate-measuring machine (CMM), mathematical model for generalized configuration of a measurement system.

UNIT-II

Comparative Methods of Measurements: D.C potentiometers, D.C (Wheat stone, and Kelvin bridge) & A.C bridges (Maxwell, Anderson, and Schering bridges), transformer ratio bridges, self-balancing bridges, interference & screening, multiple earth and earth loops, electrostatic and electromagnetic interference, grounding techniques, uncertainty analysis.

UNIT- III

Characteristics of Instruments: Objective of studying the characteristics of the instruments. Static characteristics – accuracy, precision, error, sensitivity, hysteresis, threshold, drift, span, and static stiffness, dynamic characteristics – time domain and frequency domain characteristics terms, concept of mechanical loading.

UNIT-IV

Principles of Instrumentation: Sensor interrogation principles using bridge circuits, signal amplification, signal conditioning (transduction, & linearization), phase measurements, active and passive filters, isolation and shielding, elements of control theory, digital data acquisition.

UNIT- V

Principles of Transduction and Transducers: Description of various types of transduction principles. transducers based on variable resistance, variable inductance, variable capacitance, and piezo-electric effects, displacement transducers - wire wound potentiometers, LVDT, strain gauges, diaphragm type pressure transducers and other pressure measuring techniques, design of accelerometers and their applications, temperature and flow measurement techniques.

Text Books:

1. Instrumentation for Engineering Measurements, James W. Dally, W.F. Rilley and K.G. McConnel, John Wiley & Sons Inc, 2nd Edition, ISBN:978-0471551928
2. Mechanical Measurements and Instrumentation & Control, A. K. Sawhney, Dhanpat Rai & Co. (P) Limited, ISBN:978-8177000238.

Reference Books:

1. Engineering Metrology, M. Mahajan, Dhanpat Rai Publishers, 1st Edition, ISBN:978-8177000511.
2. Mechanical and Industrial Measurements, R. K. Jain, Khanna Publishers, 1st Edition ISBN:978-8174091918

Web Links:

1. https://archive.nptel.ac.in/courses/112/106/112106139/
2. https://ocw.mit.edu/courses/20-309-biological-engineering-ii-instrumentation-and-measurement-fall-2006/

Minor Degree in Electronics and Communication Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501EC87	Fundamentals of Communications	FC	2		1	3	50	50	100	-
2501EC88	Fundamentals of Signal Processing	FC	2		1	3	50	50	100	-
2501EC89	Analog & Digital Circuits	IC	2			2	50	50	100	BEEE
2501EC42	Wireless LAN's & PAN's	IC	2	1		3	50	50	100	-
2501EC90	Linear & Digital IC Applications (or) Sensors & Actuators	IC	3			3	50	50	100	ADC
2501EC91										
2501EC92	Embedded Microcontrollers (or) Digital System Design	IC	2		1	3	50	50	100	ADC, PPSC
2501EC93										
2501EC67	Introduction to Internet of things (or) Modern Wireless Communications	AC	2		1	3	50	50	100	EM, WLAN's& PAN's
2501EC74			3			3	50	50	100	FC
TOTAL			**15**	**1**	**4**	**20**				

Fundamentals of Communication

(Common to All, Except ECE)

	L	T	P	C
Course Code: 2501EC87	**2**	**0**	**1**	**3**

Course Outcomes:

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

CO1: Summarize the functional blocks of a communication system.
CO2: Interpret the modulation and demodulation techniques of AM.
CO3: Discuss the concepts of Angle modulation and demodulation.
CO4: Infer Pulse analog modulation and demodulation Techniques.
CO5: Interpret the transmitter and receiver sections.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2	-	1	-	1	2	1	-	1
CO2	3	2	2	-	1	-	1	2	1	-	1
CO3	3	2	2	-	1	-	1	2	1	-	1
CO4	3	2	2	-	1	-	1	2	1	-	1
CO5	3	2	2	-	1	-	1	2	1	-	1

UNIT – I

Introduction to Communication system, Elements of Communication system, Modulation, Need for Modulation, Electromagnetic Spectrum, Frequency Division Multiplexing(FDM). Introduction to Amplitude Modulation (AM), Generation and detection of AM, Spectrum of AM Signals, Power and Power Efficiency of AM.

Practice:

1. Generate amplitude modulated signal, determine the percentage modulation and demodulate the modulated signal using envelope detector.

UNIT – II

Double Sideband Suppressed Carrier ((DSB-SC) Modulation, Spectrum of DSB-SC Signals, Coherent Demodulation of DSB-SC signals, Introduction to Single Sideband (SSB) Modulation, Generation, and detection of SSB Modulation, Introduction to VSB modulation.

Practice:

1. Generate AM-DSBSC modulated signal and demodulate the modulated signal.

UNIT – III

Frequency modulation: Frequency Modulation: Narrow Band FM, Wide BandFM, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FMSignals.

Practice:

1. Generate frequency modulated signal, determine the modulation index and Bandwidth, also demodulate the frequency modulated signal.

UNIT – IV

Digital representation of analog signals: Need for Digitizing Analog information, Time Division Multiplexing, Pulse Code Modulation: Sampling, Quantization, Encoding, Regeneration, Decoding, and Filtering, Introduction to Delta Modulation, Signal Reconstruction in Delta Modulation, Slope Overload Distortion and Granular Noise, Differential Pulse Code Modulation (DPCM).

Practice:

1. Analyse the process of pulse Code modulation.

UNIT – V

Transmitters and Receivers: Classification of Transmitters, AM Transmitters, FM Transmitters Receivers: Radio Receiver - Receiver Types - Tuned radio frequency receiver, Superheterodyne receiver, RF section and Characteristics - Frequency changing and tracking, Intermediate frequency, Image frequency, AGC.

Practice:

1. Verify the characteristics of mixer.
2. Experimentally study the characteristics of a given AGC circuit.

Capstone Project:

1. AM Transmitter and Receiver Design
   Design and simulate or build an Amplitude Modulation system.
   Tools: Breadboard, signal generator, MATLAB/Scilab, or Python

Text Books:

1. Introduction to Analog and Digital Communications, Simon Haykin, Wiley, 2nd Edition, ISBN: 0471432229.
2. Electronics Communication Systems-Fundamentals through Advanced-Wayne Tomasi, Pearson, 5th Edition, 30 August 2019, ISBN: 978-8131719534.
3. Modern digital and analog communication systems—B.P.Lathi , Zhi Ding,oxford,4th Edition, ISBN: 0195331451.

Reference Books:

1. Principles of Communication Systems - Herbert Taub, Donald L Schilling, Goutam Saha, McGraw-Hill, 4thEdition, ISBN: 1259029859.
2. Analog and Digital Communication – K. Sam Shanmugam, Willey, 2018, ISBN: 9788126536801.

Web Links:

1. https://archive.nptel.ac.in/courses/117/105/117105143/
2. https://onlinecourses.nptel.ac.in/noc21_ee74/preview
3. https://archive.nptel.ac.in/courses/108/102/108102096/
4. https://archive.nptel.ac.in/courses/117/101/117101051/
5. https://web.stanford.edu/class/ee179/

6. https://www.udemy.com/course/analog-communication-e/

Fundamentals of Signal Processing
(Common to All, Except ECE)

	L	T	P	C
Course Code: 2501EC88	**2**	**0**	**1**	**3**

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

CO1: Analyse the characteristics of CT periodic signals using Fourier series.
CO2: Analyse the spectral characteristics of CT aperiodic signals using Fourier Transforms.
CO3: Analyse sampling process and reconstruction of signals.
CO4: Analyze the response of continuous time LTI system.
CO5: Apply Laplace and Z-transform techniques on signals.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	-	1	-	1	1	1	-	1
CO2	2	1	1	-	1	-	1	1	1	-	1
CO3	2	2	1	-	1	-	1	1	1	-	1
CO4	3	2	1	-	1	-	1	1	1	-	1
CO5	2	2	2	-	1	-	1	1	1	-	1

UNIT – I

Signals: Classification of Signals, Different deterministic signals: impulse, step, ramp,gate, signum, sinc,sinusoidal, exponential, complex exponential, operations on signals.Fourier Series: Representation of Fourier series for continuous time periodic signals,Trigonometric Fourier series and Exponential Fourier series, Convergence of Fourier Series: Dirichlet's conditions, properties of Fourier series.

Practice:

1. Generation of various signals such as unit impulse, unit step, ramp, exponential and sinewave.
2. Perform Operations on signals such as Addition, Multiplication, Scaling, Shifting, and Folding.
3. Perform Fourier synthesis of square wave.

UNIT – II

Fourier Transform: Deriving Fourier Transform (FT) from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals, properties of Fourier transforms, Fourier transforms involving impulse function and Signum function.

Practice:

1. Calculate the Fourier Transform and Inverse Fourier Transform of a for Continuous time signal.
2. Calculate the Fourier Transform and Inverse Fourier Transform for the Standard signals.

UNIT – III

Sampling: Sampling, Sampling theorem – Graphical and analytical proof for BandLimited Signals, Nyquist rate, Nyquist duration, Impulse sampling, Natural samplingand Flat top Sampling, Reconstruction of signal from its samples, Effect of undersampling – Aliasing.

Practice:
1. Perform convolution of given continuous time signals.
2. Verify Sampling theorem.

UNIT – IV

Laplace Transform: Bilateral and unilateral Laplace Transforms, Region of convergence and its properties, Constraints on ROC for various classes of continuous time signals, Properties of Laplace Transform, Inverse Laplace Transform.
Z-Transform: Concept of Z- Transform of a Discrete Sequence, Region of convergence in Z-Transform,Properties of Z-Transform, Inverse Z-Transform.

Practice:
1. Obtain Laplace Transform and inverse Laplace Transform of a given continuous time signal.
2. Calculate the Z-Transform and Inverse Z-Transform of a given discrete time signal.

UNIT – V

Introduction to Digital Signal Processing: Discrete time signals & sequences, linear shift invariant systems, stability, and causality. Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems,Discrete Fourier transforms.

Practice:
1. Obtain Impulse and step response of given LTI system.

Capstone Project:

Spectral Decomposition and Analysis of Complex Signals

Text Books:

1. Signals and Systems - A.V. Oppenheim, A.S. Willsky, and S.H. Nawab, PHI,2nd Edition, ISBN: 9332550239.
2. Signals and Systems – A. Anand Kumar, PHI, 4th Edition, ISBN: 8120348400.

Reference Books:

1. Signals & Systems - Simon Haykin and Van Veen, Wiley, 2nd Edition, ISBN: 0471164747 .
2. Fundamentals of Signals and Systems- Michel J. Robert, MGH International Edition, ISBN: 9780070702219.
3. Digital Signal Processing, P. Ramesh Babu, SciTech Publications, 6th Edition, ISBN: 9395245271.

Web Links:

1. https://freevideolectures.com/course/3540/signals-and-systems-i (Signals and Systems IbyProf. K.S. Venktesh IIT Kanpur)
2. https://nptel.ac.in/courses/108104100 (Principles of Signals and System by Prof. Aditya K. Jagannatham, IIT Kanpur)
3. https://nptel.ac.in/courses/117/102/117102060/ (Digital Signal Processing - by Prof. S.C. Dutta Roy Department of Electrical Engineering IIT Delhi)

Analog & Digital Circuits
(Common to All, Except ECE)

L T P C

Course Code: 2501EC89 **2 0 0 2**

Course Outcomes:

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

CO1: Examine the characteristics of special semiconductor diode.
CO2: Illustrate the performance of FET and MOSFET.
CO3: Realize logic minimization using suitable techniques
CO4: Illustrate various combinational logic circuits.
CO5: Construct different sequential logic circuits.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	2	-	-	-	-	-	-	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-
CO5	2	2	3	-	-	-	-	-	-	-	-

UNIT – I

Semiconductor Devices: Tunnel Diode, Varactor Diode, LED, Photo Diode, Transistor as a switch, Transistor as an Amplifier.

UNIT – II

Transistor Characteristics-FET& MOSFET: Construction and operation of FET, Characteristic of FET, FET as a switch and an amplifier, MOSFET working and Characteristics (Depletion mode & Enhancement mode).

UNIT – III

Boolean Algebra &Minimization Techniques: Boolean theorems, principle of complementation & duality, De-Morgan theorems, minimization of logic functions using Boolean theorems, minimization of switching functions using K-Map up to 5 variables.

UNIT – IV

Combinational Logic Circuits: Design of Half adder, full adder, half sub-tractor, full sub-tractor, applications of full adders, 4-bit binary adder-sub-tractor circuit, BCD adder circuit, Design of decoder, de-multiplexer,encoder, multiplexer,Realization of Boolean functions using decoders & multiplexers, priority encoder,2-bit Magnitude Comparator.

UNIT – V

Sequential Circuits: Classification of sequential circuits (synchronous and asynchronous) basic flip-flops, truth tables and excitation tables (NAND RS latch, NOR RS latch, RS flip-flop, JK flip-flop, T-flip-flop,D-flipflop with reset and clear terminals). Ripple counters,

Synchronous Counter Johnson counter, ring counter. Registers - shift register, bi-directional shift register, universal shift register.

Text Books:

1. Electronic Devices and Circuits, J. Millman, Christos C. Halkias, Tata Mc-Graw Hill, 4th Edition, ISBN: 9789339219543.
2. Digital Design, Morris Mano, Pearson, 3rd Edition, ISBN: 8178085550.

Reference Books:

1. Electronic Devices and Circuits, R.L. Boylestad and Louis Nashelsky, Pearson Publications, 9th Edition, ISBN: 0131189050.
2. Modern Digital Electronics, RP Jain, Tata Mc Graw Hill, 4th Edition, ISBN: 0070669112.
3. Introduction to Switching Theory and Logic Design, Fredriac J. Hill, Gerald R. Peterson, John Wiley & Sons Inc., 3rd Edition, ISBN: 8126520310.

Web Links:

1. https://nptel.ac.in/117103063/11
2. http://nptel.ac.in/courses/117/106/117106086/
3. https://www.nptelvideos.in/2012/12/digital-circuits-and-systems.html

Wireless LANs & PANs

(Common to All, Except ECE)

Course Code: 2501EC42	L	T	P	C
	2	1	0	3

Course Outcomes:

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

CO1: Discuss the concept of Random Access protocols
CO2: Understand the Wireless LAN Protocols
CO3: Demonstrate the IEEE802.11 Standard for WLAN
CO4: Describe the Wireless PAN Protocols
CO5: Illustrate the IEEE802.15 Standard for WPAN

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	2	-	-	-	-	-	-	-	-	1
CO2	2	2	-	-	-	-	-	-	-	-	1
CO3	1	2	-	-	-	-	-	-	-	-	1
CO4	1	2	-	-	-	-	-	-	-	-	1
CO5	2	2	-	-	-	-	-	-	-	-	1

UNIT – I

Wireless System & Random Access Protocols: Introduction, First and Second Generation Cellular Systems, Cellular Communications from 1G to 3G, Wireless 4G systems, The Wireless Spectrum; Random Access Methods: Pure ALOHA, Slotted ALOHA, Carrier Sense Multiple Access (CSMA), Carrier Sense Multiple Access with Collision Detection (CSMA/CD), Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA).

UNIT – II

Wireless LANs: Introduction, importance of Wireless LANs, WLAN Topologies, Transmission Techniques: Wired Networks, Wireless Networks, comparison of wired and Wireless LANs; WLAN Technologies: Infrared technology, UHF narrowband technology, Spread Spectrum technology.

UNIT – III

The IEEE 802.11 Standard for Wireless LANs: Network Architecture, Physical layer, The Medium Access Control Layer; MAC Layer issues: Hidden Terminal Problem, Reliability, Collision avoidance, Congestion avoidance, Congestion control, Security, The IEEE 802.11e MAC protocol.

UNIT – IV

Wireless PANs: Introduction, importance of Wireless PANs, The Bluetooth technology: history and applications, technical overview, the Bluetooth specifications, piconet synchronization and Bluetooth clocks, Master-Slave Switch; Bluetooth security;

Enhancements to Bluetooth: Bluetooth interference issues, Intra and Inter Piconet scheduling, Bridge selection, Traffic Engineering, QoS and Dynamics Slot Assignment, Scatternet formation.

UNIT – V

The IEEE 802.15 working Group for WPANs: The IEEE 802.15.3, The IEEE 802.15.4, ZigBee Technology, ZigBee components and network topologies, The IEEE 802.15.4 LR-WPAN Device architecture: Physical Layer, Data Link Layer, The Network Layer, Applications; IEEE 802.15.3a Ultra wide band.

Text Books:

1. Ad Hoc and Sensor Networks - Carlos de Morais Cordeiro and Dharma Prakash Agrawal, World Scientific, ISBN: 978-9814338882.
2. Wireless Communications and Networking - Vijay K.Garg, Morgan Kaufmann Publishers, ISBN: 9780123735805.

Reference Books:

1. Principles of Wireless Networks - Kaveh Pahlaram, Prashant Krishnamurthy, PHI, ISBN: 8120323807.
2. Guide to Wireless Communication- Marks Ciampor, Jeorge Olenewa, Cengage Learning, ISBN: 1111307318.

Web Links:

1. https://archive.nptel.ac.in/courses/106/105/106105183/
2. https://archive.nptel.ac.in/courses/108/108/108108179/

Linear & Digital IC Applications
(Common to All, Except ECE)

L T P C

Course Code: 2501EC90 **3 0 0 3**

Course Outcomes:

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

CO1: Construct Op Amps using the differential amplifier and other improvement circuits.
CO2: Explain parameters related to measurement of Op-Amp characteristics.
CO3: Construct the circuits for different linear and non-linear applications using Op-Amp.
CO4: Construct the circuits for different Data conversion and Filtering applications using Op-Amp.
CO5: Compare different digital logic families.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	1	3	-	-	-	-	-	-	-	1
CO2	3	2	-	-	-	-	-	-	-	-	1
CO3	2	2	3	-	-	-	-	-	-	-	2
CO4	2	2	3	-	-	-	-	-	-	-	2
CO5	3	2	2	-	-	-	-	-	-	-	2

UNIT – I

Introduction to Integrated Circuits: Integrated Circuits Types,Classification,Package Types,Temperature ranges and Power supplies. Differential Amplifier-DC And AC analysis of differential amplifier configurations,circuits for improving CMRR, Necessity of swamping resistors,Cascaded Differential Amplifier Stages and Level translator.

UNIT – II

Characteristics of Op-Amps: Block Diagram of an Op-Amp, Pin diagram, symbolic representation and features of 741IC, Ideal and practical characteristics of an Op-Amp, Equivalent circuit of an Op-Amp, Define the terms input offset voltage and current, input bias current, CMRR, Slew Rate, PSRR etc, Virtual ground concept, DC characteristics, AC characteristics and Measurement of Op-Amp parameters.

UNIT – III

Linear and Non-Linear Applications of Op- Amps: Inverting and Non-inverting amplifier, Integrator and differentiator, Difference amplifier, Instrumentation amplifier, AC amplifier, V to I, I to V converters, Buffers. Non-Linear Applications Comparators, Multivibrators, Triangular and Square wave generators, Log and Anti-log Amplifiers, Precision rectifiers.

UNIT – IV

D-A and A-D Converters: Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC. Different types of ADCs parallel Comparator type ADC, Counter type ADC, Successive Approximation ADC and dual slope ADC. DAC and ADC Specifications.

UNIT – V

Digital Logic Families and Interfacing: Introduction to logic families, Bipolar logic, transistor-transistor logic, TTL families, Emitter coupled logic, CMOS logic, CMOS logic families , state and dynamic electricalbehavior.

Text Books:

1. Linear Integrated Circuits–D.RoyChowdhury,New Age International(p)Ltd, 2nd Edition, ISBN: 8122403077.
2. Digital Design Principles & Practices – John F. Wakerly, PHI/ Pearson Education Asia, 4th Edition, ISBN: 8131713660.
3. Op-Amps and Linear Integrated Circuits,Ramakant A.Gayakwad, PHI, Pearson Education, 4th Edition, ISBN: 8131713660.

Reference Books:

1. Design with Operational Amplifiers & Analog Integrated Circuits-Sergio Franco McGrawHill, ISBN: 0071157220.
2. OPAMPS and Linear Integrated Circuits concepts and Applications, James MFiore, Cengage Learning India Ltd, ISBN: 9788131512340.
3. Fundamentals of Digital Logic with VHDL Design- Stephen Brown, Zvonko Vranesic, McGrawHill, 3rdEdition, ISBN: 1259025977.

Web Links:

1. http://nptel.ac.in/courses/117108038/Prof.GunashekaranM.K/IIScBangalore
2. https://ocw.mit.edu/courses/electrical-engineering-and-computerscience/6-01sc-introduction-toelectrical-engineering-and-computerscience-i-spring-2011/unit-3-circuits/op-amps

Sensors & Actuators

(Common to All, Except ECE)

	L	T	P	C
Course Code: 2501EC91	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Classify various sensors/transducers based on their applications.
CO2: Analyse various approaches, procedures and results related to Thermal sensors.
CO3: Examine the radiation sensors based on their characteristics.
CO4: Apply Smart Sensors in the field of Communication, Automation and Manufacturing
CO5: Classify various Actuators based on their applications

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	-	-	-	-	-	-	-	-
CO2	2	3	2	-	-	-	-	-	-	-	-
CO3	2	3	2	-	-	-	-	-	-	-	-
CO4	2	3	2	-	-	-	-	-	-	-	-
CO5	3	1	-	-	-	-	-	-	-	-	-

UNIT-I

Sensors/Transducers: Principles, Classification, Parameters, Characteristics, Environmental Parameters (EP) -Characterization.
Mechanical and Electromechanical Sensors: Introduction – Resistive Potentiometer – Strain Gauge – Resistance Strain Gauge – Semiconductor Strain Gauges -Inductive Sensors: Sensitivity and Linearity of the Sensor –Types-Capacitive Sensors:– Electrostatic Transducer– Force/Stress Sensors Using Quartz Resonators – Ultrasonic Sensors.

UNIT-II

Thermal Sensors: Introduction – Gas thermometric Sensors – Thermal Expansion Type Thermometric Sensors – Acoustic Temperature Sensor – Dielectric Constant and Refractive Index thermo sensors – Helium Low Temperature Thermometer – Nuclear Thermometer – Magnetic Thermometer – Resistance Change Type Thermometric Sensors –Thermo emf Sensors– Junction Semiconductor Types– Thermal Radiation Sensors – Quartz Crystal Thermoelectric Sensors – NQR Thermometry – Spectroscopic Thermometry – Noise Thermometry – Heat Flux Sensors.

UNIT-III

Radiation Sensors: Introduction – Basic Characteristics – Types of Photo sensistors /Photo detectors– X-ray and Nuclear ,Electro analytical Sensors: Introduction – The Electrochemical Cell – The Cell Potential – Standard Hydrogen Electrode (SHE) – Liquid

Junction and Other Potentials – Polarization – Concentration Polarization-– Reference Electrodes - Sensor Electrodes – Electro ceramics in Gas Media. Radiation Sensors – Quartz Crystal Thermoelectric Sensors – NQR Thermometry – Spectroscopic Thermometry – Noise Thermometry – Heat Flux Sensors.

UNIT-IV

Smart Sensors: Introduction – Primary Sensors – Excitation – Amplification – Filters – Converters – Compensation– Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface – The Automation Sensors-Applications: Introduction – On-board Automobile Sensors (Automotive Sensors)– Home Appliance Sensors – Aerospace Sensors –– Sensors for Manufacturing –Sensors for environmental Monitoring.

UNIT-V

Actuators: Pneumatic and Hydraulic Actuation Systems- Actuation systems – Pneumatic and hydraulic systems - Directional Control valves – Presure control valves – Cylinders - Servo and proportional control valves – Process control valves – Rotary actuators Mechanical Actuation Systems- Types of motion – Kinematic chains – Cams – Gears – Ratchet and pawl – Belt and chain drives – Bearings – Mechanical aspects of motor selection Electrical Actuation Systems-Electrical systems -Mechanical switches – Solid-state switches Solenoids – D.C. Motors – A.C. motors – Stepper motors

Text Books:

1. Sensors and Transducers, D. Patranabis, PHI Learning Private Limited,ISBN: 9788120321984.
2. Mechatronics, W. Bolton, Pearson Education Limited, ISBN: 1292250976.

Reference Books:

1. Sensors and Actuators, D. Patranabis, PHI, 2nd Edition, ISBN: 9788120321984..
2. Embedded Systems Architecture, Tammy Noergaard, Elsevier Publications, ISBN: 978-0123821966.

Web Links:

1. https://www.iitk.ac.in/tkic/workshop/sensors-and-actuators/ppt/sandeep.pdf
2. https://www.hella.com/techworld/ae/Technical/Sensors-and-actuators-204/
3. https://www.leanix.net/en/blog/iot-devices-sensors-and-actuators-explained

Embedded Microcontrollers

(Common to All, Except ECE)

	L	T	P	C
Course Code: 2501EC92	**2**	**0**	**1**	**3**

Course Outcomes:

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

- **CO1:** Explain the microprocessor internal architecture and programming.
- **CO2:** Discuss Microcontroller internal architecture and its assembly language programming.
- **CO3:** Describe the Hardware interfaces with Microcontroller in Assembly Language and C programming.
- **CO4:** Describe PIC Microcontroller internal architecture and its assembly language programming.
- **CO5:** Illustrate the usage of ATMEGA 328P in their project designs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	3	-	-	3	-	1	1	1	-	-
CO2	1	3	-	-	3	-	1	1	1	-	-
CO3	2	-	3	-	3	-	1	1	1	-	-
CO4	2	3	-	-	3	-	1	1	1	-	-
CO5	2	-	3	-	3	-	1	1	1	-	-

UNIT – I

Microprocessor: Basics of Microprocessor, 8086 Hardware architecture ,8086 registers and its functions, Min mode and Max mode system configuration ,Instruction set of 8086 and simple Programs,Interrupts, DMA.

Practice:

1. Write an Assembly language program to perform Arithmetic operations on 8 bit data.
2. Write an Assembly language program to perform Multi byte addition and subtraction.

UNIT – II

8051 Microcontroller: Comparisons between Microprocessors and microcontroller, 8051 architecture, Pin functions, Memory organization, Special Function Registers, addressing modes, Instruction set. C Programming- I/O programming, Timer programming, 8051 interrupts Programming.

Practice:

1. Introduction to KEIL Software.
2. Write an ALP to find Number of 1's and number of 0's in a given 8-bit.
3. Write an ALP to generate square wave using Timer control.

UNIT – III

External Peripheral Interface: LCD interfacing, Keyboard interfacing, Interfacing with external ROM, ADC interfacing, DAC interfacing,Stepper motor interfacing, DC motor interfacing.

Practice:

1. Interface Keypad to 8051using proteus software.
2. Interface LCD to 8051using proteus software.

UNIT – IV

PIC Microcontrollers: Introduction, characteristics of PIC microcontroller, memory organization, parallel and serial input and output, timers, Interrupts, PIC 16F877 architecture, instruction set of the PIC 16F877.

Practice:

1. Introduction to MPLAB XIDE software.
2. Write a C Program for LED Blinking using PIC16F877.

UNIT – V

Atmega328 Microcontroller: ATMEGA 328P architecture, register file, memory, addressing mode, instruction sets, I/O ports, Case studies: interfacing with LCD, Temperature Sensor DHT11, High-Voltage Device and Relay, Bluetooth Module (HC-05), GSM Module (SIM900A), Using I2C Protocol, Using Zigbee to interface wireless sensors.

Practice:

1. Study of Arduino software.
2. Interfacing of analog sensors with Arduino.
3. Interfacing of DC Motor with Arduino.

Capstone Project:

Password Based Door lock System with 8051 using Proteus Software.

Description: Enter a 4-digit password using keypad; correct code opens lock (simulated with LED or motor).

Text Books:

1. Advanced Microprocessors and Peripherals with ARM and an introduction to Microcontrollers and Interfacing, K. M. Bhurchandi and A. K. Ray, Tata MeGraw Hill, 3rd Edition, ISBN: 1259006131.
2. Micro Controller theory and Application ,Ajay .V. Deshmukh, TATA McGraw –Hill,1st Edition, ISBN: 0070585954.
3. Programming and Interfacing with Arduino, Dr. Yogesh Misra, Taylor and Francis, ISBN: 1032059850.

Reference Books:

1. The 8051 Microcontrollers and Embedded systems: Using Assembly and C, Muhammad Ali Mazidi, Janice Gillespie Mazidi and Rollin D. McKinlay; Pearson 2nd Edition, ISBN: 8131758990.

2. Microprocessors and Interfacing, D. V. Hall,3rdEdition (SIE), ISBN: 9781259006159.
3. The 8051 Micro Controller Architecture, Programming and Applications, Kenneth J Ayala, Thomson Publishers, 3rd Edition, ISBN: 9788131502006.

Web Links:

1. https://archive.nptel.ac.in/courses/108/103/108103157/ microprocessor and microcontrollers by IIT Gowhathi.
2. https://nptel.ac.in/courses/108108147S ensors and Actuators, IISc Bangalore Prof. Hardik Jeetendra Pandya.

Digital System Design

(Common to All, Except ECE)

	L	T	P	C
Course Code: 2501EC93	**2**	**0**	**1**	**3**

Course Outcomes:

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

CO1: Explain the design process of HDL based digital systems.
CO2: Illustrate language cinstructs in Verilog HDL
CO3: Develop Verilog Program for Combinational Logic Circuits using gete premitives.
CO4: Develop dataflow modeling Verilog Program for Logic Circuits.
CO5: Construct sequential circuits using behavioral Modeling.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	-	1	-	-	1	1	-	-
CO2	2	1	1	-	-	-	-	1	1	-	-
CO3	2	1	1	-	1	-	-	1	1	-	-
CO4	2	1	1	-	1	-	-	1	1	-	-
CO5	2	1	1	-	1	-	-	1	1	-	-

UNIT – I

INTRODUCTION TO VERILOG: Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Functional Verification, System Tasks, Programming Language Interface (PLI), Module, Simulation and Synthesis Tools.

Practice:

1. Introduction to Xilinx Software

UNIT – II

LANGUAGE CONSTRUCTS AND CONVENTIONS: Introduction, Keywords, Identifiers, White Space Characters, Comments, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Memory, Operators.

Practice:

1. Write a verilog code with the use of data types as scalara and vectors

UNIT – III

GATE LEVEL MODELING: Introduction, AND Gate Primitive, Module Structure, Other Gate Primitives, Illustrative Examples: Adders, Subtractor and Multiplexers. Additional Examples: Design of Flip-flops with Gate Primitives, Delays, Net Types.

Practice:

1. Write a Verilog code for logic gates using gate Primitives

2. Write a Verilog code for FullAdder and subtractor using gate Primitives.
3. Write a Verilog code for Multiplexer using gate Primitives.

UNIT – IV

MODELING AT DATA FLOW LEVEL: Introduction, Continuous Assignment Structures, Delays and Continuous Assignments, Assignment to Vectors, Operators, Design Examples-Encoder, Decoder and Comparator

Practice:

1. Write a Verilog code for encoder in dataflow model
2. Write a Verilog code for decoder in dataflow model.
3. Write a Verilog code for Comparator in dataflow model.

UNIT – V

BEHAVIORAL MODELING: Introduction, Operations and Assignments, Initial Construct, Always Construct, The case statement, i*f* and i*f*-else constructs, repeat construct, for loop Examples, Assignments with Delays, Design Examples-Flip-flops, Registers and Counters.

Practice:

1. Write a Verilog HDL code for the RS and JK flip-Flops using case statement.
2. Write a Verilog HDL code for the 4 bit register using if –else statement.
3. Write a Verilog HDL code for the 4 bit register using behavioral Modeling.

Capstone Project:

4-bit ALU Design

- Functions: Addition, Subtraction, AND, OR, NOT
- Input: Two 4-bit operands and a 2-bit opcode.
- Output: 4-bit result and carry/overflow flags

Text Books:

1. Fundamentals of Digital Logic with Verilog Design- Stephen Brown, ZvonkoVranesic, McGrawHill, 3rd Edition, ISBN: 1259025977.
2. Advanced digital design with the Verilog HDL, Michael D. Ciletti, Eastern economy edition, PHI, ISBN: 0136019285.

Reference Books:

1. A Verilog HDL primer by J.Bhaskar, Star galaxy publishing, 3rd Edition,2018, ISBN: 0965039161.
2. Design through Verilog HDL by T. R. Padmanabhan, B. Bala Tripura Sundari, A JOHN WILEY & SONS, INC., Publication, ISBN: 0471441481.

Web Links:

1. http://nptel.ac.in/courses/117105080 / by Prof.D. Roy chaudhry, IIT kharagpur
2. http://nptel.ac.in/courses/117106086/1 by Prof.S.Srinivasan, IIT Madras

3. https://onlinecourses-archive.nptel.ac.in/noc17_cs21/ course by Prof. Indranil Sen Gupta, IIT kharagpur

Introduction to Internet of Things
(Common to All, Except ECE)

Course Code: 2501EC67	L	T	P	C
	2	0	1	3

Course Outcomes:

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

CO1: Describe M2M and IOT Technologies.
CO2: Identify the layers and protocols in IOT.
CO3: Describe various communication technologies used in IOT.
CO4: Demonstrate various hardware components required for IOT applications
CO5: Identify the cloud technologiesExplain the applications of IoT

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	-	-	-	-	1	1	-	-
CO2	2	2	-	-	-	-	-	1	1	-	-
CO3	2	2	-	-	-	-	-	1	1	-	-
CO4	3	2	-	-	-	-	-	1	1	-	-
CO5	2	2	-	-	-	-	-	1	1	-	-

UNIT – I

Introduction from M2M to IoT - An Architectural Overview, building architecture, Main design principles and needed capabilities, An IoT architecture outline, M2M and IoT Technology Fundamentals - Devices and gateways.

Practice:

1. Interfacing of analog sensors with Arduino.
2. Interfacing of Digital sensors with Arduino.

UNIT – II

Functionality of Layers in IoT: Study of protocols - Wireless HART, Z-Wave, 6LoWPAN, RPL, CoAP, MQTT.

Practice:

1. Interfacing of actuators with Arduino/Node-MCU.
2. Control an actuator based on sensor input with Arduino/Node-MCU.

UNIT – III

Communication Technologies in IoT : IoT Connectivity-IEEE 802.15.4, Wi-Fi, Bluetooth, Zigbee, LPWAN, 5G Era.

Practice:

1. Develop an Application to Interface Bluetooth module with Arduino.
2. Develop an Application to Interface Wi-Fi module.

UNIT – IV

System Hardware : Sensors, Actuators, Radio Frequency Identification, Introduction to Embedded Devices for IoT - RASPBERRY PI.

Practice:

1. Interfacing of analog sensors with Raspberry pi.
2. Interfacing of digital sensors with Raspberry pi/Node-MCU.

UNIT – V

Cloud Computing: Data Collection, Storage and Computing Using a Cloud Platform for IoT Applications/ Services. Use Cases - Smart and Connected Cities, Agriculture, and Healthcare.

Practice:

1. Deploy sensor data on a cloud platform.
2. Develop IoT model using soil moisture sensor for Agriculture application.

Capstone Project:

Develop IoT model to design Weather Monitoring System which Measures temperature, humidity, and pressure and Sends data to ThingSpeak or Blynk.

Text Books:

1. From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, Academic Press,. 1st Edition, ISBN: 012407684X.
2. Internet of Things (A Hands-on- Approach), Vijay Madisetti and ArshdeepBahga,1st Edition,VPT, ISBN: 8173719543.
3. Internet of Things - By Raj Kamal, McGraw-Hill Education. Copyright, ISBN: 9352605225.

Reference Books:

1. Internet of Things—From Research and Innovation to Market Deployment, Peter Friess, River Publishers, ISBN: 8793102941.
2. From Internet of Things to Smart Cities: Enabling Technologies - edited by Hongjian Sun, Chao Wang, Bashar I. Ahmad, CRC Press -2018, ISBN: 9781498773782.
3. Peter Waher,'Learning Internet of Things',Packt Publishing,2015, Editors Ovidiu Vermesan, ISBN: 1783553537.

Web Links:

1. NPTEL :: Computer Science and Engineering - NOC:Introduction to internet of things BY IIT Kharagpur.
2. https://nptel.ac.in/courses/108108147 Sensors and Actuators, IISc Bangalore Prof. Hardik Jeetendra Pandya.

Modern Wireless Communications

(Common to All, Except ECE)

	L	T	P	C
Course Code: 2501EC74	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Summarize the functioning of basic cellular mobile radio systems
CO2: Identify the general problems of cellular mobile networks
CO3: Summarize various mobile propagation models
CO4: Make use of managerial techniques for efficient use of cellular frequency bands.
CO5: Compare basic digital cellular networks

Mapping of Course Outcomes with Program Outcomes:

CO\PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	1	-	-	-	-	-	-	-	-
CO2	3	1	2	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-
CO5	3	2	2	-	-	-	-	-	-	-	-

UNIT – I

Cellular Mobile Radio Systems: Introduction to Cellular Mobile Systems, Generations- 1G, 2G, 3G 4G, Performance criteria, uniqueness of mobile radio environment, operation of cellular systems, Hexagonal shaped cells, Analog and Digital Cellular systems.
Elements of Cellular Radio System Design: General description of the problem, concept of frequency channels, Co-channel Interference Reduction Factor, desired C/I from a normal case in a Omni directional Antenna system, consideration of the components of Cellularsystem.

UNIT – II

Interference: Introduction to Co-Channel Interference, real time Co-Channel interference, Co-Channel measurement, diversity receiver, non-co channel interference-different types.

UNIT – III

Cell Coverage for Signal and Traffic: Signal reflections in flat and hilly terrain, effect of human made structures, phase difference between direct and reflected paths, constant standard deviation, straight line path loss slope, general formula for mobile propagation over water and flat open area, near and long distance propagation antenna height gain, form of a point to point model.

UNIT – IV

Frequency Management and Channel Assignment: Numbering and grouping, setup access and paging channels channel assignments to cell sites and mobile units, channel sharing and borrowing, Sectorization, overlaid cells, non-fixed channel assignment.
Handoff: Handoff, dropped calls and cell splitting, types of handoff, handoff invitation, delaying handoff, forced handoff, mobile assigned handoff. Intersystem handoff, cell splitting, micro cells, vehicle locating methods, dropped call rates and their evaluation.

UNIT – V

Digital Cellular Networks: GSM architecture, GSM channels, GSM call flow, CDMA(IS-95),Forward and Reverse CDMA Channels, DECT, PACS.

Text Books:

1. Mobile Cellular Tele Communications, W.C.Y. Lee, Tata McGraw Hill, 2nd Edition, ISBN: 978-0070635999.
2. Principles of Mobile Communications, Gordon L. Stuber, Springer International, 2nd Edition, ISBN: 9780792379980.

Reference Books:

1. Wireless Communications, Theodore. S. Rapport, Pearson education, 2nd Edition, ISBN: 978-8131731864.
2. Wireless Communication and Networking, Jon W. Mark and WeihuaZhqung, PHI, 1st Edition, ISBN: 978-0130409058.
3. Wireless Communication Technology, R. Blake, Thompson Asia Pvt. Ltd., 1st Edition, ISBN: 978-8131518403.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc20_ee61/preview?msclkid=f61e217ec14311ecb1ce5ecbd56ce03d
2. https://www.electronics-notes.com/articles/connectivity/cellular-mobile-phone/what-is-cellular-communications.php

Minor Degree in Petroleum Technology

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501PT27	Introduction to Petroleum Engineering	FC	3			3	50	50	100	-

2501PT35	Unit Operations in Petroleum Industry	FC	3			3	50	50	100	-
2501PT47	Fundamentals of Geology & Reservoir Engineering	IC	3			3	50	50	100	-
2501PT48	Fundamentals of Drilling & Production Engineering (or)	IC	2			2	50	50	100	-
2501PT16	Unconventional Hydrocarbon Resources		2			2				
2501PT49	Natural Gas Hydrates (or)	AC	2			2	50	50	100	-
2501PT05	Fundamentals of Liquefied Natural Gas		2			2				
2501PT50	Artificial Lift Techniques (or)	AC	3			3	50	50	100	-
2501PT03	Enhanced Oil Recovery		2	1						
2501PT12	Petroleum Refinery Engineering	AC	2		2	4	50	50	100	-
TOTAL			**17**	**1**	**2**	**20**				

Introduction to Petroleum Engineering

(Common to All, Except PT)

Course Code: 2501PT27	L	T	P	C
	3	0	0	3

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

- **CO 1:** Identify the various streams in the petroleum industry.
- **CO 2:** Outline the onshore and offshore reservoirs.
- **CO 3:** List out the various artificial lift techniques.
- **CO 4:** Illustrate various attributes in mid-stream processing and storage.
- **CO 5:** Describe the crude oil products and their specifications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

UNIT-I

What is Petroleum Engineering & Significance? Introduction Petroleum Industry- Upstream Sector- Midstream Processing-Downstream Processing-Indian and World Scenario of Petroleum and Natural Gas- Petroleum Trade- Geopolitics.

UNIT- II

Exploration & Production-Indian and World Scenario of Petroleum and Natural Gas Resources- The Reservoir-Reservoir fluids- Hydrocarbon Phase diagrams- Onshore and Offshore Reservoirs - Reservoir Drives. Exploration and Drilling Rigs- Rig Components-Drill and drill bits- Drilling fluids.

UNIT- III

Well Completions Production System: Sketches of Well - Well head- Christmas tree and Casing and various other parts- Cementing-Safety Systems.
Artificial Lift: Principles and operation of Rod Pumps Down Hole Pumps - Gas Lift - Plunger Lift- Electrical submersible pumps.

UNIT- IV

Separation of Reservoir Fluids- Manifolds and Gathering - Production Separators - Gas Treatment and Compression - Oil & Gas Storage.
Midstream processing: Transportation of Crude Oil & its Products and Natural Gas- - World

and Indian pipeline scenario- Design of Oil and Gas pipelines Safety aspects of pipelines- Environmental issues.

UNIT -V

Crude Oil Refining: Classification and Composition - Constituents - Products and their specifications- Pre-treatment of crude oil- Refinery distillation- Safety in refinery operations.

Text Books:

1. Havard Devold, Oil and Gas Production Handbook: An Introduction to Oil & Gas Production, ABB ATPA Oil and Gas. eISBN: 978-1329783454
2. John R. Fanchi and Christiansen, R.L. Introduction to Petroleum Engineering, John Wiley & Sons. eISBN:9781119193463

Reference Books:

1. Production and transport of oil and gas (part B: gathering and transport); Szilas A.P; Elsevier publications, 2nd Edition. eISBN: 0-444-99564-1
2. Subsea Engineering Handbook; Yong Bai., QiangBai; Gulf Professional Publishing; Elsevier eISBN: 978-1-85617-689-7

Web Links:

1. https://www.studentenergy.org
2. https://petrowiki.org/Hydrate_problems_in_production
3. https://en.wikipedia.org/wiki/Pipeline_transport
4. https://petrowiki.org/Production_system

Unit Operations in Petroleum Industry

(Common to All, Except PT)

Course Code: 2501PT35	L	T	P	C
	3	0	0	3

Course Outcomes:

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

CO1: Understand the Heat and Mass Transfer Principles
CO2: Prioritize Proficiency in Conduction Mechanisms
CO3: Explain Mastery of Convective Heat Transfer
CO4: Apply Knowledge of Heat Exchange Equipment and Evaporation
CO5: Distinguish Mass Transfer and Distillation Techniques

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	-	-	-	-	-	-	-	2	1
CO2	3	-	-	-	-	-	-	-	-	2	1
CO3	3	-	-	-	-	-	-	-	-	2	1
CO4	3	-	-	-	-	-	-	-	-	2	1
CO5	3	-	-	-	-	-	-	-	-	2	1

UNIT – I

Introduction: Objective, scope and outcome of the course.
Conduction: Introduction to unit operation and its application in petroleum engineering. Heat Transfer and its application, Modes of heat transfer one dimensional and two-dimensional, heat rate equations, Theory of insulation, critical radius calculations, types of insulation material, conduction through slab, cylinder and sphere.

UNIT – II

Convection: Convective heat transfer, natural and forced convection, co/counter/cross current contacting for heat transfer, individual and overall heat transfer coefficient, Fouling factor, Heat transfer with and without phase change conditions**.**

UNIT – III

Heat Exchange equipment: Introduction to double pipe, shell and tube exchangers, condensers, extended surface equipment.
Evaporation- Type of evaporators and their applications single and multiple effect evaporators, operation of forward– backward and mixed feed operations.

UNIT – IV

Mass transfer and its application: Analogies in transfer process, basic concept of diffusion

and interphase mass transfer. Mass transfer theory film theory Penetration and surface renewal theory.

UNIT – V

Distillation: Rectification, reflux ratio, calculation of numbers of plates by McCabe Thiele method, optimum reflux ratio
Basic introduction to absorption, liquid extraction, leaching
Drying: Equilibrium mechanism theory of drying, drying rate curve

Text Books:

1. Heat and Mass Transfer: Fundamentals and Applications by Yunus A. Çengel and Afshin J. Ghajar. eISBN: 978-9339223199
2. Introduction to Chemical Engineering Thermodynamics" by J.M. Smith, H.C. Van Ness, and M.M. Abbott. eISBN: 978-0070145870

Reference Books:

1. Transport Processes and Separation Process Principles" by Christie John Geankoplis. eISBN: 9789332549432
2. Process Heat Transfer" by Donald Q. Kern. eISBN: 978-0074632178

Weblinks:

1. https://onlinecourses.nptel.ac.in/noc22_me139/preview
2. https://www.engineeringtoolbox.com/convective-heat-transfer-d_430.html
3. https://www.thomasnet.com/articles/process-equipment/double-pipe-heat-exchangers/
4. https://pages.mtu.edu/~fmorriso/cm3120/lectures/2020%20CM3120%20First%20Diffusion%20Lecture%209.pdf
5. http://www.dempt.co.za/mso2015/handout4.pdf

Fundamentals of Geology & Reservoir Engineering

(Common to All, Except PT)

	L	T	P	C
Course Code: 2501PT47	**3**	**0**	**0**	**3**

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

CO 1: Explain the general facts of the earth.
CO 2: Compare and classify various kinds of rocks.
CO 3: Explain how basins are formed.
CO 4: Understand the basic concepts in petroleum reservoir engineering.
CO5: Acquire the knowledge on drive mechanisms and how to apply the material balance to oil reservoirs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	-	-	-	-	-	-	-	2	1
CO2	3	-	-	-	-	-	-	-	-	2	1
CO3	3	-	-	-	-	-	-	-	-	2	1
CO4	3	-	-	-	-	-	-	-	-	2	1
CO5	3	-	-	-	-	-	-	-	-	2	1

UNIT-I

Origin and Evolution of Earth: Dimensions, origin, internal structure of the earth -- crust, mantle, core. Internal dynamic process- Plate tectonics, Continental drift, Earthquake and Volcanoes. External dynamic process – weathering-erosion-deposition. Principles of stratigraphy.

UNIT-II

Petrology: Origin of igneous, sedimentary and metamorphic rocks. Sedimentology -Sedimentary structures-petrographic characters of conglomerate, sandstone, shale, and limestone.

UNIT-III

Sedimentary Basins: Introduction to sedimentary basins and deltaic systems; Topographic maps, Thematic maps, and their profiles

UNIT-IV

Some basic concepts in reservoir engineering: Calculation of hydrocarbon volumes- Fluid pressure regimes- Oil recovery and recovery factor-Volumetric gas reservoir engineering – Application of the real gas equation of state - Gas material balance and recovery factor- Hydrocarbon phase behaviour, Basic concepts in PVT analysis.

UNIT-V

Material balance applied to oil reservoirs: General form -The material balance expressed as a linear equation- Reservoir drive mechanism- Solution gas drive- Gas cap drive- Natural water drive- compaction drive under related pore compressibility phenomena.
Darcy's law and applications: Darcy's law and field potential- Sign convention

Textbooks:

1. Engineering Geology, Bell, F.G., 2nd Edition, Butter worth Heimann. eISBN: 978-0750680776
2. Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science eISBN: 978-0444418302

Reference Books:

1. Text book of Geology, Mukherjee, P.K., The World Press Pvt. Ltd., eISBN: 9786039657736.
2. Principles of Engineering Geology, Bangar, K.M., 2nd Edition, Standard Publishers eISBN: 9788180141157.
3. Reservoir Engineering Handbook, Tarek Ahmed, 3rdEdition, Gulf Professional Publishing eISBN: 9780080480688.

Web Links:

1. web.crc.losrios.edu/~jacksoh/classes/earthscience/Chapter1.pdf
2. 4https://ocw.mit.edu/courses/earth-atmospheric-and.../12...sedimentary.../ch11.pdf
3. www.ucmp.berkeley.edu/fosrec/ONeill.html
4. https://wiki.seg.org/wiki/Volumetrics
5. https://petrowiki.spe.org/Material_balance_in_oil_reservoirs

Fundamentals of Drilling & Production Engineering

L T P C

Course Code: 2501PT48 **2 0 0 2**

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

(Common to All, Except PT)

CO1: Explain the Overview of GTO
CO2: Design of the drill string, drilling hydraulics.
CO3: Determine the well head pressure, down-hole pressure and operating oil/ gas flow rates of the reservoir.
CO4: Illustrate the concepts of artificial lift methods
CO5: Determination of stimulation methods in production operations

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	-	-	-	-	-	-	-	2	1
CO2	3	-	-	-	-	-	-	-	-	2	1
CO3	3	-	-	-	-	-	-	-	-	2	1
CO4	3	-	-	-	-	-	-	-	-	2	1
CO5	3	-	-	-	-	-	-	-	-	2	1

UNIT-I

Overview of drilling: Drilling plan - GTO -Types of drilling, Hydrostatic pressure, Pore pressure, Causes of abnormal pore pressure, abnormal pore pressure evaluation - Measurement while drilling & logging while drilling data -Direct measurements of pore pressure – Drilling fluid properties - Drilling fluid hydraulics calculations - Bit Hydraulics Formation integrity tests – Fracture gradient determination – Theory of wellbore – FIT procedural Guidelines – Predicting fracture gradient.

UNIT-II

Wellbore stability – e in-situ stress - Determination of rock properties, Failure criteria – Stress distribution around a wellbore - safe mud weights to prevent hole collapse, Kick tolerance Use of kick tolerance to calculate wellbore pressures. Casing: Functions of casing – Types of casing – Casing properties and specifications – Casing connections – Factors influencing casing design – Combination strings – Tension criterion - Compression loads – Biaxial effects – Triaxial analysis. Cementation: Introduction to cement slurries - Cementing nomenclature - Cement additives.

UNIT-III

Petroleum production system over all view, Production from various types of reservoirs based on drive mechanisms, field development method, Safety control system. Properties of oil and natural gas: Solution Gas-oil ratio, density of oil and gas, viscosity of oil and gas, formation volume factor of oil and gas, oil and gas compressibility, specific gravity of gas and gas pseudo critical pressure and temperature.

UNIT-IV

Basic concepts on artificial lift methods: Sucker rod pumping system, electrical submersible pumps, hydraulic piston pumping, progressive cavity pumping, plunger lift, hydraulic jet pumping, and Gas lift system.

UNIT-V

Production Stimulation: Well problem identification, Matrix acidizing, Fundamentals of Hydraulic fracturing.

Text Books:

1 Petroleum Engineering: Drilling and Well Completion, Carl Gatlin, Prentice-Hall, Inc. eISBN: 978-0136621553
2 Petroleum Production Engineering: A Computer Assisted Approach, BoyunGuo, William C. Lyons, Ali Ghalambor, Elsevier Science & Technology Books. eISBN: 9780080479958

Reference Books:

1 Oil Well Drilling Engineering: Principles and Practice, H. Rabia, Graham & Trotman eISBN: 978-0860107149
2 Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University

Web Links:

1 https://www.slb.com/resource-library/oilfield-review/defining-series/defining-drilling
2 https://www.slb.com/resource-library/oilfield-review/defining-series/defining-drilling
3 https://onepetro.org/JPT/article/36/06/889/73274/Wellbore-Stability
4 https://petrowiki.spe.org/Production_system
5 https://wiki.aapg.org/Artificial_lift
6 1. https://www.petrosync.com/blog/what-is-well-stimulation/

Unconventional Hydrocarbon Resources

(Common to All, Except PT)

	L	T	P	C
Course Code: 2501PT16	**2**	**0**	**0**	**2**

Course Outcomes:

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

CO1: Explain the present global energy scenario
CO2: Determine the Characteristics of a Tight Reservoir and Oil
CO3: Illustrate the origin and characterize shale gas
CO4: Demonstrate the Characteristics of Coal Bed Methane and Gas Hydrates
CO5: Explain the heavy oil reservoirs and their challenges

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	-	-	-	-
CO5	2	-	-	-	-	-	-	-	-	-	-

UNIT – I

Introduction
Introduction to Unconventional Hydrocarbon resources, Coal Bed Methane: Geological controls in CBM plays, Resource estimation, Drilling, completion and production performance of a CBM well, Indian Scenario

UNIT – II

Tight Gas and Oil
Characteristics of a Tight Reservoir; What makes them Tight; The Permeability Jail; Where to find Tight Reservoirs; Drilling practices for Tight reservoirs; Formation Evaluation; Hydraulic Fracturing, Post Fracture Reservoir evaluation; New Technologies

UNIT – III

Shale Gas/ Oil
Introduction, geology, important occurrences, petrophysical properties, hydro fracturing, horizontal wells, production profiles.

UNIT – IV

Coal Bed Methane and Gas Hydrates
Characteristics of Coal Bed Methane Gas; Drilling practices for Coal Beds; Workflow for Coal Bed Formation Evaluation, Cleat, Gas Content; Hydraulic Fracturing, Depressuring and Dewatering issues Success and Lessons learnt so far; Gas Hydrates: Minerology, Chemistry and physical properties, stability, challenges and pitfalls

UNIT – V

Non-Conventional Oil

Introduction to Heavy oil, extra heavy oil, Tar Sand and bituminous, oil shales; origin and occurrence worldwide, resources, reservoir characteristics, new production technologies

Textbooks:

1. Unconventional Gas Reservoirs: Evaluation, Appraisal, and Development, Islam M.R., Gulf Professional Publishing, 2014 eISBN: 978-0128017682.
2. Coal Bed Methane: From Prospects to Pipeline, Thakur P., Aminian K., Schatzel S., Elsevier Science Publishing, 2015. eISBN: 978-0128002138

Reference Books:

1. Geophysical Characterization of Gas Hydrates: 14 (Geophysical Developments), Michael Riedel, Satinder Chopra, Society of Exploration Geophysicists; 1st edition, 2010 eISBN: 978-1560802454
2. Shale Gas: Exploration and Environmental and Economic, Anurodh Mohan Dayal, Devleena Mani, Elsevier Science Publishing, 2017. eISBN: 978-0128041519.

Web Links:

1. https://link.springer.com/article/10.1007/s13202-021-01404-x
2. https://spgindia.org/10_biennial_form/P260.pdf
3. https://www.iogp.org/wp-content/uploads/2016/10/An-introduction-to-shale-oil-and-gas-Jul2015-1.pdfhttps://link.springer.com/chapter/10.1007/978-3-030-21414-2_1
4. https://link.springer.com/chapter/10.1007/978-3-030-21414-2_1
5. https://www.open.edu/openlearn/science-maths-technology/living-without-oil/content-section-1.

Natural Gas Hydrates

(Common to All, Except PT)

	L	T	P	C
Course Code: 2501PT49	**2**	**0**	**0**	**2**

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

CO 1: Explain the necessity of natural gas hydrates, different hydrate types and formers.
CO 2: Apply different hand calculation methods and computer methods for rapid estimation of hydrate formation conditions.
CO 3: Outline the design information for battling hydrates using chemicals and the reasons responsible for dehydration of gas.
CO 4: Identify the regions of pressure and temperature for combating hydrate formation and the importance of physical properties of design processes.
CO 5: Examine the relationship between fluid phase equilibria and hydrate formation and water content of natural gas.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	-	-	-	-	-	2
CO2	2	2	-	-	-	-	-	-	-	-	2
CO3	3	2	-	-	-	-	-	-	-	-	2
CO4	3	2	-	-	-	-	-	-	-	-	2
CO5	2	2	-	-	-	-	-	-	-	-	2

UNIT-I

Introduction: Overview of Natural Gas Hydrates**;** Natural Gas; The Water Molecule; Hydrates; Water and Natural Gas; Heavy Water.
Hydrate Types and Formers: Type I Hydrates; Type II Hydrates; Type H Hydrates; Size of the Guest Molecule; N-Butane; Other Hydrocarbons; Cyclopropane; 2-Butane; Hydrogen and Helium; Chemical Properties of potential Guests; Liquid Hydrate Formers; Hydrate Forming Conditions; L_A+L_N+H Correlations; Quadruple Points; Other Hydrate Formers; Hydrate Formation at ^{0}C; Mixtures.

UNIT-II

Hand Calculation Methods: Gas Gravity Method; K-Factor Method; Baillie-Wichert Method; Other Correlations; Comments on all of these methods; Local Models.
Computer Methods: Phase Equilibrium; Van der Waals and Platteeuw; Parrish and Prausnitz; NG and Robinson Methods; Calculations; Dehydration.

UNIT-III

Inhibiting Hydrate Formation with Chemicals: Freezing Point Depression; Hammer-Schmidt Equation; Nielsen-Bucklin Equation; New method; Brine Solutions; Comment on the Simple Methods; Advanced Calculation Methods; Inhibitor Vaporization; Comment on the Injection Rates; Safety Considerations; Low Dosage Hydrate Inhibitors.
Dehydration of Natural Gas: Water Content Specification; Glycol Dehydration; Mole Sieves; Refrigeration.

UNIT-IV

Combating Hydrates using Heat and Pressure: Plugs;Use of heat; Depressurization; Melting a Plug with Heat; Hydrate Plug Location.
Physical Properties of Hydrates: Molar Mass; Density; Enthalpy of Fusion; Heat Capacity; Thermal conductivity; Mechanical Properties; Volume of Gas in Hydrate.

UNIT-V

Phase Diagrams: Phase Rule; Comments about Phases; Single Component Systems; Binary Systems; Phase behavior below 0°C; Multi component Systems.
Water Content of Natural Gas: Dew Point;Equilibrium with Liquid Water; Equilibrium with Solids.

Text Books:

1. Natural Gas Hydrates: A Guide for Engineers, John Carroll, Elsevier Publications, 3rd Edition, 2014.eISBN: 9780128000748
2. Clathrate Hydrates of Natural Gas, E Dendy Sloan, Jr., C Koh, CRC Publications, 3rd Edition, 2007. eISBN: 978-0849390784

Reference Books:

1. Natural Gas Hydrates in Flow Assurance, E Dendy Sloan, Jr., C Koh, Amadeu K Sum, Elsevier Publications, 2011. eISBN: 9781856179454
2. Exploration of Gas Hydrates; Geophysical Techniques, Naresh Kumar Thakur, Sanjeev Rajput, Springer Publications, 2011. eISBN: 978-3662519578

Web Links:

1. https://www.researchgate.net/publication/300953314_Hydrate_Types_and_Formers
2. https://petrowiki.org/Hydrate_problems_in_production
3. https://en.wikipedia.org/wiki/Glycol_dehydration
4. https://www.hindawi.com/journals/jther/2010/271291/
5. https://www.ogj.com/articles/print/volume-91/issue-13/in-this-issue/gas-processing/chart-estimates-water-content-of-sour-natural-gas.html

Fundamentals of Liquefied Natural Gas

(Common to All, Except PT)

	L	T	P	C
Course Code: 2501PT05	**2**	**0**	**0**	**2**

Course Outcomes:

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

CO1: Explain the LNG value chain
CO2: Classify the different liquefaction technologies of LNG
CO3: Explain the components of LNG receiving terminals
CO4: Summarize LNG storage and transportation facilities
CO5: Identify major equipment and safety aspects of LNG industry

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	2
CO3	3	2	-	-	-	-	-	-	-	-	2
CO4	3	2	-	-	-	-	-	-	-	-	2
CO5	3	2	-	-	-	-	-	-	-	-	2

UNIT – I

Introduction: Overview of LNG industry -History of LNG industry – Base load LNG – Development of an LNG Project – World and Indian Scenario– Properties of LNG.

UNIT – II

Propane precooled mixed refrigerant process – Description of Air products C3MR LNG process–. Description of Conoco Phillips optimized cascade (COPOC) process – Liquefaction– LNG flash and storage.
Other Liquefaction Processes: Description of Linde MFC LNG process- Precooling and Liquefied Petroleum Gas (LPG) recovery – Liquefaction and sub cooling- Trends in LNG train capacity –strategy for grassroots plant- offshore LNG production.

UNIT – III

Gas pre-treatment: Slug catcher– NGL stabilization column – Acid gas removal unit – Molecular sieve dehydrating unit Receiving terminals in India – Main components and description of marine facilities – LNG tanks– Process descriptions. –Mercury and sulphur removal unit–NGL recovery–Nitrogen rejection–Helium recovery.

UNIT – IV

LNG Shipping Industry: LNG fleet – Types of LNG ships – Moss – Membrane – prismatic; Cargo measurement and calculations, Cryogenic heat exchangers: Spiral– Wound heat exchangers – Plate & fin heat exchangers – Cold boxes; Centrifugal compressors –Axial compressors – Reciprocating compressors; LNG pumps and liquid expanders –Loading Arms and gas turbines, Description of Regasification.

UNIT – V

Submerged combustion vaporizers- Open rack vaporizers–Shell and tube vaporizers: direct heating with seawater, and indirect heating with seawater. Safety design of LNG facilities –

Security issues for the LNG industry – Environmental issues– Risk-based analysis of an LNG plant.
Ambient air vaporizers: Direct heating with ambient air – Indirect heating with ambient air.

Textbooks:

1. LNG: Basics of Liquefied Natural Gas, Stanley Huang, Hwa Chiu and Doug Elliot, Ist Edition, PETEX. eISBN: 978-0886982171
2. Marine Transportation of LNG (Liquefied) and related products, Richard G. Wooler, Gornell Marine Press. eISBN: 9780608024646

Reference Books:

1. Natural Gas by Sea: The Development of a new technology, Roger Rooks, Wither by Publishers eISBN: 9780856140549
2. Marine Transportation of Liquefied Natural Gas, Robert P Curt, Timothy D. Delaney, National Maritime Research Centre. eISBN:

Web Links:

1. http://folk.ntnu.no/skoge/prost/proceedings/aiche2008/data/papers/P139095.pdf
2. https://ceonline.austin.utexas.edu/petexonline/file.php/1/ebook_demos/lng/html/index.Htm
3. http://petrowiki.org/Liquified_natural_gas_(LNG
4. http://www.chebeague.org/fairwinds/risks.htm
5. http://www.beg.utexas.edu/energyecon/LNG_Safety_and_Security_Update_2012.pdf

Artificial Lift Techniques
(Common to All, Except PT)

Course Code: 2501PT50	L	T	P	C	Course
	3	0	0	3	

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

- **CO1:** Explain the fundamental concepts of artificial lift techniques such as reservoir pressure, well productivity and reservoir fluids
- **CO2:** Apply sucker rod lift system, polished rod motion, FRP sucker rods,criteria for rod string design with advantages and limitations.
- **CO3:** Apply gas lift, gas compression requirements sonic flow, subsonicflow, volumetric efficiency advantages and limitations.
- **CO4:** Explain electrical submersible pumps, principle hydraulic piston pumping advantages and limitations.
- **CO5:** Explain hydraulic jet pumping advantages and disadvantages.

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-

UNIT-I

Introduction of artificial lift: Definition and Purpose of artificial lift selection-Reservoir pressure and wellproductivity-reservoir fluids-Types of artificial lift.

UNIT-II

Sucker Rod lift: Sucker rod lift system-polished rod motion-load to the pumping unit-pump deliverability and power requirement-sucker rods-steel sucker rods-pony rods-FRP sucker rods-Non-API sucker rods-criteria for rod string design, advantages and limitations-Trouble shooting sucker rod lift installation.

UNIT –III

Gas lift: Gas lift system-gas compression requirements sonic flow-subsonic flow- volumetric efficiency-stage compression-gas lift valve design-selection of gas lift valves-pilot valve-continuous and intermittent gas lift advantages and limitations

UNIT-IV

Electrical submersible pumps, Progressive cavity pumping: Electrical submersible Pumps (ESP)-principle-hydraulic piston pumping-ESP design-ESP advantages and limitations. **Progressive cavity pumping:** Plunger lift-working principle-design-plunger lift models-progressive cavity pumping (PCP) advantages and limitations

UNIT-V

Hydraulic Jet pumping: Hydraulic Jet pumping-selection of jet pump-advantages and dis-advantages. **Selection of artificial lift method:** Artificial lift method selection-gas lift vs pumpassisted lift-installation and replacement of artificial lift-maintenance of artificial lift.

Text Books:

1. Petroleum Production engineering: A computer-assisted approach, Boyun GUO, William C. Lyons, Ali Ghalambor, Elsevier Science and Technology books.eISBN: 978-0123838469
2. Petroleum Engineering Handbook-Production Operations Engineering, volume 4by Joe Dunn Clegg and Larry W. Lake, SPE. eISBN: 978-1555631147

Reference Books:

1. Petroleum production systems, M.J. Economides, A. Daniel Hill & C. E. Economides, Prentice-Hall, N.J-07488. eISBN: 978-0136586832
2. The Technology of Artificial Lift Method, Brown, K.E, Volume 1-4, Penn Well Books, Tulsa, Oklahoma.ceISBN: 978-0878141545

Web Links:

1. http://petrowiki.org/Sucker-rod_lift
2. http://petrowiki.org/Gas_lift
3. http://petrowiki.org/Electrical_submersible_pumps
4. http://petrowiki.org/Hydraulic_pumping
5. https://en.wikipedia.org/wiki/Progressive_cavity_pump.

Enhanced Oil Recovery
(Common to All, Except PT)

	L	T	P	C
Course Code: 2501PT03	**2**	**1**	**0**	**3**

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

- **CO1:** Explain the basic features and technical foundations of the most common EOR methods
- **CO2:** Explain the basic geological factors for flooding of reservoirs
- **CO3:** Apply screening criteria to a given reservoir to select an displacement method both technically and economically
- **CO4:** Make Use of rock, fluid, and reservoir data for the Displacement of fluids in the reservoir
- **CO5:** Apply screening criteria to a given reservoir to select a chemical method for flooding

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	-	-	-	-	-	-	-	-	2
CO2	2	-	-	-	-	-	-	-	-	-	2
CO3	3	-	-	-	-	-	-	-	-	-	2
CO4	3	-	-	-	-	-	-	-	-	-	2
CO5	2	-	-	-	-	-	-	-	-	-	2

UNIT – I

Principles of enhanced oil and gas recovery methods. IOR, EOR& EGR. Screening criteria for EOR methods.

UNIT – II

Geological Factors in Enhanced Oil Recovery
Reservoir heterogeneities, Examples of geological factors in enhanced recovery projects Natural fractures,
Determination of Residual Oil Saturation based on
Geophysical Well logging techniques, Determination of residual saturation, Well-log-derived oil saturation determination in open hole, Residual oil saturation determination in cased wellbore

UNIT – III

Immiscible displacement: Injection well location, production well completion, surface installation.Miscible drive: Miscible slug flooding, thermodynamic miscibility, ternary diagrams, methods of miscible drive. Benham's correlations, physical and mathematical modelling.

UNIT – IV

Displacement of fluids in reservoir: capillary force; viscous force; phase trapping; mobilization of trapped phases, and alteration of viscous/capillary force ratio.

UNIT – V

Design aspects of chemical flooding. Case studies of surfactant, alkali, polymer, ASP flooding. WAG process, SWAG process, and Chemical augmented WAG process. Foam flooding.

Textbooks:

1. Enhanced Oil Recovery: Mechanisms, Technology, and Feasibility" by Ajay Mandal and Keka Oja. eISBN: 978-0128200810.
2. Applied Enhanced Oil Recovery, Aural Carcoane, Prentice Hall eISBN: 9780130442727

Reference Books:

1. Basic Concepts in Enhanced Oil Recovery Processes, Marc Baviere, SCI, eISBN: 9781851666171
2. Enhanced Oil Recovery: Proceedings of the Third European Symposium on Enhanced Oil Recovery, F. John Fayers, Elsevier eISBN: 978-3-319-31421-1
3. Enhanced Oil Recovery, Larry W. Lake, Prentice Hall, eISBN: 9780132816014

Web Links:

1. https://www.ogj.com/oil-drilling-and-production/production-operations/ior-eor.html
2. http://www.ccop.or.th/ppm/document/INWS4/INWS4DOC03c_Norway_GUNNAR.pdf
3. https://petrowiki.org/Polymer_waterflooding
4. https://www.glossary.oilfield.slb.com/en/Terms/a/alkaline_flooding.aspx
5. https://petrowiki.org/Conformance_improvement

Petroleum Refinery Engineering
(Common to All, Except PT)

	L	T	P	C
Course Code: 2501PT12	**2**	**0**	**2**	**4**

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

- **CO1:** Identify the types of petroleum feed stocks and products by their properties
- **CO2:** Make use of process knowledge to solve operational problems and increase the efficiency
- **CO3:** Apply the knowledge of crucial processes to meet the end product demands
- **CO4:** Prioritize the demand of various petrochemicals to optimize the processes
- **CO5:** Classify various petrochemical products and their uses

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	-	-	-	-
CO5	2	-	-	-	-	-	-	-	-	-	-

UNIT – I

Basic of Petroleum:
Role of Crude oil in global economy, Present Scenario of Crude Oil Refinery, Importance, Occurrence, Origin(formation), Exploration, Composition, Classification and Evaluation of Crude oil, Crude Assay Analysis, Distillation Characteristics such as True Boiling (TBP), American Society for Testing Materials (ASTM).

UNIT – II

Properties of Crude and Petroleum Products:
Various types of Average Boiling Points of Crude Oil & Petroleum Fractions.
Types of Gases & their Composition, Types of Gasoline & it's Important Properties and tests such as ASTM Distillation, RVP, Octane Number, Oxidation Stability, Sulphur Content etc,
Various Types of Naphtha and their Important Properties & Applications.
Important Tests & Properties of Kerosene such as Flash& Fire Point, Smoke Point, Aniline Point etc.,
Types of Diesel & its Important Properties & Tests such as Pour Point, Diesel Index, Cetane Number etc.
Heavy Fractions like Lube Oil, Bitumen, Asphalt etc & their Important Properties such as Viscosity Index, Carbon Residue, Penetration Index, Softening Point etc.

UNIT – III

Processing of Petroleum:

Pretreatment of Crude (Dehydration & Desalting), Pumping of Waxy Crude, Heating of Crude, Distillation of Petroleum & Types of Reflux, ADU & VDU.

UNIT – IV

Thermal & Catalytic Cracking:
Thermal cracking – Processes, operating parameters, feed stock selection and product yields, Advantages –Types and functions of secondary processing – Visbreaking – Processes, operating parameters and advantages–Coking –Operating parameters and advantages. Fluid catalytic cracking –processes, operating parameters, feed stock selection and product yields –Advantages.

UNIT – V

Treatment Techniques:
Physical Impurities found in Crude& their Removal, Sweetening Techniques, Production and Treatment of LPG & their Methods, Dehydration and Sweetening of Gases, Gasoline Treatment such as Lead Doctoring, Merox Sweetening, Catalytic Desulphurization etc. Treatment of kerosene.

Textbooks:

1. PetroleumRefining:Technology and Economics ,J.H.Gary and G.E.Handwerk, 5th Edition, Marcel Dekkar, Inc. eISBN: 9780203907924
2. Elements of Petroleum Processing, D S Jones, Wiley–Blackwell. eISBN: 9780471964896

Reference Books:

1. Petroleum Refining Engineering, WL Nelson, 4th Edition, McGraw Hill Company eISBN: 9780070462687
2. Fundamentals of Petroleum Chemical Technology, P Belov, Mir Publishers eISBN: 9780846404385
3. Petrochemical Processes, A. Chauvel and G.Lefebvre, Volume 1 & 2, Gulf Publishing Company eISBN: 9782710810650

Web Links:

1. https://www.scribd.com/doc/.../Surface-Production-Operations-Volume-1-Oil-System
2. www.academia.edu/.../Ken_Arnold-Surface_Production_Operations_Volume_1_3rdE
3. https://byjus.com/chemistry/petroleum/
4. https://www.slideshare.net/.../surface-production-operations-volume-iv-pumps-compr...
5. https://www.researchgate.net/publication/359449933_Petroleum_sludge_treatment_and_disposal_techniques_a_review

Minor Degree in Mining Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501MN03	Development of Mineral Deposits	FC	3			3	50	50	100	-
2501MN41	Green Mining	FC	3			3	50	50	100	-
2501MN06	Surface Mining	IC	3			3	50	50	100	DMD
2501MN24	Drilling & Blasting	IC	3			3			100	DMD
2501MN07 2501MN08	Underground Coal Mining Technology (or) Underground Metal Mining Technology	IC	3			3	50	50	100	DMD
2501MN14 2501MN28	Mine Legislation & General Safety (or) Environmental Pollution & Control	AC	3			3	50	50	100	UCMT / UMMT
2501MN45 2501MN46	Industrial Safety Practices (or) Ground Control	AC	2			2	50	50	100	-
TOTAL			**2**			**20**				

Development of Mineral Deposits
(Common to All, Except Min.E)

	L	T	P	C
Course Code: 2501MN03	**3**	**0**	**0**	**3**

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

CO1: Summarize different stages in the life of a mine
CO2: Choose a suitable location for opening to a deposit.
CO3: Explain Exploratory and Production Drilling
CO4: Categorize the use of explosives and blasting.
CO5: Summarize material handling and transportation in mining

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

UNIT – I

Introduction to mining: Mining terminologies, Stages in the life of the mines- Prospecting, Exploration, Development, Exploitation, Reclamation, Brief overview of Surface & Underground Mining Methods.

UNIT – II

Access to mineral Deposits: Adits, shafts, incline - location, shape and size; Drilling, blasting and removal of debris. Methods of shaft sinking –conventional, mechanized and special methods; opening up of surface deposits.

UNIT – III

Exploratory and Production Drilling: Principles of drilling, Types of drill, Drill rods and drill bits – types and applications, Exploratory drilling - Drilling fluid; Production drilling – Rotary, Percussive, Rotary- percussive, pneumatic; Drill patterns.

UNIT – IV

Explosives and Blasting: Types of explosives, Properties of explosives, Detonators. Detonating cords, and detonating fuse and nonel detonator. Storage and transport of explosives, Mechanics of blasting, Primary and secondary blasting, Blast geometry and design, electrical and non electrical methods, delay blasting techniques, handling misfires.

UNIT – V

Material Handling and Transportation in Mines: LHD, SDL, shuttle car, AFC and belt conveyors; Raises, winzes, ore passes, ore chutes; shovels, dumpers, silo, bin, CHP, tippler.

Text Books:

1. Elements of Mining Technology, D.J.Deshmukh, Denett& Co., Nagpur Vol. I, ISBN: 978-8189904333.
2. Surface Mining, Dr T.N.Singh, Lovely Prakashan, Dhanbad , 2nd Edition, ISBN: 978-8179561294.

Reference Books:

1. Indian Bureau of Mines, Minerals Year Book & other publications, Latest Edition.
2. Explosives and blasting techniques, G.K Pradhan, Latest edition. ISBN: 978-0470512275.
3. Rock Blasting and Overbreak Control, Dr. Calvin Konya; Precision Blasting Services, Montville, Ohio 2nd Edition, ISBN: 9780318198965.

Web Links:

1. http://www.miningglobal.com/operations/gifs-5-stages-mining-life-cycle
2. https://www.minecationstandards.org/fileadmin/MAS/documents/nmas-national
3. stabdards/afghanistan/AMAS_07.04_Storage_Transportation_Handling_of_Explosives. Pdf

Green Mining
(Common to All, Except Min.E)

	L	T	P	C
Course Code: 2501MN41	**3**	**0**	**0**	**3**

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

CO1: Explain the importance of green mining.
CO2: Plan and scheduling of activities related to mine waste management.
CO3: Analyze the impact of water pollution due to mining.
CO4: Distinguish progressive and final mine closure planning
CO5: Explain the usage of renewable energy in mines.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	3	1	-	-	-	-	-	-	-	-
CO2	-	-	1	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	-	-	-	-
CO5	-	3	1	-	-	-	-	-	-	-	-

UNIT – I

Footprint Reduction: Importance of green mining, Sustainable project management, Corporate social responsibility for industrial sustainability, Environment Friendly Mining Equipment's, Clean development mechanism (CDM), CCUS technology, Application of Bio Fuels.

UNIT – II

Mine Waste Management: Types of mine waste Overburden, Tailings and other wastes. Characterization, disposal, management of different types of mining waste.

UNIT – III

Mine Water: Sources of pollution, Effect of mining on water bodies, Treatment of mine water, Water conservation initiatives in mines, zero waste water discharge.

UNIT – IV

Mine Closure Planning: Progressive and final mine closure planning, structure of mine closure report, Legislative provisions on mine closure planning.

UNIT – V

Renewable Energy: Usage of renewable energy in mines solar power, wind power; associated problems.

Text Books:

1. Green Mining:The Way Forward, Anil Jha, Das Gupta Co Pvt Ltd Publication, 2019, ISBN: 978-8194161424.
2. Sustainable Mining Practices, A.K. Gorai and D. Nimaje, Narosa Publishing House, ISBN: 9788184876048.

Reference Books:

1. Mining and Environmental Sustainability, G. S. Roonwal, ASTRAL Publication, ISBN: 9789351247591.
2. Advances in Productive, Safe, and Responsible Coal Mining, Joseph Hirschi, Elsevier Ltd, 2019, ISBN: 9780128156263.

Web Links:

1. https://www.mdpi.com/books/pdfview/book/3216
2. https://web.mit.edu/12.000/www/m2016/finalwebsite/solutions/greenmining.html
3. https://www.sciencedirect.com/science/article/pii/S187661021200077X
4. Oxford scientists show how green mining could pave the way to net zero and provide the metals we need for a sustainable future | University of Oxford
5. Green Mining (mdpi.com)

Surface Mining
(Common to All, Except Min.E)

	L	T	P	C
Course Code: 2501MN06	**3**	**0**	**0**	**3**

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

CO1: Analyze different surface mining methods
CO2: Design the layout of a large opencast mine
CO3: Design drilling and blasting for Surface mining
CO4: Choose the better excavation and loading equipments
CO5: Organize the transportation system

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	1	-	2	-	-	-	-	-	-	-
CO2	3	1	1	-	-	-	-	-	-	-	-
CO3	3	1	1	-	-	-	-	-	-	-	-
CO4	3	1	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

UNIT – I

Introduction: Status and scope of surface mining- Applicability, Limitations and, advantages and disadvantages. Methods of opening box cut, selection of site for box cut. Surface Mining Methods: Open pit Mining, Open cast Mining,Quarrying, High-wall Mining Modern Methods. Placer Mining.

UNIT – II

Open Pit Layout and Design: Planning the layout and open pit mine with special reference to large mechanized mines. Optimum dimensions of open pit mines. Removal of over burden and disposal, Bench Design/Geometry, Design and stability slopes.

UNIT – III

Blast Design in Surface Mines: Drillability, mechanics of drilling, major types of drilling machines. Blasting: Basics of mechanics of blasting, principles of fragmentation. Blast design, Adverse impacts of blasting in surface mines. Controlled blasting techniques. Novel methods of blasting.

UNIT – IV

Excavation and Loading: Shovels, Dragline, Front-end loader. Non-Cyclic Surface Mining: Bucket Wheel Excavators and Continuous surface miners. Auxiliary Equipment: Stackers, Graders, Dozers, Ripper.

UNIT – V

Transport Equipment: Selection of mode of transport. Dumpers, Aerial ropeways-monocable and bicable types and their constructional details. Conveyor systems, ICC system, Slurry Transportation.

Text Books:

1. Surface Mining Technology, S. K. Das, Lovely Prakashan, Dhanbad.
2. Surface Mining, G. B. Mishra, Dhanbad Publishers.

Reference Books:

1. Opencast Mining unit operations, V.V.Rzhevsky, Mir Publisher's, Mascow, ISBN: 978-0873351087.
2. Open Pit Mine Planing and Design Crawford, T.john, American Institute of Mining, Metallurgical and Petroleum Engineers, ISBN: 978-0873351027.

Web Links:

1. http://www.cienciaviva.pt/img/upload/Introduction%20to%20mining.pdf
2. http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/safework/documents/normativeinstrument/wcms_107828.pdf
3. https://www.iitbhu.ac.in/faculty/min/rajesh-rai/NMEICTSlope/Pdf/03%20Types%20of%20slope%20failure.pdf

Drilling & Blasting
(Common to All, Except Min.E)

	L	T	P	C
Course Code: 2501MN24	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Differentiate between types of drilling machines.
CO2: Identify and classify explosives
CO3: Analyze problems associated with open cast blasting and mitigation.
CO4: Analyze problems associated with underground blasting and mitigation.
CO5: Assess blasting in metal mines.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	3	2	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-
CO3	1	3	-	-	-	-	-	-	-	-	-
CO4	1	3	-	-	-	-	-	-	-	-	-
CO5	1	3	-	-	-	-	-	-	-	-	-

UNIT – I

Drilling: Drillability, mechanics of drilling, major types of drilling machines, Principles of drilling, Types of drill, Drill rods and drill bits -Types and applications, Exploratory and Production Drilling.

UNIT – II

Explosives and Blasting Accessories: Mechanism of blasting, Explosives- types and properties. Selection of explosives, Handling, and storage of explosives. Types of initiating systems – Electrical Detonators, Detonating Fuse, Detonating Relays, NONEL, Electronic Detonators, Blasting accessories, exploders. Blast Design in Surface and Underground Mines.

UNIT – III

Drilling and Blasting in Surface Mines: Factors affecting blasting, Blast design - estimation of burden and spacing, estimation of charge requirement; Initiation patterns; secondary blasting – pop and plaster shooting; Problems associated with blasting, Ground vibration and air over pressure.

UNIT – IV

Drilling and Blasting in Underground Coal Mines: Blast hole patterns and their applicability, blasting-off-solid, ring hole blasting, calculation of specific charge, specific drilling and detonator factor, initiation patterns.

UNIT – V

Drilling and Blasting in Underground Metal mines: Blast hole patterns and their applicability, blast design for horizontal drivage, long hole blasting, vertical crater retreat blasting.

Text Books:

1. Principle of rock drilling, B. Misra, U.M. Rao Karanam, Taylor & Francis, CRC Press, ISBN: 9781138033646.
2. Drilling & Blasting Minetech, Pradhan G.K., Ghose A.K., Bhubaneswar, India: Mintech, ISBN: 9789383183039.

Reference Books:

1. Elements of Mining Technology,DJ Deshmukh, Denet, First Edition, Vol. 1, ISBN: 978-81-89940-02-7.
2. Surface mining, GB Mishra, Dhanbad, Vol.1, ISBN: 978-0873351027.

Web Links:

1. https://archive.nptel.ac.in/courses/123/105/123105003/
2. https://www.rpmdrilling.co.za/blast-hole-drilling-process/
3. www.railsystem.net/drill-and-blast-method/

Underground Coal Mining Technology

(Common to All, Except Min.E)

	L	T	P	C
Course Code: 2501MN07	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Illustrate the fundamentals of underground coal mining.
CO2: Explain the various mine development methods.
CO3: Explain the long wall mining method.
CO4: Analyze the various thick and deep seam mining methods.
CO5: Categorize the various modern mining methods.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	-	-	-	-	-	-	-	-	-
CO2	2	-	3	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-
CO5	2	-	-	3	-	-	-	-	-	-	-

UNIT – I

Introduction: Formation of coal deposits, structures associated with coal deposits, rank and grade of coal. Different coal mining methods: factors influencing choice of coal mining methods. Status of coal mining industry in India and global scenario.

UNIT – II

Bord and Pillar Mining: Applicability, limitations, advantages and disadvantages of Bord and pillar mining method. Development-Design of pillars and panel, supports. Depillaring-methods and sequence of operations, splitting and slicing of pillars, supports. Partial extraction techniques. Extraction of multi seams. Stowing Techniques. Mechanization- SDL, LHD, Continuous miners, belt conveyors, UDM etc., Case studies.

UNIT – III

Longwall Mining: Applicability, limitations, merits and demerits, Longwall mining Methods- Advancing and Retreating, Thin and Thick seam. Longwall Development- Gate roads, longwall face. Face Mechanization, Shearer, Plough, AFC, Powered Supports. Sequence of operations- Cutting and conveying of coal from face. Case studies.

UNIT – IV

Thick Seam Mining: Applicability, limitations, and problems associated with thick seam mining, selection of mining method, caving and stowing methods. Different slicing methods-inclined Slicing, Horizontal Slicing, Diagonal Slicing, Transversely Inclined Slicing, Caving methods- Sublevel Caving Working Steep and Moderately Thick Seams- Blasting Gallery method, Room and Pillar method, Descending Shield method of Mining. Design of Supports, Case studies.

UNIT – V

Modern Coal Mining Methods: Horizon Mining, Hydraulic Mining, Underground Coal Gasification. Case studies.

Text Books:

1. Principles and Practices of Modern Coal Mining, R. D. Singh, New Age International, ISBN: 978-8122429705.
2. Modern Coal Mining Technology, S. K. Das, Lovely Prakashan Publishers,2nd Edition, ISBN: 978-81-7850-043-6.

Reference Books:

1. Underground Coal Mining Methods, J. G. Singh, BrajKalpa Publishers, Varnasi, ISBN: 81-7525-204-9.
2. Coal Mining, I.C.F. Statham, The Caxton Publishing Company Ltd. Inc, Vol. I, II, III and Vol. III, ISBN: 978-81-7850-043-9.
3. Winning and working coal, R. T. Deshmukh, D.J Deshmukh Vol 1 & 2, ISBN: 97-88-189904333.

Web Links:

1. https://osme.co.in/wp-content/uploads/2023/01/UCMR-BAL-1.pdf
2. https://www.digitalxplore.org/up_proc/pdf/340-151522605452-56.pdf

Underground Metal Mining Technology

(Common to All, Except Min.E)

	L	T	P	C
Course Code: 2501MN08	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Illustrate the fundamentals of metal mining
CO2: Analyze the various mine development methods.
CO3: Analyze the basics of stoping
CO4: Compare the various stoping methods.
CO5: Categorize the various special stoping methods.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	-	-	-	3	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

UNIT – I

Introduction to Metal Mining: Terminologies in metal mining. Special Characteristics of Metalliferous deposit. Scope and limitations of underground metal mining. Access to deposits, Status of metal mining in India and World.

UNIT – II

Mine Developments: Factors affecting choice of level interval, Cross cuts, drive, shape and size of drive, shaft station, ore bin, ore pass and their position in relation to ore body and general scheme of its development. Division of mining area into working units and level pattern, dimensions of panels and blocks. Unit Operations in Metal Mining.

UNIT – III

Basics of Stoping: Stoping methods- applicability, limitations, merits and demerits. Selection of stoping methods. Stope design and production planning in various methods of stoping. Support design.

UNIT – IV

Stoping Methods: Supported and un-supported Stoping Methods, Caving methods. Description, application and design of stoping methods. Mechanisation of stopes.

UNIT – V

Novel Techniques: In-situ leaching, bio-mineral engineering, hydraulic mining, Extraction of remnant pillars, shaft pillars and contiguous reefs, their supporting system and special precautions during extraction.

Text Books:

1. Introductory Mining Engineering, H L Hartman, John Wiley and sons. ISBN: 978-0471811778.
2. Elements of Mining Technology, D.J.Deshmukh. Vol III. ISBN: 978-8184890700.

Reference Books:

1. Deep Mining, jack Spalding, mining publications, ISBN: 978-0-903078-36-8
2. Mineral engineers hand book, Peele, Vol. I &II, ISBN: 978-0873352205 & 978-0873352212.
3. U/G Mining Method,Hustrulid, society for mining, metallurgy &Exploration, ISBN: 978-0873352643.

Web Links:

1. https://www.911metallurgist.com/methods-mining-metals/
2. https://www.greatmining.com/metals.html

Mine Legislation & General Safety

(Common to All, Except Min.E)

	L	T	P	C
Course Code: 2501MN14	**3**	**0**	**0**	**3**

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

CO1: Illustrate the general principle of mining laws and regulations
CO2: Compare the rules and regulation framed under CMR& MMR.
CO3: Explain the various mining rules and Indian electricity rules
CO4: Explain the Mineral concession rules and mine act
CO5: Explain the training rules and DGMS circular

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	3	-	-	-	2	-	-	-	-	-
CO2	1	3	-	-	-	-	-	-	-	-	-
CO3	-	-	2	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	3	-	-	-	-	-	-	-	-

UNIT – I

General principles of mining laws, The Mines Act 1952, The mines & Minerals (Regulation & Development) Act 2015, Industrial dispute Act 1947.

UNIT – II

The Coal Mines Regulations 2017 and The Metalliferous Mines Regulations 2019.

UNIT – III

The Mines Rules 1955, Mine rescue rule 1985, Indian Electricity rule 1956.

UNIT – IV

The Mineral Concession Rules 2017, The Mineral Concession and Development Rules 2017.

UNIT – V

Introduction to Environmental Legislation in mines, Land Acquisition & Revenue: Concepts: Related laws and regulations. Forest Conservation Act 1980.

Text Books:

1. Mines act, Mine Rules, CMR, MMR, MVTC, Mine Rescue Rules, DGMS
2. Legislation in Indian Mines: A critical appraisal, Rakesh and S. D. Prasad, Mrs Asha Lata Varnasi, 5th Edition.

Reference Books:

1. Proceeding of the National Seminar on Policies, A. K. Ghosh, S. K. Ray and A. K. Patra, Statutes & Legislation in Mines, CIMFR, Dhanbad.
2. Mineral Concession Rules 1960, V. K. Malhotra, Malhotra Bros., Patna, Supplementary Edition.

Web Links:

1. https://mines.gov.in/writereaddata/UploadFile/MMDR%20Act,1957.pdf
2. https://dgms.gov.in.

Environmental Pollution & Control
(Common to All, Except Min.E)

	L	T	P	C
Course Code: 2501MN28	**3**	**0**	**0**	**3**

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

CO1: Illustrate the fundamentals of environmental issues in mining
CO2: Examine the various causes of water pollution.
CO3: Analyze the various causes of air pollution.
CO4: Analyze the methods for mine reclamation
CO5: Assess environmental impact due to mining.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

UNIT – I

Air Pollution: Atmospheric science; Sources of air pollution in mines; Effect of air pollution and preventive measures; Ozone layer and greenhouse effect; Dispersion model.

UNIT – II

Water Pollution: Sources of water pollution; Effect and preventive measures of water pollution; Ground water and its contamination; Water pollution modeling - biological oxygen demand and chemical oxygen demand; Acid mine drainage; Waste water treatment.

UNIT – III

Noise Pollution: Terminologies associated with noise; Sources and effects of noise; Measurement of noise; Noise standard and guidelines; Noise control strategies.

UNIT – IV

Land Reclamation and Rehabilitation: Causes of land degradation; Land reclamation method- Rehabilitation, Reclamation, Restoration; Factor affecting the land restoration; Land reclamation planning.

UNIT – V

Socio-Economic Impact Assessment: Socio-economic impact of mining, Quality of life index.

Text Books:

1. Environmental Pollution and Control, Peirce J. Jeffrey, Elsevier Science & Technology, Fourth Edition, 2018, ISBN: 978-0128125428.
2. Principle and practices of modern coal mining,R.D. Singh, New Age International, ISBN: 978-8122416464.

Reference Books:

1. Ground Control, Peng, S.S. Wiley Publications, New York, ISBN: 978-0471775410.
2. Open pit mine planning and Design, W. Hustrulid and M. Kuchta, A. A. Balkema Rotterdam, 1st edition, Vol – I, ISBN: 978-9056990736.
3. Surface Mining, G. B. Mishra, Lovely Prakashan Dhanbad, 1st Edition, ISBN: 978-81-85500-42-6.

Web Links:

1. https://miningandblasting.wordpress.com/2011/08/30/mine-planning-and-scheduling-smart practice
2. https://onlinecourses.nptel.ac.in/noc22_ce22/preview

Industrial Safety Practices

(Common to All, Except Min.E)

	L	T	P	C
Course Code: 2501MN45	**2**	**0**	**0**	**2**

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

CO1: Describe Occupational Health Hazards
CO2: Analyze the concept of Ergonomics and its importance in Industrial safety
CO3: Describe Importance of Industrial safety.
CO4: Analyze and apply effects of radiation on human body
CO5: Analyze different accident prevention techniques

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-
CO3	2	3	-	-	-	-	-	-	-	-	-
CO4	2	3	-	-	-	-	-	-	-	-	-
CO5	2	3	-	-	-	-	-	-	-	-	-

UNIT – I

Introduction to industrial safety: Safety scenario in national and international arena, identification of safety issues in different industries and their remedial measures, general safety practices.

UNIT – II

Ergonomics: Ergonomics – Importance, Ergonomics Hazards – Musculoskeletal Disorders and Cumulative Trauma Disorders, ergonomics studies.

UNIT – III

Industrial Health and Hygiene: Occupational health hazard & classification of health hazards, Occupational health and hygiene surveillance, legislative measures and prevention of health hazards.

UNIT – IV

Personal Protective Equipment: Types of personal protective equipment and their usages.

UNIT – V

Accident Prevention Techniques: Types of accidents, causes of accidents- unsafe acts and conditions, accident investigation and prevention.

Text Books:

1. The Factories Act with amendments, Govt. of India Publications DGFASLI, Mumbai, ISBN: 978-9352471010.

2. Frank P Lees – Loss of prevention in Process Industries, Butterworth- Heinemann Ltd., London, Vol. 1 and 2, ISBN: 978-0750633016 & 978-0750633023.

Reference Books:

1. Accident Prevention Manual, NSC, Chicago, ISBN: 978-1118240295.
2. Occupational safety Manual, BHEL, Trichy, ISBN: 978-81-73190163.
3. Safety Management, John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, ISBN: 978-8173190162.

Web Links:

1. https://www.osha.gov/
2. https://www.healthandsafetyatwork.com/
3. http://ohsonline.com/

Ground Control
(Common to All, Except Min.E)

L T P C

Course Code: 2501MN46 **2 0 0 2**

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

CO1: Describe about concept of ground control in mines.
CO2: Analyze strata pressure and management.
CO3: Illustrate types of Roof support.
CO4: Analyze the design of structure in rock.
CO5: Explain about the Subsidence in mining.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-
CO3	2	3	-	-	-	-	-	-	-	-	-
CO4	2	3	-	-	-	-	-	-	-	-	-
CO5	2	3	-	-	-	-	-	-	-	-	-

UNIT – I

Introduction: Definition and concept of ground control in mines, Ground control practice in mines, constraints on ground control design.

UNIT – II

Strata pressure and management: The modern concept of strata pressure redistribution. Manifestation of strata pressure, convergence, load on the prop, creep, heave, roof fall, and fracture systems due to mining. In-situ stress measurement, instrumentation.

UNIT – III

Roof support: Timber and steel supports, friction and hydraulic prop, arches, shotcrete, roof truss, roof bolts and cable bolts powered supports stowing caving strip packing pump packing rock reinforcement.

UNIT – IV

Design of structures in rock: Design of underground openings. Design of pillars, design of open pit slopes, waste dumps, and embankments, design of stopes.

UNIT – V

Subsidence: Theories of subsidence, factors affecting subsidence, prediction, and measurement of subsidence. Damage and prevention of damage due to subsidence, Bumps and rock bursts-causes, occurrence, and control.

Text Books:

1. Rock Mechanics and Design of structures in rock, Obert & Duvall, ISBN: 978-0471192994.
2. Coal Mining Ground Control, Peng S.S., ISBN: 978-0470512277.

Reference Books:

1. Fundamental of Rock Mechanics, Jaeger and cook, ISBN: 978-0470015393.
2. Rock Mechanics and Ground Control, V. Singh & B.P. Khare, ISBN: 978-8187739557.

Web Links:

1. https://www.sciencedirect.com/science/article/pii/S1877705812045055
2. https://core.ac.uk/download/pdf/237427482.pdf
3. https://raiseandrelevel.com/how-to-prevent-ground-subsidence-in-residential-areas/

Minor Degree in Agricultural Engineering

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501AE82	Fundamentals of Renewable Energy Sources	FC	3			3	50	50	100	

2501AE83	Post-harvest Engineering of Cereal Crops	FC	3			3	50	50	100	
2501AE84	Ground Water Hydrology	FC	3			3	50	50	100	
2501AE85	Micro Irrigation Systems	IC	2			2	50	50	100	
2501AE86	Surface Water Hydrology (or) Land & Water Management Engineering	IC	3			3	50	50	100	GWH
2501AE87										
2501AE88	Agricultural Process Engineering & Food Quality (or) Post-harvest Engineering for Horticultural Produce	AC	3			3	50	50	100	PHECC
2501AE89										
2501AE90	Agricultural Machinery & Equipment (or) Design of Bio-energy systems	AC	3			3	50	50	100	FRES
2501AE91										
TOTAL			**20**			**20**				

Fundamentals of Renewable Energy Sources
(Common to All, Except AE)

	L	T	P	C
Course Code: 2501AE82	**3**	**0**	**0**	**3**

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

CO1: Explain the fundamental concepts of renewable energy.
CO2: Analyze the principles of solar energy and explore its various applications.
CO3: Describe wind energy conversion systems, including wind generators, and evaluate their power generation capabilities.
CO4: Analyze the processes involved in biogas production from biomass.
CO5: Explain the basic principles and operations of tidal energy, fuel cells, and geothermal energy systems.Explain the basic principles and operations of tidal energy, fuel cells, and geothermal energy

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	3	2	-	-	-	-	-	-	-
CO2	3	2	2	2	-	-	-	-	-	-	-
CO3	3	-	3	-	2	-	-	-	-	-	1
CO4	3	-	3	2	-	1	-	-	-	-	-
CO5	3	-	3	2	-	1	-	-	-	-	-

UNIT – I

Renewable energy sources: Different sources of renewable energy- concepts and limitations of different renewable energy sources (RES) as solar, wind, geothermal, biomass, ocean energy sources. Criteria for assessing the potential of RES. Comparison of renewable energy sources with non-renewable sources.

UNIT – II

Solar energy: Solar energy- energy available from sun, solar radiation data, solar energy conversion into heat through flat plate and concentrating collectors, different solar thermal devices, principle of natural and forced convection solar drying system. Solar photo voltaics-basics and applications, p-n junctions. Solar cells, PV systems, stand alone, grid connected solar power station. Calculation of energy through photovoltaic power generation and cost economics.

UNIT – III

Wind Energy: Wind energy- energy availability, general formula, lift and drag. Basics of wind energy conversion, effect of density, frequency variances, angle of attack, wind speed, types of windmill rotors, determination of torque coefficient, induction type generators. Working principle of wind power plant. Wind farms, aero-generators, wind power generation system.

UNIT – IV

Energy from Biomass: Biogas- basics of anaerobic digestion, types and constructional details of biogas plants, biogas generation and its properties, factors affecting biogas generation and

usages, design considerations, advantages and disadvantages of biogas spent slurry. Generation of power from biogas. Design & use of different commercial biogas plants.

UNIT – V

Other source of energy: Power generation from urban, municipal and industrial waste. Ocean thermal and electric power generation, wave and tidal power. Power generation from biomass (gasification & Dendro- thermal). Mini and micro hydel plants. Fuel cells and its associated parameters

Text Books:

1. Rai G D. Non-Conventional Energy Sources. Khanna Publishers, New Delhi. (ISBN:978-81-7409-073-8)
2. Basu P. Biomass Gasification and Pyrolysis Practical Design and Theory. Academic Press. (ISBN: 10-0123749883)

Reference Books:

1. Patel M R. Wind and Solar Power Systems. CRC Press, Bota Racon. (ISBN: 978-0849315701)
2. DeubleinD and SteinhauserA. Biogas from Waste and Renewable Resources. WILEY- VCH Verlag GmbH & Co. KGaA, Weinheim. (ISBN:9783527621705)

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_ch27/preview
2. https://www.vssut.ac.in/lecture_notes/lecture1428910296.pdf

Post-harvest Engineering of Cereal Crops

(Common to All, Except AE)

	L	T	P	C
Course Code: 2501AE83	**3**	**0**	**0**	**3**

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

- **CO1:** Explain the importance of different unit operations and working of size reduction equipments.
- **CO2:** Identify various methods for determining moisture content, EMC and drying.
- **CO3:** Compare separator equipments based on physical characteristics of grains and explain material handling devices.
- **CO4:** Explain the importance, design and working of milling equipments for cereals.
- **CO5:** Explain the importance, design and working of milling equipments for rice.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3	2	-	1	1	-	-	-	-	-
CO2	3	2	2	2	-	-	-	-	-	-	-
CO3	3	2	2	2	2	-	-	-	-	-	-
CO4	3	2	2	2	-	-	-	-	-	-	-
CO5	3	2	2	1	-	-	-	-	-	-	-

UNIT – I

Unit operations in grain processing: General unit operations in agricultural process engineering and importance of these unit operations in grain processing; Structure and composition of cereals. Cleaning and grading: Principles of cleaning, scalping, sorting and grading; Size reduction: Principle; Bond's law, Kick's law, Rittinger's law; Sieve analysis; Different classifications of size reduction machines; description of jaw crusher, hammer mill, attrition mill, and ball mill.

UNIT – II

Drying: Moisture content and water activity, free moisture, bound moisture and equilibrium moisture content, isotherm, hysteresis effect, EMC determination; Psychrometric chart and its use in drying; Drying principles and theory, thin layer and deep bed drying analysis, falling rate and constant rate drying periods, maximum and decreasing drying rate periods, drying equations, mass and energy balance, Shedd's equation; Drying methods (conduction, convection, radiation, batch, continuous); Different types of cereal grain dryers (bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray), tempering during drying; dryer performance.

UNIT – III

Separation and Material Handling: Screens, different types of screen separators, fixed and variable aperture screens, capacity and effectiveness of screens, sieve analysis; various types of separators as specific gravity, magnetic, disc, spiral, pneumatic, inclined belt draper, velvet roll separator, colour sorter, cyclone separator.
Basic parts of different types of conveyors and elevators, viz. belt, roller, chain, screw, and bucket elevator, cranes & hoists, pneumatic conveying, power requirement for conveying and elevating.

UNIT – IV

Milling of wheat, corn, pulses and oil seeds: Milling of wheat: unit operations and equipment; Milling of corn: unit operations and equipment in dry and wet milling methods; Milling of pulses: pre-conditioning, dry milling and wet milling methods, CFTRI and Pantnagar methods.

UNIT – V

Milling of Rice: Merits and demerits, changes during parboiling of rice, parboiling methods, viz. traditional methods, CFTRI method, Jadavpur method, pressure parboiling; different unit operations and equipment involved in traditional and modern rice milling methods; Preparation of rice products as rice flakes and puffed rice.

Text Books:

1. Unit Operations of Agricultural Processing, Sahay KM and Singh KK, Vikas Publishing House Pvt. Ltd., New Delhi. (ISBN-13. 978-8125911425)
2. Post-Harvest Technology of Cereals, Pulses and oil seeds, Chakraverty A, Oxford and IBH Publishing. Ltd., Calcutta.(ISBN-10. 9788120409699)

Reference Books:

1. Transport Processes and separation Process Principle, Geankoplis C J Prentice-HallInc., New Jersey.(ISBN-13. 9788120409699)
2. Unit Operations of Chemical Engineering, McCabe WL, Smith JC and Harriott P McGraw-Hill Book Co., Boston.(ISBN-13. 978-8184959635)

Web Links:

1. http://www.cigr.org/documents/CIGRHandbookVol4.pdf
2. http://ecoursesonline.iasri.res.in/course/view.php?id=22

Ground Water Hydrology

(Common to All, Except AE)

Course Code: 2501AE84	L	T	P	C
	3	0	0	3

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

CO1: Explain properties of various water bearing formations and movement of ground water.

CO2: Determine the aquifer properties under unsteady state and steady state subsurface flow conditions.
CO3: Explain design, development and construction of wells.
CO4: Analyze various water quality parameters and explain the occurrence of saline water intrusion.
CO5: Select appropriate method for exploration and replenishment of ground water.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	-	-	-	-	-	-	-	-	-	-
CO2	-	2	-	-	3	-	1	-	-	-	-
CO3	-	-	3	2	-	-	-	-	-	-	-
CO4	1	-	2	-	-	-	-	-	-	-	-
CO5	1	1	-	-	-	-	-	-	-	-	-

UNIT-I

Occurrence and Movement of Ground water: Introduction- Global water scenario; Water resources status in India; Origin and age of ground water; groundwater column, zones of aeration and saturation, Aquifer and its types; Aquifer characteristics.
Ground water movement: Darcy's law; Determination of Hydraulic conductivity; Ground water flow rates and directions; Ground water tracers, General flow equations through porous media.

UNIT-II

Well Hydraulics: Determination of aquifer parameters under steady/ unsteady, uniform/ radial flow to a well in a confined/ unconfined /leaky aquifer by different methods- Dupit Theim, Theis, Jacob and Chow's; Characteristic well losses; Specific capacity.

UNIT-III

Water Wells: Classification of wells; Methods of drilling of wells; Design and assembly of gravel packing; Installation of well screens; Common well drilling difficulties; Completion and development of well; Well Rehabilitation.

UNIT-IV

Ground water quality: Sources of salinity; Measures of water quality; Chemical, Physical and Biological analysis of ground water; Ground water samples; Water quality criteria; Occurrence of saline water intrusion- Ghyben-Herzberg relation between fresh and saline waters.

UNIT-V

Ground Water Investigations: Geological /geophysical exploration/ remote sensing / electric resistivity /seismic refraction-based methods for surface investigation of ground water, sub-surface ground water investigation through geophysical / resistivity; Methods of artificial recharge of ground water.

Text Books:

1. Groundwater, H.M. Raghunath, New Age International,3rd Edition. (ISBN: 978-8122419047)
2. Groundwater Hydrology, D.K. Todd, John Wiley and Son, New York, 2nd Edition. (ISBN: 9788126508365)

Reference Books:

1. Land and Water Management Engineering, V.V.N Murty and M.K Jha, Kalyani Publishers, 6th Edition. (ISBN: 978-9327214659)
2. Groundwater and tube wells, Garg S.P, Oxford and IBH publishing company limited, New Delhi.(ISBN: 8120408268)

Web Links:

1. http://nptel.ac.in/courses/105105042/
2. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=124667/

Micro Irrigation Systems

(Common to All, Except AE)

	L	T	P	C
Course Code: 2501AE85	**2**	**0**	**0**	**2**

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

CO1: Assess the adaptability, problems, and prospects of different types of sprinkler irrigation systems.

CO2: Plan and design the layout of sprinkler irrigation systems, including the hydraulic design of lateral, sub-main, and main pipelines, and select appropriate pumps and power units.

CO3: Evaluate the performance of sprinkler irrigation systems by analyzing water distribution patterns, overlapping of sprinklers and laterals, uniformity coefficient, and pattern efficiency.

CO4: Explain the types, components, and advantages and disadvantages of micro irrigation systems (drip, spray, and bubbler), and design effective drip irrigation systems considering wetting patterns and irrigation requirements.

CO5: Perform proper operation and maintenance of micro irrigation systems, addressing issues like clogging, filter cleaning, flushing, and chemical treatment, and apply fertigation techniques, understanding their benefits, limitations, and best practices.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	1	-	-	-	-	-	-
CO2	2	-	1	-	2	-	-	-	-	-	-
CO3	-	-	-	-	1	-	-	-	-	-	-
CO4	2	-	1	-	2	-	-	-	-	-	-
CO5	-	2	-	-	1	1	-	-	-	-	1

UNIT – I

Introduction to Sprinkler Irrigation Systems: Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems.

UNIT – II

Design and Components of Sprinkler Irrigation Systems: Design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; Selection of pump and power unit for sprinkler irrigation system.

UNIT – III

Performance Evaluation and Micro Irrigation Systems: Performance evaluation of sprinkler irrigation system: water distribution pattern and overlapping of sprinklers and laterals, uniformity coefficient and pattern efficiency; Micro Irrigation systems: types- drip, spray, & bubbler systems, merits and demerits, different components.

UNIT – IV

Design and Operation of Drip Irrigation Systems: Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection; Hydraulics of drip irrigation system, design steps; Necessary steps for proper operation of a drip irrigation system, maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment.

UNIT – V

Fertigation in Micro Irrigation Systems: Fertigation: advantages and limitations of fertigation, fertigation frequency, duration and injection rate, methods of fertigation.

Text Books:

1. Principles of Sprinkler Irrigation system, Mane M S and Ayare B L.Jain Brothers, New Delhi.(ISBN : 9788183601504)
2. Irrigation: Theory and Practice, Michael A M. ,Vikas Publishing, New Delhi. (ISBN:978-8125918677)

Reference Books:

1. Micro Irrigation - Theory and Practices, Suresh R, Standard Publishers Distributors, Delhi. (ISBN:9788180141508)
2. Sprinkler Irrigation, Sivanappan R K.,Oxford & IBH Publishing House, New Delhi. (ISBN:978-8120402324)

Web Links:

1. http://agritech.tnau.ac.in/agricultural_engineering/agriengg_swc_microirri_ferti.html
2. Course: Micro Irrigation Systems Design 3(2+1) (iasri.res.in)

Surface Water Hydrology

(Common to All, Except AE)

Course Code: 2501AE86	L	T	P	C
	3	0	0	3

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

CO1: Calculate the mean areal precipitation using various methods.
CO2: Explain rainfall characteristics and measuring devices in India.
CO3: Explain runoff and stream flow measurement methods.
CO4: Estimate the discharge volume of runoff using hydrographs and unit hydrographs.
CO5: Plan a reservoir using flood routing techniques for management of natural resources.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	-	-	-	-	-	-	-	-	-
CO2	2	1	-	-	2	-	-	-	-	-	-
CO3	2	1	-	-	2	-	-	-	-	-	-
CO4	2	-	-	2	3	-	-	-	-	-	-
CO5	1	2	-		3	-	-	-	-	-	-

UNIT-I

Precipitation: Hydrology-definition, hydrological cycle and its components. Forms of Precipitation, Characteristics of rainfall in India (types of monsoon). Measurement of Rainfall – Recording and Non-Recording Rain gauges- Rain gauge network density for different topographic conditions – Point rainfall analysis - Presentation of Rainfall data – Mass Curve and hyetograph, Mean Precipitation over an area –

Arithmetic Mean, Thiessen Polygon, Isohyetal methods, DAD Relationships and curves. Probability Analysis of Rainfall – Return Period, Plotting position by Weibull's method – Rainfall events at different probability levels (20%, 40%, 60%, and 80 %).

UNIT-II

Runoff: definition-components of runoff-direct runoff and base flow, overload flow and interflows, pictorial representation of different routes of runoff. Runoff characteristics of streams – perennial, intermittent and ephemeral streams. Definition and Estimation of peak runoff using rational method.
Stream flow measurement: Measurement of stream flows. Measurement of stage and velocities, staff gauge, wire gauge, automatic stage recorders, current meters (horizontal and vertical axis meters), calibration (V= a Ns + b). Rainfall-Runoff relations (R=a P + b), curve fitting and determination of 'a' and 'b' and (correlation coefficient). Intensity-Duration-Frequency-Relationship (i= ((KTx) / (D+A) n). Determination of net effective rainfall-infiltration indices- Phi index.

UNIT-III

Hydrographs: definition and components, factors affecting flood hydrographs, hydrograph separation for simple and complex storms – Method I, II and III. Unit Hydrograph-concept and the three implications of the definitions and the two basic assumptions. Effects of the characteristics of storms (duration of rain, time-intensity pattern, areal distribution of runoff and amount of runoff) on the shape of the resulting hydrographs. Derivation of Unit hydrographs for simple and complex storms.

Derivation of an average unit hydrographs from several storms of the same duration (proper procedure of computing average peak flow and time to peak).

UNIT-IV

Unit Hydrographs: The methods for conversion of unit hydrograph of different durations, (1) method of superposition and (2) S-curve. Concept of S-curve method, explanation application and determination of lower duration graph from the given higher duration graph and vice-versa. Concepts of Synthetic unit hydrograph, Snyder' synthetic unit hydrograph and formulas relating to hydrograph features (basin lag, Peak flow and time base of the unit hydrograph). Concept and application of Instantaneous unit hydrograph and SCS Triangular Hydrograph.

UNIT-V

Flood Routing: Flood Routing-introduction, two broad categories of flood routing and channel routing, hydrologic routing and hydraulic routing, basic equations. Hydrologic storage routing, Schematic representation of storage routing, modified Pul's method (semi-graphical method). Explanation of the features of the modified Pul's method. Flood routing through a reservoir by modified Pul's method. Applications of Hydrology in land and water management, watershed management, Flood mitigation, Floodplain mapping, Retards, Flood control and Regulation.

Text Books:

1. Engineering Hydrology, Raghunath H.M., Willey Eastern Limited, New Delhi, 3rd Edition. (ISBN: 978-9393159045)
2. Watershed Hydrology, Suresh R., Standard Publisher and Distributors, New Delhi. (ISBN: 978-8186308233)

Reference Books:

1. Engineering Hydrology, Subramanyam K., Tata Mc. Graw – Hill PublishingCo., Limited, New Delhi.(ISBN: 978-1259029974)
2. Hydrology for Engineers, Linsley R.K. Kholer A. & Paul Hus J.L.H., Mc-Graw Hill Book Co. New Delhi. (ISBN-13. 978-0070379565)
3. Watershed Management, Dhruvanarayana, VV., ICAR Publication, New Delhi. (ISBN: 978-8120346765)

Web Links:

1. http://www.nptelvideos.in/2012/11/advanced-hydrology.html
2. https://www.slideshare.net/MohammedSalahat1/chapter-3-surface-water-hydrolo
3. https://theconstructor.org/water-resources/types-of-rain-gauges/12801/
4. http://nptel.ac.in/downloads/105101002/

Land & Water Management Engineering

(Common to All, Except AE)

	L	T	P	C
Course Code: 2501AE87	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Apply methods for assessing and mitigating soil erosion to enhance soil conservation and sustainable land management.

CO2: Design, implement, and evaluate various water erosion control measures, incorporating both agronomical and engineering approaches to enhance soil conservation and land sustainability.

CO3: Apply energy and momentum principles in open channels, design soil erosion control structures, and implementing permanent gully control structures, ensuring hydrologic, hydraulic, and structural integrity.

CO4: Demonstrate wind erosion control measures, land use capability classification and sedimentation of reservoirs.

CO5: Classify water harvesting techniques, design and construct various structures such as farm ponds and percolation ponds, and apply design considerations for nala bunds.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2	-	-	2	3	-	2	1	2
CO2	2	3	3	-	-	2	3	-	2	1	2
CO3	2	3	3	-	-	2	3	-	2	1	2
CO4	2	2	-	-	-	-	2	-	-	-	-
CO5	2	2	2	-	-	-	2	-	-	1	-

UNIT – I

Soil Erosion: Causes, Types, Mechanisms, and Measurement

Soil erosion: introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion; Water erosion: mechanics and forms- splash, sheet, rill, gully, ravine and stream bank erosion; Gullies: classification, stages of development; Soil loss estimation– Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity- estimation by KE>25 and EI30 methods; Soil erodibility- topography, crop management and conservation practice factors; Measurement of soil erosion- Runoff plots, soil samples.

UNIT – II

Water Erosion Control Measures and Techniques

Water erosion control measures- agronomical measures, contour farming, strip cropping, conservation tillage and mulching; Engineering measures- bunds and terraces, bunds: contour and graded bunds- design and surplussing arrangements; terraces: level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stone wall and trenching; Gully and ravine reclamation- principles of gully control, vegetative measures, temporary structures and diversion drains. Grassed waterways and design.

UNIT – III

Hydraulic Principles and Soil Erosion Control Structures

Energy and momentum principles in open channels; specific energy and specific force, hydraulic jump and its application, types of hydraulic jump, energy dissipation due to the jump; Soil erosion control structures- introduction, classification and functional requirements. Permanent structures for soil conservation and gully control- check dams, drop, chute and drop

inlet spillways- design requirements, planning for design, design procedures- hydrologic, hydraulic and structural design and stability analysis.

UNIT – IV

Wind Erosion and Sedimentation Control in Agriculture
Wind erosion- factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes; Land capability classification, dryland farming; Rate of sedimentation, silt monitoring and storage loss in tanks, control of sedimentation in reservoirs.

UNIT – V

Water Harvesting Techniques and Structures for Agricultural Use
Water harvesting techniques- classification based on source, storage and use, runoff harvesting- short- term and long-term techniques; Structures- farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes; Farm pond- components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction; Percolation pond - site selection, design and construction details. Design considerations of nala bunds.

Text Books:

1 Open-Channel Hydraulics, Chow V T, McGraw- Hill Book Company, Inc.**(**ISBN: 9780070107762)
2 Manual of Soil and Water Conservation Practices, Singh. G., Venkataraman C, Sastry G and Joshi B P., Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.(ISBN: 978-8120405523)

Reference Books:

1 Land and Water Management Engineering, Murthy V V N., Kalyani Publishers, New Delhi,4th Edition, (ISBN: 978-9327214659)
2 Principles of Agricultural Engineering, Michael A M and Ojha T.P, Volume II. Jain Brothers, New Delhi, 4th Edition. (ISBN: 978-8183601849)

Web Links:

1 Course: Soil & Water Conservation Engg. 3(2+1) (iasri.res.in)
2 Soil-and-Water-Conservation-Engineering.pdf (agrimoon.com)

Agricultural Process Engineering & Food Quality

(Common to All, Except AE)

	L	T	P	C
Course Code: 2501AE88	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Explain the functions of various unit operations and working of size reduction equipments for processing of fibrous and dry size reduction in processing of agriculture produce.

CO2: Explain the design and working of mixing equipments for powder, high and low viscosity liquids.

CO3: Classify separator equipment based on physical characteristics of grains.

CO4: Identify various methods for determining moisture content, EMC and drying process.

CO5: Explain the importance, design and working of milling and material handling devices, food quality control, food laws, food standards and HACCP.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	1	1	-	-	-	-	-	-	-
CO2	3	1	2	2	-	-	-	-	-	-	-
CO3	3	2	1	2	-	-	-	-	-	-	-
CO4	3	1	1	1	-	-	-	-	-	-	-
CO5	3	2	2	2	-	-	-	-	-	-	-

UNIT-I

Unit operation in agricultural Processing: Scope and importance crop processing – principles and methods of food processing,cleaning, grading, screening, scalping, sorting, size reduction, mixing, separation, drying, storage, milling, material handling, packaging, baking.

Size reduction: Size reduction –principle of comminution/size reduction, particle shape, average particle size, crushing efficiency. Determination and designation of the fineness of ground material, screen analysis, Empirical relationships (Rittinger's, Kick's and Bond's equations) and related problems. Size reduction equipment – Crushers (Jaw crusher, Gyratory crusher, Crushing rolls), Grinders (Attrition mill, Hammer mill, Ballmill), Fine grinders (Rietz mill or disintegrator, Dispersion and colloid mills) and Cutting machines (Rotary knife cutter).

UNIT-II

Mixing: Mixing –Introduction, theory of solids mixing, Mixing of low and moderate viscosity liquids (paddle mixer, turbine mixer, propeller mixer) its applications. Mixing of high viscosity liquids, pastes and plastic solids (pan mixer, kneaders) its applications. Mixers for dry powders and particulate solids (Horizontal screw and ribbon mixer,Vertical screw mixer, Tumbling mixer) and its applications, mixing index,

Separator units: Theory of separation, types of separators, separator based on length, width,

shape of the grains, specific gravity, density, cyclone separators, Pneumatic separator. Air-screen grain cleaner principle and types, Design considerations of air-screen grain cleaners, Sieve analysis- particle size determination, Ideal screen and actual screen– effectiveness of separation and related problems

UNIT-III

Drying: Moisture content and its representation (wet basis, dry basis), methods for determination moisture content (direct and indirect methods) and related problems, Importance of EMC and methods of determination (static-dynamic methods), EMC models, hysteresis effect, bound, unbound and free moisture. Principles of drying, theory of diffusion, mechanism of drying, falling rate, constant rate period, thin layer,deep bed dying methods, Effect of different factors on the drying process, types of dryers.

UNIT-IV

Milling and Material handling devices: Rice milling, principles and equipments, paddy parboiling methods and milling equipment, milling of pulses and oilseeds. Scope and importance of material handlingdevices, Belt Conveyor– idlers, idler spacing, belt tension, Bucket elevator– classification, operation, capacity, drive mechanism, advantages and disadvantages.
Screw conveyor – Principle of operation, capacity, and power requirement. Pneumatic conveying system- types, limitations of pneumatic conveying system

UNIT-V

Food Quality: Concept, objectives and importance. Sensory evaluation or organoleptic evaluation of food quality, Food laws and regulations in India. Food gradeand standards –BIS, AGMARK, PFA, FPO. Hazard analysis and critical control point (HACCP) – objectives, principles, Steps involved in implementation of HACCP

Text Books:

1. Unit Operations of Agricultural Processing, Sahay KM and Singh KK, Vikas Publishing House Pvt. Ltd., New Delhi. (ISBN: 978-8125911425)
2. Post-Harvest Technology of Cereals, Pulses and oil seeds, Chakraverty A,Oxford and IBH Publishing. Ltd., Calcutta. (ISBN: 978-8120409699)
3. Unit operations in Food processing, Earle R L, Pergamon Press, New York. (ISBN: 978-0080255361)

Reference Books:

1. Transport Processes and separation Process Principle, Geankoplis C J Prentice-HallInc., New Jersey. (ISBN:978-0134181028)
2. Unit Operations of Chemical Engineering, McCabe WL, Smith JC andHarriott PMcGraw-Hill Book Co., Boston.(ISBN: 978-0072848236)

Web Links:

1. http://www.cigr.org/documents/CIGRHandbookVol4.pdf

2 http://www.rpaulsingh.com/Learning and teaching resources

3 http://ecoursesonline.iasri.res.in/course/view.php?id=22

4 https://moodle.ufsc.br/pluginfile.php/772348/mod_resource/content/0/UnitOperations_in_Food_Engineering_-_A._Ibarz_G._BarbosaCanovas_CRC_2003_WW.pdf

5 http://www.nzifst.org.nz/unitoperations/matlenerg2.htm

Post-harvest Engineering for Horticultural Produce

(Common to All, Except AE)

	L	T	P	C
Course Code: 2501AE89	**3**	**0**	**0**	**3**

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

CO1: Explain about various properties and factors affecting quality of fruits and vegetables.
CO2: Classify various post harvest operations involved in horticulture processing.
CO3: Identify various preservation techniques for processed foods.
CO4: Apply the advanced packaging technology in food preservation.
CO5: Categorize different beverages based on method of preparation and explain the procedure for extraction of oleoresins and essential oils.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11
CO1	3	2	2	2	-	-	-	-	-	-	-
CO2	3	1	1	1	-	-	-	-	-	-	-
CO3	3	2	2	2	-	-	-	-	-	-	-
CO4	3	2	2	2	-	-	-	-	-	-	-
CO5	3	1	1	1	-	-	-	-	-	-	-

UNIT-I

Properties of Fruits and Vegetables: Engineering properties of fruits and vegetables - physical, aerodynamic, rheological and thermal properties. Electrical properties- Near Infrared reflectance (NIR), radiation, dielectric properties and optical properties: Light transmittance, Light reflectance, machine vision. Quality parameters of fruits and vegetable for processing: sensory, biochemical and nutritional characteristics.
Factors affecting fruits and vegetables quality: Pre-harvest factors, environmental factors, cultural factors and post-harvest factors. Harvesting indices of different horticultural produce, modern techniques for determination of harvesting indices. Handling and transportation of fruits and vegetables. Determination of quality parameters for fruits and vegetables: aroma, fruit ripening, leaf changes, firmness, juice content, sugar content, skin color, total soluble solids, pH and acidity.

UNIT-II

Post-Harvest Operations: Cleaning of fruits & vegetables: soaking, rinsing, sanitizing, washing methods: agitating, spraying water, wet and dry brushing, chemical washing. Peeling of fruits and vegetables: hand peeling, mechanical peeling, peeling by heat treatment and lye peeling. Grading of fruits & vegetables, factors affecting grading, types of graders: screen grader, roller grader, rope and cable type grader and weight grader. Canning of fruits & vegetables: grading, washing, peeling, cutting, blanching, cooling, filling, syruping/brining, exhausting, sealing, retorting, cooling, storage, labeling. Cans making, causes of spoilage of canned foods.

UNIT-III

Principles of Preservation of Fruits & Vegetables: Asepsis, preservation by high temperature: pasteurization, flash pasteurization, sterilization. Chemical preservation with sulphur dioxide and benzoic acid, advantages, disadvantages. Drying and dehydration of fruits & vegetables (flow chart), types of dryers: cabinet dryer, tray dryers, tunnel dryer, freeze drying. Rehydration, ratio of rehydration coefficient. Freezing: Definition and methods - slow freezing, quick freezing and IQF, advantagesand disadvantages. Types of freezing - direct immersion, indirect contact with refrigerant, air blast, cryogenic and de-hydro freezing. Cooling methods - pre-cooling, room cooling, hydro cooling, refrigerated trucks.

UNIT-IV

Packaging of Horticultural crops: Controlled atmospheric storage (CAS), factors effecting on CAS, additional benefits, limitations, maintaining CAS, modified atmosphere storage/packaging (MAS/MAP), maintenance of MAP, active modification, passive modification, requirements of fresh fruits package under CAS orMAS. Packaging of fruits and vegetables, advantages and disadvantages. Packaging materials: cellophane, poly vinyl chloride, polyethylene, ethyl vinyl alcohol. Packaging of horticultural crops.

UNIT-V

Preparation and Preservation of Beverages: Preservation of unfermented fruit beverages: apple juice, grape juice, pineapple juice, citrus juice, mango juice with all flow sheets. Fermented beverages: wine, grape wine with all flow charts. Preparation of vinegar - alcoholic fermentation and acetic acid fermentation.
Oleoresin and Essential Oil Extraction: Turmeric oleoresin and chilli oleoresin. Solvents used for oleoresin extraction, advantages and disadvantages. Extraction of essential oil from spices by steam distillation.

Text Books:

1. Food Science by Potter N. and Hotchkiss J. H, An Aspen Publication, 5th Edition. (ISBN:978-8123904726)
2. Fruits and Vegetable Preservation: Principles and Practices, Srivastava, R.P. & Kumar, S. CBS Publishing, 3rd Edition. (ISBN: 978-8123924373)
3. The Complete Technology Book on Processing, Dehydration, Canning, Preservation of Fruits & Vegetables by NIIR Project Consultancy Services, 3rd Edition. (ISBN: 978-9381039694)

Reference Books:

1. Fruits: Tropical and subtropical, Bose T. K & Mitre, S. K. Naya Prakash, 3rd Edition. (ISBN: 978-8185971810)
2. Fruits and Vegetable processing, Bhatti, S. and Varma U., CBSPublishers, 1st Edition. (ISBN: 978-8123904047)
3. Food Processing and Preservation, Sivasenkar, B., CBS Publications. (ISBN:

978-8120320864)

Web Links:

1. http://www.rpaulsingh.com/animations/animaitons_master3.html
2. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=1098
3. https://onlinecourses.nptel.ac.in/noc18_ar08/preview

Agricultural Machinery & Equipment

(Common to All, Except AE)

Course Code: 2501AE90	L	T	P	C
	3	0	0	3

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

CO1: Explain the process of selection, cost estimation and methods of ploughing of farm mechanization.
CO2: Calculate the forces acting on tillage implements.
CO3: Explain inter-culture equipments and understand the sowing, planting and transplanting operation with various implements used for these operations.
CO4: Explain the harvesting and threshing operation with various implements used for these operations.
CO5: Explain the operation of grain combines harvesting mechanism.

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	-	-	2	2	-	-	-	-	-	1
CO2	-	1	-	-	3	-	-	-	-	-	2
CO3	3	-	-	-		-	-	-	-	-	-
CO4	3	-	-	-	1	-	-	-	-	-	-
CO5	3	1	-	-	-	-	-	-	-	-	-

UNIT-I

Introduction to farm mechanization: Classification of farm machines. Introduction to materials used in construction of farm machines. Heat treatment processes and their requirement in farm machines. Selection of farm machinery and cost estimation. Hitching systems and controls of farm machinery. Introduction to seed-bed preparation. Familiarization with land reclamation and earth moving equipment. Methods of Ploughing.

UNIT-II

Tillage Practices: Definition, primary tillage, secondary tillage, rotary tillage, deep tillage, minimum tillage and conservation tillage. Draft measurement of tillage equipment, Identification and major functional components of mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators, levelling, Forces acting on tillage implements. Cost of operation of farm machinery.

UNIT-III

Introduction to inter-culture equipments: Weeder – manual and powered, main components and their functional requirement.
Introduction to sowing, planting & transplanting equipment: Study of working of

seed drills, no-till drills, happy seeder and strip-till drills. Brief description and working of planters. Study of types of furrow openers and metering systems in drills and planters. Calibration of seed-drills/ planters. Adjustments during operation. Introduction to plant protection equipment – sprayers and dusters.
Classification of sprayers. Types of nozzles. Calculations for calibration of sprayers and chemical application rates.

UNIT-IV

Study of harvesting operation – methods and terminology. Study of Reapers, Mowers and windrowers – types, working and adjustments. Introduction to threshing systems – manual and mechanical systems. Types of threshing drums and their applications. Types of threshers- tangential and axial, factors affecting thresher performance. Chaff cutters and capacity calculations.

UNIT-V

Study of grain combines (Wheat and Paddy) - Combine terminology, Computation of combine losses, study of combine troubleshooting. Study of Root crop diggers –potato and groundnut. Cotton harvesting mechanisms, study of cotton pickers and strippers. Introduction to vegetables and fruit harvesting equipment and tools.

Text Books:

1. Principles of Agricultural Engineering (Vol. II). A. M. Michael and T.P. Ojha, Jain brothers, New Delhi. (ISBN: 8183601849)
2. Principals of Farm Machinery, R.A. Kepner, Bainer Roy, and E.C. Barges, Publishers and Distributors, Delhi-17. (ISBN: 8123909772)
3. Theory, Construction and Calculation of Agricultural Machines (Vol. 1 and 2), Bosoi, E.S., Oxonion Press Pvt. Ltd., New Delhi. (ISBN: 9383692378)

Reference Books:

1. Agricultural Machines, Theory and Construction (Vol. 1 & 2). Kanafoshi, C.Z. and Karwawshi T. (ISBN: 9388399838)
2. Agricultural Machines, Kelnin, N.I.,Popov, I.F., and Sakun, V.A Amerind Publishers, New Delhi. (ISBN: 978-9061914488)

Web Links:

1. https://nptel.ac.in/courses/126/105/126105009/
2. http://www.hillagric.ac.in/edu/coa/agengg/lecture/243/agriengg-243.htm

Design of Bio-energy systems
(Common to All, Except AE)

	L	T	P	C
Course Code: 2501AE91	**3**	**0**	**0**	**3**

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

- **CO1:** Comprehend Biomass Sources and Fermentation Processes
- **CO2:** Explore Biomass Production and Preparation
- **CO3:** Analyze Biomass Conversion Technologies
- **CO4:** Evaluate Biofuel Production Processes and Applications
- **CO5:** Assess Environmental and Economic Aspects of Bio-Energy

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	-	-	-	2	3	-	-	-	-
CO2	3	2	-	1	-	2	-	-	-	-	-
CO3	2	1	-	-	-	2	3	-	-	-	-
CO4	2	1	-	-	-	3	1	-	-	-	-
CO5	2	1	-	-	-	3	1	-	-	-	-

UNIT – I

Biomass sources and characteristics. Fermentation processes and its general requirements. Aerobic and anaerobic fermentation processes and their industrial applications. Heat transfer processes in anaerobic digestion systems.

UNIT – II

Biomass production- wastelands, classification and their use through energy plantation. Selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Biomass preparation techniques for harnessing (size reduction, densification and drying).

UNIT – III

Bio-energy :Properties of biomass and conversion technologies, pyrolysis of biomass to produce solid, liquid and gaseous fuels. Biomass gasification, types of gasifiers, various types of biomass cook stoves for rural energy needs.

UNIT – IV

Thermo-chemical degradation: History of small gas producer engine system. Chemistry of gasification. Producer gas- type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Applications, shaft power generation, thermal application and economics.

UNIT – V

Trans-esterification for biodiesel production and application in CI engines. production process, properties and application of ethanol. Bio-hydrogen production routes. Environmental aspect of bio-energy. Assessment of greenhouse gas mitigation potential. Cost economics of bio-energy systems.

Text Books:

1. Biomass Gasification, Pyrolysis and Torrefaction, Basu P, Academic Press, 2018. (ISBN: 10-10128129921)
2. Renewable Energy Academy Training wood energy professionals,Butler S. (ISBN: 13-978-0128129920)

Reference Books:

1. The Biodiesel Handbook, Knothe G, Gerpen J V, Krahl J. (Eds.), AOCS Press. (ISBN: 9781893997622)
2. Non-Conventional Energy Sources, Rai G D,Khanna Publishers, New Delhi. (ISBN: 978-8174090737**)**

Web links:

1. https://elearning.icar.gov.in/
2. https://saveetha.ac.in/images/sec/2021/Syllubus/Agriculture/19AG423-_BIO-ENERGY_SYSTEM_DESIGN_AND_APPLICATIONS.pdf

Minor Degree in Entrepreneurship Development & Incubation

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
2501MB07	New Product Development	FC	3			3	50	50	100	-
2501MB08	Entrepreneurship & Small Business Management	IC	2			2	50	50	100	-
2501MB09	Insurance & Risk Management	IC	3			3	50	50	100	-
2501MB10	Change & Innovations Management	IC	3			3	50	50	100	-
2501MB11	Personal Financial Planning (or) E-Business management	IC	3			3	50	50	100	-
2501MB12										
2501MB13	Business Policy & Strategic Management (or) Green Marketing	AC	3			3	50	50	100	-
2501MB14										
2501MB15	Startup Management (or) Venture Management	AC	3			3	50	50	100	-
2501MB16										
TOTAL			**20**			**20**				

New Product Development
(Common to All)

Course Code: 2501MB07	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- **CO1:** To learn how to develop and implement a new product or service to an existing and potential target market.
- **CO2:** Understand the importance of new product development to firm performance
- **CO3:** To help the student to prepare a Business Plan for a new product or service.
- **CO4:** Learn methods of generating, evaluating and testing product ideas.
- **CO5:** Understanding the impact of intellectual property and patents on new product development and management

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	-	1	-	-	-	-
CO2	-	-	-	-	-	-	-	1	1	-	-
CO3	-	-	-	-	-	-	-	2	-	-	-
CO4	-	-	-	-	-	-	3	-	-	-	-
CO5	-	-	-	-	-	-	2	-	-	-	-

UNIT – I

Introduction- Types of products – Product development - Factors contributing to New Product Development - New product development process – product life cycle in theory and practice - Invention Vs Innovation.

UNIT – II

StrategicPlanningforNewProduct-Sourcesofnewproductideas-Generation of ideas - Criteria for screening –understanding customer needs – need assessment based on secondary and primary research - Concept generation

UNIT – III

BusinessAnalysis–Purpose,StagesofBusinessanalysis-Marketpotentialand Demand - Estimating first time sales - Replacement Sales - Repeat Sales - Estimating costs, Sales and Profit – Business plan preparation

UNIT – IV

Product testing - Test Marketing, its advantages and disadvantages - Test marketing strategies - Launch cycle - Managing Growth and Maturity - Commercialization

UNIT – V

Defining Intellectual Property and Patents–Patent application–ownership and transfer of patent – infringements - The future of New Product management – Contemporary issues

Text Books:

1. Product Management in India, Ramanuj Manjumdar, Prentice Hall Publication, 3rd Edition, ISBN: 9788120312524.
2. Business plan template and example: How to write a Business Plan, Alex Genadinik, ISBN: 9781519741783.

Reference Books:

1. Production design and Development, Karl T Ulrich, Steven D. Eppinger and Amita Goyal, Tata Mc GrawHill, 5th Edition, ISBN: 9781260566437.
2. New Products Management,Crawford, Merle and Di Benedetto, Anthony, McGraw-Hill/Irwin, 10th Edition, ISBN: 9781260575088.

Web Links:

1. https://www.youtube.com/watch?v=QxQfAw1049M
2. https://ocw.mit.edu/courses/15-783j-product-design-and-development-spring-2006/resources/clas7_cncpt_genr/

Entrepreneurship & Small Business Management

(Common to All)

Course Code: 2501MB08	L	T	P	C
	2	0	0	2

Course Outcomes:

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

- **CO1:** Explain the nature of entrepreneurship and how it relates to small business.
- **CO2:** Develop and demonstrate competence in basic business and marketing planning
- **CO3:** Explain factors related to readiness for entrepreneurship and getting started in entrepreneurship career.
- **CO4:** Identify the factors affecting choice of a business location and explain how layout of physical facility and equipment could lead to efficiency
- **CO5:** Explore techniques for improving quality and productivity.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	-	-	3	-	-	-
CO2	-	-	-	-	-	-	-	-	1	-	-
CO3	-	-	-	-	-	-	-	2	-	-	-
CO4	-	-	-	-	-	-	1	-	-	-	-
CO5	-	-	-	-	-	1	-	-	-	-	-

UNIT – I

Fundamentals of Business: Forms of business organization, Small-scale industrial undertakings with particular reference to India, and Government incentives for entrepreneurial ventures.

UNIT – II

Business Model and Business Plan: Business plan, Business description, Business environment analysis, SWOT analysis, Competitor analysis, Market analysis, and Marketing, Operations and Financial plan.

UNIT – III

Funding new ventures: Fixed and working capital needs, Capital structure, Public and private sources of capital, Equity and debt financing, Terms loans, Private placements, Project finance, Miscellaneous sources, Special institutional schemes, Venture capital.

UNIT – IV

Launch of a Startup: Location, Facility planning, Resource acquisition, Business operations, Costing and pricing of product/service, and Marketing strategy.

UNIT – V

Managing and Growing the Enterprise: Transition to managerial approach and Functions of Management; Operations, quality and productivity management; Market segmentation, Product positioning.

Text Books:

1. Entrepreneurship and Small Business Management, Dr.P.T.Vijayshree & Dr. M.Alagammai, Margham Publication, 2021
2. Essentials of Entrepreneurship and Small Business Management, M. Scarborough , Jeffrey R. Cornwell, Pearson Education, ISBN: 9780134741086.

Reference Books:

1. Entrepreneurship And Small Business, Dr. B. K. Mehta, Prof. R. C. Agarwal, SBPD Publishing House 1st Edition, ISBN: 9789350470688.
2. Entrepreneurship And Small Scale Business, Sanjeet Sharma, VK Global Publications Pvt Ltd, 1 January 2020, ISBN: 9780000861917.

Web Links:

1. http://digimat.in/nptel/courses/video/110106141/L06.html
2. https://www.coursera.org/learn/fundamentals-of-management

Insurance & Risk Management

(Common to All)

Course Code: 2501MB09	L	T	P	C
	3	0	0	3

Course Outcomes:

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

- **CO1:** Identify and assess various types of risks, and develop strategies to mitigate or manage them.
- **CO2:** Explain the principles of insurance, including types of insurance, policy terms, and claims processing.
- **CO3:** Conduct risk assessments and analyses to determine potential losses and develop strategies to minimize them.
- **CO4:** Develop and implement risk management strategies, including risk avoidance, transfer, mitigation, and acceptance.
- **CO5:** Understand the differences between personal and commercial insurance, including types of policies and coverage.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	1	-	-	-	1	-
CO2	-	-	-	-	-	-	2		2	-	-
CO3	-	-	-	-	-	-		2		-	-
CO4	-	-	-	-	-	-	2	-	-	-	-
CO5	-	-	-	-	-	-	1	-	-	-	-

UNIT – I

Insurance: Concept, Nature of Insurance, Functions of Insurance, Importance of Insurance, Principles of Insurance Contract; Features of Life and Non-life Insurance.

UNIT – II

Insurance and IRDA: IRDA Act 1999, Provisions, Duties, Powers and Functions of IRDA.

UNIT – III

Risk and risk management process - Concept of risk, risk vs. Uncertainty, types of risks, risk identification and evaluation.

UNIT – IV

Risk management objectives-selecting and implementing risk management techniques. Commercial risk management applications.

UNIT – V

property, liability, commercial property insurance, different policies and contracts– business liability and risk management.

Text Books:

1. Life and Health Insurance, Black K. Jr., Skipper. H. D. Jr, Pearson Education, ISBN: 9780138912505.
2. Insurance in India, Response Books, Palande P.S., Shah R.S. and Lunawat M.L., Sage Publications Ltd, ISBN: 9780761997481.

Reference Books:

1. Insurance and Risk Management, Gupta, P.K., Himalaya Publishing House, New Delhi, ISBN: 978-9350246726.
2. Business Policy And Strategic Management, Vipin Gupta, Kamala Gollakota, R. Srinivasan, Phi Learning Pvt. Ltd, ISBN: 9788120328624.

Web Links:

1. https://archive.nptel.ac.in/courses/110/105/110105160/
2. https://ocw.mit.edu/courses/15-997-practice-of-finance-advanced-corporate-risk-management-spring-2009/resources/mit15_997s09_lec01_3/

Change & Innovations Management

(Common to All)

Course Code: 2501MB10	L	T	P	C
	3	0	0	3

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

- **CO1:** Understand innovation, innovative models and implementing those Models in organization.
- **CO2:** Understand Intervention techniques and implement it effectively at the workplace.
- **CO3:** Appreciate resistance-to-change, and strategies to overcome those resistances.
- **CO4:** Enable learners with in-depth understanding of individual, team, work-group or organizational interventions to work successfully.
- **CO5:** Develop and Enhance Competencies to use the Innovative and Change Management techniques effectively at workplace.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	-	-	2	-	1	-
CO2	-	-	-	-	-	-	-	-	3	-	-
CO3	-	-	-	-	-	-	-	2		-	-
CO4	-	-	-	-	-	-	1	-	-	-	-
CO5	-	-	-	-	-	2	-	-	-	-	-

UNIT – I

Defining innovation, understanding the role of innovation,Understanding innovation, innovation and organizational performance, Understanding how to use innovation as strategy, Defining exploration vs. exploitation in innovation, and Defining disruptive, destructive, and displacement innovation.

UNIT – II

Frameworks for Creating Innovation & The Product Development Process: Identifying and understanding the sources of innovation, Defining and discussing a standard PDP phase gate methods vs. spontaneous methods for managing innovation and product development, Leading practices designed to foster creativity, open innovation vs. closed innovation, Understanding internal barriers to innovation and how to best address resistance, and Assessing the strategic and financial impact of innovation.

UNIT – III

Leading Innovation & Change: How to form innovation teams, Understanding team behavior & dynamics, How to manage innovation teams for high-performance results, How to best measure team performance, Discussion various tips & traps for leading innovation, Factors and considerations in selecting team members and managing innovation teams.

UNIT – IV

Implementation consideration in using incubators and accelerators, Understanding how and when to use DARPA, "Skunk Works," and Accelerators for innovation, How to identify, assess and address organizational, legal, and cultural impediments to innovation, Assessing environmental factors and how they affect innovation.

UNIT – V

Social Implications of Innovation: Understanding how innovation and society interact, Examining ethical issues of innovation, Determining the role of social entrepreneurship and innovation Creating social innovation.

Text Books:

1. Managing change, bernard burnes, seventh edition, pearson education, 30 june 2020, ISBN: 9780273033769.
2. Change Management for Beginners, Steffen Lobinger, Tim Ongpublisher,2021, ISBN: 9781687022622.

Reference Books:

1. Innovation Management: Strategies,Concepts and Tools for Growth and Profit, Shlomo Maital , D V R Seshadri , SAGE Publications Pvt. Ltd, ISBN-13: 9788132107224.
2. Managing Innovation and Change, David Mayle, SAGE Publications, ISBN: 9781412922500.

Web Links:

1. https://hits.digimat.in/nptel/courses/video/110107094/L31.html
2. https://ocw.mit.edu/courses/15-351-managing-innovation-and-entrepreneurship-spring-2008/resources/01_intro/

Personal Financial Planning
(Common to All)

	L	T	P	C
Course Code: 2501MB11	**3**	**0**	**0**	**3**

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

- **CO1:** To provide basic principles for managing personal finance.
- **CO2:** To help individual learn investment decisions
- **CO3:** Identify and describe various types of risk associated with investments, such as market risk, credit risk, liquidity risk, and operational risk.
- **CO4:** Calculate interest, dividend, and capital gains on personal investments, including bonds, stocks, and mutual funds.
- **CO5:** To mitigate old age financial planning.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	-	-	-	-	-	1
CO2	-	-	-	-	-	-	2	-	-	-	-
CO3	-	-	-	-	-	-	-	2	-	-	-
CO4	-	-	-	-	-	-	3	-	-	-	-
CO5	-	-	-	-	-	1	1	-	-	-	-

UNIT – I

Basics of Personal Financial Management: Basics of Personal Financial Management: Budget, The Personal Financial Planning Process, Preparation of Personal Budget, Personal Financial Statements, Personal Income Tax Planning. Case studies on personal financial planning of individuals.

UNIT – II

Personal Savings & Investment: Investment Criteria- liquidity, safety and profitability. Savings instruments of Post Office and Banks. Chit Funds. Investment in Shares, Debentures, Corporate and Government Bonds, Mutual Fund. Investment in Physical Assets – Real Estate, Gold and Silver, Gold certificates.

UNIT – III

Risk and Return associated with these investments: Case studies on risk and return perception of retail investors on various investments.

UNIT – IV

Computation of Return and Risk of Personal Investment: Present Value and Future Value of a Single Amount and an Annuity. Computation of interest, dividend and capital gains on personal investments. Impact of leverage on return. Personal tax planning.

UNIT – V

Retirement Savings Plans: Retirement Savings Plans: Gratuity plans from the government. Life Insurance types. Health insurance. Pension Plans- Defined Contribution Plan and Defined Benefit Plan. Provident Fund, Gratuity. Life Insurance Plans. General Insurance Plans. Reverse Mortgage Plans.

Text Books:

1. Personal Financial Planning, CS Monika Saini, Dr. Neerza, Scholar Tech Press, 1 January 2024.
2. Personal Financial Planning, Dr Shalu Garg, Sultan Chand & Sons, 1 January 2024, ISBN: 9780357987872.

Reference Books:

1. 5 W's of Financial Planning: Master the Art of Personal Finance Strategy, Dr Vimal Krishna Rajput, Sultan Chand & Sons 5 November 2021, ISBN: 9781685388850.
2. Personal Financial Planning, Dr kamal Garg, Sultan Chand & Sons, 1 January 2020.

Web Links:

1. https://archive.nptel.ac.in/courses/122/106/122106031/
2. https://www.coursera.org/learn/fundamentals-of-management

E-Business Management
(Common to All)

L	T	P	C

Course Code: 2501MB12 **3 0 0 3**

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

CO1: Explain the concept and significance of e-business.
CO2: Evaluate and select appropriate hardware and software components for e-business.
CO3: Apply e-business technologies to enhance marketing strategies.
CO4: Design hybrid distribution networks that optimize cost and customer experience.
CO5: Understand the role of smart cards in payment systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	-	-	1	-	-	1
CO2	-	-	-	-	-	-	-	-	-	1	-
CO3	-	-	-	-	-	-	-	-	2	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	2	-	-	-	-

UNIT – I

Introduction Concept of e-business: Nature, scope, and impact of e-business; Difference between e-business and ecommerce; History and development of e-business; Advantages of e-business; Business models for e-products and e-services

UNIT – II

Technologies in e-business Introduction: e-business technologies - hardware, e-business software applications, internet and World Wide Web; Database management system; e-business security; Online payment technology

UNIT – III

Digital Marketing Concept: Effects of e-business technologies on marketing strategy, customer retention and e-CRM; Measuring the extent of digital marketing activity; Market analysis; Digital marketing tools

UNIT – IV

Online Distribution Components of a distribution system: Characterization of online distribution; hybrid distribution networks; Model for electronic software distribution.

UNIT – V

E-Payment System Characteristics of payment system; Classification of payment systems - E-cash, E-check, overview of smart card; Applications of IPSec.

Text Books:

1. E- Business & E- Commerce, Dr. P. Rizwan Ahmed, Margham Publication, ISBN: 978-9383242320.
2. E-Business and E-Commerce Management, Chaffey Dave, Pearson Education India,2020, ISBN: 978-0273707523.

Reference Books:

1. E-Business 2.0: Roadmap for Success, Kalakota, Pearson, 2nd Edition.
2. Entrepreneurship And Small Business, Dr. B. K. Mehta, Prof. R. C. Agarwal, SBPD Publishing House 1 Edition.

Web Links:

1. https://archive.nptel.ac.in/courses/110/105/110105083/
2. https://srmuniv.digimat.in/nptel/courses/video/110105083/L57.html

Business Policy & Strategic Management

(Common to All)

	L	T	P	C
Course Code: 2501MB13	**3**	**0**	**0**	**3**

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

- **CO1:** Apply the concepts in strategy and their application under various management functions.
- **CO2:** Understand the importance of analyzing external factors that impact an organization.
- **CO3:** Understand how organizations maintain their current position by focusing on existing products and markets.
- **CO4:** Learn how to turn strategic plans into executable steps, ensuring alignment with organizational goals and objectives.
- **CO5:** Explore the opportunities and threats posed by digital disruption.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	-	-	-	-	-	2
CO2	-	-	-	-	-	-	-	-	-	1	-
CO3	-	-	-	-	-	-	-	-	3	-	-
CO4	-	-	-	-	-	-	-	2	-	-	-
CO5	-	-	-	-	-	-	1	-	-	-	-

UNIT – I

Strategic Management: Meaning, Historical Development, Nature, Scope and Significance; Strategic Decision Making; Enterprise Strategists; Strategic Management Model; Strategic Intent- Vision, Mission and Objectives.

UNIT – II

External Environmental Appraisal: Meaning, Significance and Forces. Environmental Scanning: Process and Techniques; Corporate Appraisal- Meaning; Process; Significance & Techniques; Porter's Generic Strategies

UNIT – III

Strategy Alternatives, Variation and Choices: Stability, Growth,Retrenchment and Combination Strategies, Strategic Alliances, Mergers, Acquisitions, Diversification, Integration, Liquidation; Corporate Portfolio Analysis; Strategic Choices Models- BCG Matrix.

UNIT – IV

Strategic Implementation: Strategy Implementation Process, Issues in Strategy Implementation: Behavioral, Functional, Operational and Functional Implementation

UNIT – V

Strategy, Evaluation and Control : Process and Methods. Strategic Management in internet era.

Text Books:

1. Business Policy and Strategic Management, Dr. Sangeeta & Dr. Neeraj, Rigi Publication, 7th Edition, ISBN : 978-9391041656.
2. Business Policy (Strategic Management), by Shiva Manoj Bimal Jaiswal, New Royal Book Company, 1 January 2021, ISBN: 978-8195175215

Reference Books:

1. Business Policy And Strategic Management, Vipin Gupta, Kamala Gollakota, R. Srinivasan, Phi Learning Pvt. Ltd, ISBN:978-8120332447.
2. Business Strategies in Times of Crisis, Dr. Charles O. Usigbe, New Royal Book Company, ISBN : 978-1514431771.

Web Links:

1. https://archive.nptel.ac.in/courses/110/105/110105161/
2. https://ocw.mit.edu/courses/15-904-strategic-management-ii-fall-2005/resources/strag/

Green Marketing

(Common to All)

	L	T	P	C
Course Code: 2501MB14	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: To impart knowledge on this area of environmental marketing

CO2: To analyse the Environmental Ethics

CO3: To gain the knowledge in the area of environmental marketing.

CO4: Understand how CDM credits can be used by industrialized countries to meet their emission reduction targets.

CO5: Identify marketing opportunities in different countries and regions.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11
CO1	-	-	-	-	-	-	-	1	-	-	-
CO2	-	-	-	-	-	-	-	-	-	1	-
CO3	-	-	-	-	-	-	-	-	2	-	-
CO4	-	-	-	-	-	-	-	1	-	-	-
CO5	-	-	-	-	-	-	2	-	-	-	-

UNIT – I

Environment-Pollution, cause, and remedy, Biodiversity, Environmentalism- Definition, concepts, its impact and relationship to businesses, need to study environment in the modern era, environment- an interdisciplinary approach.

UNIT – II

Environment and its relevance to marketing- ethical products, creating awareness about Green Products, Green Labeling of products, Standards- environmentaudit-Globalenvironmentalchallenges.Environmentconscious customer and consumer segment.

UNIT – III

Environment- Developed and developing countries- Influence of Green Marketing on corporate social responsibility, marketing ethical products- challenges and opportunities, promoting green products- advertising on the green platform, Environmental marketing strategies.

UNIT – IV

Building Green Brands, transforming non-green organizations to green organizations-greening the organization structure- building green business- challenges, international organizations, standards, Clean Development Mechanism (CDM), guides for the use of environmental marketing claims.

UNIT – V

The influence of global environmental issues on international business, international marketing opportunities, Project- mini- project- Business process reengineering with the introduction of green technologies, developed and developing markets, environmental marketing of services.

Text Books:

1. Environmental marketing- strategies, Practice, Theory and Research by Michael J. Polansky, and Alma T. Mintu. Wimsatt, Kogan Page Publishers, ISBN: 9781136590337.
2. Environmental Marketing – positive strategies for reaching the green consumer by Walter Codington Peter Florain, McGRaw Hill Professional, 2020, ISBN: 9780070115996

Reference Books:

1. Green Marketing and management- A global perspective by John. F. Wasik , Blackwell publisher, 2022, ISBN: 9781557866349.
2. Marketing, Morality, and the natural environment by Andrew Crane Routledge publishers, ISBN: 9780415439619.

Web Links:

1. https://www.youtube.com/watch?v=LxxpEKyu134
2. https://www.teachmint.com/tfile/studymaterial/b-com/management/unit-7lecture-14greenmarketingpdf/b3248a3e-01af-4f2a-bb41-695c71975ec1

Startup Management

(Common to All)

	L	T	P	C
Course Code: 2501MB15	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Develop a start-up Enterprise with Big Idea Generation.
CO2: Analyze start-up capital requirement by analyzing legal factors.
CO3: Interpret feasibility Analysis towards funding issues.
CO4: Access growth stages in new venture and reasons for scaling ventures.
CO5: Evaluate financial stability and decide on expansion possibilities.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	-	1	-	1	1	1
CO2	-	-	-	-	-	-	-	-		-	-
CO3	-	-	-	-	-	-	-	-	2	-	-
CO4	-	-	-	-	-	-	-	3	-	-	-
CO5	-	-	-	-	-	-	1	-	-	-	-

UNIT – I

Start-up opportunities: The New Industrial Revolution – The Big Idea- Generate Ideas with Brainstorming- Business Start-up - Ideation- Venture Choices - The Rise of The start up Economy - The Six Forces of Change- The Start-up Equation – The Entrepreneurial Ecosystem – Entrepreneurship in India. Government Initiatives.

UNIT – II

Startup Capital Requirements and Legal Environment: Identifying Startup capital Resource requirements - estimating Startup cash requirements - Develop financial assumptions- Constructing a Process Map - Positioning the venture in the value chain - Launch strategy to reduce risks- Startup financing.

UNIT – III

Starting up Financial Issues: Feasibility Analysis - The cost and process of raising capital – Unique funding issues of a high-tech ventures - Funding with Equity – Financing with Debt- Funding startups with bootstrapping- crowd funding- strategic alliances.

UNIT – IV

Start-up Survival and Growth: Stages of growth in a new venture- Growing with the market - Growing within the industry- Venture life patterns- Reasons for new venture failures- Scaling Ventures – preparing for change - Leadership succession. Support for growth and sustainability of the venture.

UNIT – V

Planning for Harvest and Exit: Dealing with Failure: Bankruptcy, Exit Strategies- Selling the business - Cashing out but staying in-being acquired- Going Public (IPO) – Liquidation.

Text Books:

1. Launching New Ventures, An Entrepreneurial Approach, Kathleen R Allen, CengageLearning, ISBN: 9780357039175.
2. Managing New Ventures Concepts and Cases, AnjanRaichaudhuri, Prentice Hall International, ISBN:978-8120341562.

Reference Books:

1. Entrepreneurship, S. R. Bhowmik& M. Bhowmik, New Age International, ISBN: 9788122419061.
2. The Startup Equation -A Visual Guidebook for Building Your Startup, Indian Edition, Steven Fisher, Ja-nae' Duane, Mc Graw Hill Education India Pvt. Ltd, ISBN: 9780071832366.

Web Links:

1. http://tjsec.digimat.in/nptel/courses/video/110106141/L57.html
2. https://archive.nptel.ac.in/courses/127/105/127105007/

Venture Management

(Common to All)

	L	T	P	C
Course Code: 2501MB16	**3**	**0**	**0**	**3**

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

CO1: Describe the role of venture managers in promoting entrepreneurship.
CO2: Learn how to secure and manage IP assets within a venture.
CO3: Analyse and assess risks associated with ventures.
CO4: Evaluate and choose appropriate exit strategies based on venture goals and market conditions.
CO5: Develop a comprehensive plan for scaling and entering global markets.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	-	-	-	-	2	-	-
CO2	-	-	-	-	-	-	-	-		2	-
CO3	-	-	-	-	-	-	-	-	2	-	-
CO4	-	-	-	-	-	-	-	3	-	-	-
CO5	-	-	-	-	-	-	2	-	-	-	-

UNIT – I

Introduction to Venture Management: Understanding the concept of venture management, Role of entrepreneurship and innovation in creating ventures,
Market Research and Opportunity Identification: Techniques for market research and identifying business opportunities, Analyzing customer needs, market trends, and competitive landscape.

UNIT – II

Legal and Regulatory Aspects: Legal structures for ventures (sole proprietorship, partnership, corporation, etc.). Intellectual property rights, contracts, and compliance.
Financial Management for Ventures: Budgeting, financial forecasting, and managing startup costs, Sources of funding (bootstrapping, angel investors, venture capital).

UNIT – III

Risk Management and Decision Making: Assessing and mitigating risks associated with ventures. Making informed decisions under uncertainty.

UNIT – IV

Exit Strategies and Succession Planning: Options for exiting the venture (selling, merging, going public), Planning for the long-term sustainability of the venture.

UNIT – V

Venture Scaling and Internationalization: Learn strategies for scaling ventures beyond their initial markets, Understand the challenges and opportunities of international expansion.

Text Books:

1. New Venture Creation: A Framework for Entrepreneurial Start-ups, Paul Burns, MacMillan publication, Latest Edition, ISBN: 9781350321793.
2. Entrepreneurship: New Venture Creation, David H. Holt, Pearson publication, Latest Edition, ISBN: 9780132826747.

Reference Books:

1. Entrepreneurship and new Venture Creation, Excel publication, Latest edition, A Sahay, V Sharma, ISBN: 978-9332568730.
2. Entrepreneurship: Successfully Launching New Ventures, Bruce R. Barringer, R. Duane Ireland , Pearson publication, Latest Edition, ISBN:978-935306649.

Web Links:

1. https://hits.digimat.in/nptel/courses/video/109105098/L17.html
2. https://ocw.mit.edu/courses/15-351-managing-the-innovation-process-fall-2002/resources/lecture2021/
3. https://ocw.mit.edu/courses/15-351-managing-the-innovation-process-fall-2002/resources/lecture2324/

Minor Degree in Quantum Technologies

S.No.	Course Code	Course Name	L	T	P	C	Semester
Mandatory Courses							
1	251EC097	Survey of Quantum technologies and Application	3	0	0	3	IV
2	251EC098	Foundations of Quantum Technologies	3	0	0	3	V
3	251EC099	Basic Programming Lab (or)	1	0	2	3	V
	251EC100	Basic Laboratory Course for Quantum Technologies					
4	251EC101	Quantum Algorithms and Cryptography	12 week 3 Credit - NPTEL MOOC			3	VII/VIII
Any One course from the below							
5	251EC102	Introduction to Quantum Computation	3	0	0	3	VI
6	251EC103	Introduction to Quantum Communication	3	0	0	3	VI
7	251EC104	Introduction to Quantum Sensing	3	0	0	3	VI
8	251EC105	Introduction to Quantum Materials	3	0	0	3	VI
Any One course from the below							
9	251EC106	Engineering Foundations of Quantum Technologies	3	0	0	3	VII
10	251EC107	Solid State Physics for Quantum Technologies	3	0	0	3	VII
11	251EC108	Quantum Optics	3	0	0	3	VII
12	251EC109	Quantum Cybersecurity	3	0	0	3	VII
13	251EC110	Quantum Machine Learning	3	0	0	3	VII
Total			**18**	**0**	**0**	**18**	

Survey of Quantum Technologies and Applications

	L	T	P	C
Course Code: 251EC097	3	0	0	3

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

- **CO1** Explain the core quantum mechanical principles relevant to qubits and quantum technologies.
- **CO2** Analyze and compare major qubit hardware platforms used in quantum computation.
- **CO3** Describe the principles and operating mechanisms of quantum sensing techniques.
- **CO4** Evaluate practical applications of quantum sensing in measurement and metrology.
- **CO5** Explain and assess quantum communication protocols over fibre-based and free-space channels.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2	2						2
CO3	2	2		2	2						2
CO4	2	2		3	2	2					2
CO5	3	3		2	3	2	1				2

UNIT – 1: Quantum Technologies – four verticals: Motivation for Quantum Technologies A qualitative overview of salient aspects of quantum physics: Quantum States, Wavefunctions, Probabilistic interpretation, Physical observables, Hermitian operators, expectation values, Heisenberg uncertainty principle, Schrodinger equation, Time evolution; distinction from classical physics; Heuristic description of Superposition, Tunnelling and entanglement; No cloning theorem; Simulating classical systems – Feynman's idea of a quantum simulator and the birth of the field.

UNIT-II: Quantum Computation: Basics of qubits -- what is a qubit?, How is it different from a classical bit? – Review of classical logic gates; Di Vincenzo criteria for realising qubits; Basics of qubit gates and quantum circuits; Physical implementation of qubits (very qualitative description); Solid State Qubits: Semiconducting Qubits – quantum dots, spins, Superconducting Qubits – charge, flux and phase, Topological Qubits – proposals and advantages; Atoms and Ions: Trapped ions, Rydberg atoms, Neutral atoms; Photonic Qubits: Conventional linear optical setups, Integrated Photonics; NMR qubits: Conventional NMR qubits, NV centres Overview of applications and recent achievements: RSA and Shor's algorithm, Quantum Advantage; Long term goals and strategies being followed : Error correction

UNIT-III: Quantum Sensing: Basics of quantum sensing, Basics of Photon (single and entangled) generation and detection, Gravimetry, Atomic clock, Magnetometry, State of the art in Quantum Sensing

UNIT-IV: Quantum Communications: Basics of digital communication, Quantifying classical information – Shannon entropy, Basic ideas of quantum communication, security, eavesdropping, Overview of quantum communication achievements : Terrestrial – fibre-based, Free space, Satellite-based

UNIT-V: Introduction to Quantum Materials: What are quantum materials, Why are they important, Applications (quantum computing, spintronics, etc.)

Overview of Key Classes of Quantum Materials: Topological Insulators, Superconductors, Mott Insulators, 2D Materials and Quantum Spin Liquids.

Course References:

1. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
2. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10th Anniversary edition, Cambridge University Press (2010)
3. Elements of Quantum Computation and Quantum Communication, A. Pathak, Boca Raton, CRC Press (2015)
4. An Introduction to Quantum Computing, Phillip Kaye, Raymond Laflamme, and Michele Mosca, Oxford University Press (2006)
5. Quantum computing explained, David McMahon, Wiley (2008)

Foundations of Quantum Technologies

	L	T	P	C
Course Code: 251EC098	**3**	**0**	**0**	**3**

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

- **CO1** Apply mathematical tools to model and analyze classical and quantum physical systems.
- **CO2** Explain and apply the postulates of quantum mechanics to solve elementary quantum system problems.
- **CO3** Analyze statistical physics concepts and differentiate classical and quantum statistical distributions.
- **CO4** Explain and interpret information-theoretic concepts in classical and quantum information systems.
- **CO5** Analyze and compare classical and quantum computational complexity classes with reference to post-quantum cryptography.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2			1						2
CO2	3	3		2	1						2
CO3	3	2		2							2
CO4	2	2			2						2
CO5	2	3			1	1	1				2

UNIT-I: Brief overview of classical physics (This segment is meant for the student to understand what a Hamiltonian is, which will feature later in quantum mechanics) : Hamiltonian function and Hamilton's equations, Phase-space description of a system, Connection and Equivalence with Newton's laws for simple systems – free particle, particle moving in a conservative potential, examples of Harmonic oscillator, hydrogen atom. Historical evolution of quantum mechanics: Planck's quantum hypothesis, Photo electric effect, Atomic spectra, Bohr's quantisation principle, De Broglie's Wave particle duality

UNIT-II Postulates of Quantum Mechanics: State vectors and Hilbert Space, Dirac Bra-Ket notation, Measurables and Hermitian Operators, Unitary Transformations, Schrodinger. Equation and Time evolution of quantum states, Measurement Postulate, Schrodinger, Heisenberg and Interaction pictures, Eigen values, Expectation values and Matrix elements, Heisenberg's Uncertainty principle

UNIT-III:

Density operator formalism of quantum mechanics – pure and mixed states; Superposition and Entanglement in quantum mechanics; No cloning theorem; Applications of postulates – Particle in a box, Hydrogen atom, Harmonic Oscillator. Number states, ladder operators and Coherent states of a harmonic oscillator; Spin and Angular momentum – spin half particles; Rabi problem

of a spin-half particle in a rotating magnetic field; Bosons and Fermions

UNIT-IV:

Statistical Physics: Quick review of first and second laws of thermodynamics, Thermal Equilibrium and Gibbs principle, Applying Gibbs principle to Classical and Quantum harmonic oscillators, Bosons and Fermions and Quantum statistics – Fermi-Dirac and Bose- Einstein distributions

UNIT - V: Information Science: Digital communication and information: Quantifying information in terms of Shannon entropy; Basic ideas of quantum information; Decoherence and noise; Introductory ideas of Kraus operators Brief overview of Computational Complexity: Qualitative ideas of a Turing machine: Types of Turing machines; Time and Space complexity – P vs NP, PSPACE; Quantum complexity classes – Q, EQP, BQP, BPP, QMA; Post Quantum Cryptography (PQC)

Course References:

1. Introduction to Quantum Mechanics, Griffiths D. J., 3rd Edition, Cambridge University Press (2024)
2. Introduction to Electrodynamics, Griffiths D. J., 4th edition, Cambridge University Press (2020)
3. Principles of Quantum Mechanics, Shankar, R., 2nd edition, Springer (2014)
4. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
5. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10th Anniversary edition, Cambridge University Press (2010)
6. A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press (2015)
7. Information Theory, Robert B. Ash, Dover Publications (2003)
8. Introduction to the Theory of Computation, Michael Sipser, 3rd edition, Cengage India Pvt. Ltd. (2014) Statistical Mechanics, Pathria R. K., Paul D. Beale, 4th edition, Academic Press, (2021)

Basic Programming Lab

L	T	P	C
1	0	2	3

Course Code: 251EC099

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

- **CO1** Apply basic programming concepts and object-oriented principles to develop scientific programs.
- **CO2** Implement and analyze simple algorithms and evaluate their computational performance.
- **CO3** Apply numerical methods to solve differential equations and linear algebra problems.
- **CO4** Analyze probabilistic and statistical data using numerical and simulation techniques.
- **CO5** Develop computational models for quantum mechanics and electromagnetism applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2			2						2
CO2	3	3			2						2
CO3	3	2		2	2						2
CO4	2	3		2	2						2
CO5	3	3	2	3	2	1		1			2

Course Content and syllabus:

- Basics of programming
  - Data structures, classes, Object-oriented programming
  - Data storage and retrieval, Memory allocation
  - Scientific plotting, documentation of codes
- Simple algorithms and benchmarking run time
  - Sorting
  - Searching
  - Arithmetic algorithms like GCD, Prime factorisation
- Numerical Integration and differential equations
  - Linear 2nd Order ODEs with constant coefficients
  - Linear 2nd order ODEs with variable coefficients
  - Boundary value problems
    - Poisson equation
    - Laplace equation
    - Wave equation
    - Diffusion Equation
- Numerical techniques in linear algebra
  - Matrix inverse
  - Eigenvalue problem

- Diagonalisation of matrices
- Singular value decomposition

- Numerical techniques in Probability and Statistics
  - (Pseudo) Random number generation
  - Computing statistical moments for data samples
  - Least Squares fitting
  - Error Analysis
  - Hypothesis Testing
  - Monte Carlo sampling
- Applications to Quantum Mechanics (can be done using openly available modules in languages like Python, Julia etc.)
  - Eigen energies of coupled two level systems
  - Eigen energies of two-level system coupled to oscillator (Jaynes-Cummings Model)
  - Driven two-level system – Rabi Problem
  - Driven damped oscillator — coherent states
- Applications to EM theory (e.g. magnetic field simulation)
  - Electrostatic charge distributions
  - Magnetostatic current distributions
  - Finite Element techniques for electromagnetic simulations

Course References:

Computational Physics, Nicholas Giordano, Hisao Nakanishi, 2nd edition, Pearson-Addison Wesley (2005)

Basic Laboratory Course for Quantum Technologies

	L	T	P	C
Course Code: 251EC100	1	0	2	3

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

- **CO1** Apply optical experimental techniques to measure wavelength, diffraction, polarization, and imaging parameters.
- **CO2** Analyze and characterize RLC circuits and resonators to determine quality factor and losses.
- **CO3** Implement and verify basic digital circuits using standard ICs and laboratory instruments.
- **CO4** Operate RF and microwave instruments to measure transmission, reflection, noise, and network parameters.
- **CO5** Acquire, process, and interpret experimental data using computer interfacing and quantum simulation tools.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2		2	2						2
CO2	3	3		2	2						2
CO3	3	2	2		2		1				2
CO4	3	3		2	2	1					2
CO5	3	3	2	2	2	1	1				2

Course Content and syllabus:

- Optics
  - Interferometry – wavelength measurements, intensity measurements
  - Diffraction – single slit, grating
  - Microscopy – magnification, aberration
  - Polarization optics – PBS, HWP, QWP
- RLC circuits
  - Series and parallel RLC circuits – Verifying the quality factor formulae
  - Extracting intrinsic losses
- Digital circuits
  - Adder, Multiplier
  - Encoder, Decoder
  - D flipflop, shift registers
  - How to use common Integrated Circuit chips
- Radio Frequency Technology:
  - Using Oscilloscope
    - Ring-up and ring-down time measurements of RLC circuits

- Measurements of different pulse-shapes generated by a function generator
  - Using Vector Network Analyser
- Transmission and reflection measurements of coaxial cable in open, short and matched termination
- Voltage standing wave ratio measurement
- Amplitude and Phase quadrature, In-phase and Out-of-phase quadrature plots and Quality factor measurement of RLC circuits
- Characterising S-parameters, ABCD and Z matrices of common 2 port networks – coaxial cable, attenuator, low pass high pass bandpass filters etc.
- Characterising 3 port networks – directional couplers, circulators, isolators
  - Using a spectrum analyser
- Noise from a resistor at different temperatures

- Interfacing instruments with a computer
- Data acquisition
  - Signal demodulation – heterodyne vs Homodyne, Mixing of signals
  - Sampling, digitisation using ADCs – under-sampling and aliasing, oversampling and noise
  - Averaging and interpolation techniques
- Quantum Simulators
  - Running quantum protocols in a quantum simulator
  - Implementing simple quantum algorithms on cloud-based quantum computers (depending on availability of time on such machines)
- Running simple algorithms on cloud-based quantum processors (optional)

Course References:

1. Optics, Eugene Hecht, A. R. Ganesan, 5th edition, Pearson (2019)
2. Art of Electronics, Paul Horowitz and Winfield Hill, 3rd edition, Cambridge University Press (2015)
3. Digital Design, Morris Mano, Michael D. Cilletti, 6th edition, Pearson Education (2018)
4. Microwave Engineering, David Pozar, 4th edition, Wiley (2013)
5. Discrete-time signal processing, Alan V. Oppenheim and Ronald W. Shaffer, 4th edition, Pearson (2009)
6. Optical quantum information and quantum communication, A. Pathak and A. Banerjee, SPIE Spotlight Series, SPIE Press (2016)

Introduction to Quantum Computation

	L	T	P	C
Course Code: 251EC102	3	0	0	3

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

CO1 Explain the principles of qubits and compare their physical realizations with classical bits.

CO2 Analyze quantum correlations, entanglement, and Bell-type inequalities in quantum systems.

CO3 Apply universal quantum gates and circuits to construct basic quantum computational models.

CO4 Analyze and explain the working of fundamental quantum algorithms such as Grover's and Shor's algorithms.

CO5 Explain quantum computational complexity, error correction techniques, and the limitations of NISQ-era processors.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2							2
CO3	3	2			2						2
CO4	3	3		2	2						2
CO5	2	3		2	2	2	1		1		2

Course Content and syllabus:

- Qubits versus classical bits
  - Spin-half systems and photon polarizations
  - Trapped atoms and ions
  - Artificial atoms using circuits
  - Semiconducting quantum dots
  - Single and Two qubit gates – Solovay - Kitaev Theorem
- Quantum correlations
  - Entanglement and Bell's theorems
- Review of Turing machines and classical computational complexity
  - Time and space complexity (P, NP, PSPACE)
- Reversible computation
- Universal quantum logic gates and circuits
- Quantum algorithms
  - Deutsch algorithm
  - Deutsch Josza algorithm
  - Bernstein - Vazirani algorithm
  - Simon's algorithm
- Database search

- Grover's algorithm
- Quantum Fourier Transform and prime factorization
  - Shor's Algorithm.
- Quantum complexity classes – Q, EQP, BQP, BPP, QMA
- Additional Topics in Quantum Algorithms
  - Variational Quantum Eigensolver (VQE)
  - HHL
  - QAOA
- Introduction to Error correction
- Fault-tolerance
- Simple error correcting codes
- Survey of current status
  - NISQ era processors
  - Quantum advantage claims
  - Roadmap for future

Course References:

1. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
2. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10th Anniversary edition, Cambridge University Press (2010)
3. A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press (2015)
4. Quantum error correction and Fault tolerant computing, Frank Gaitan, 1st edition, CRC Press (2008)
5. Quantum computing explained, David McMahon, Wiley (2008)
6. Introduction to Quantum Computing: From a lay person to a programmer in 30 steps, Hui Yung Wong, 1st edition, Springer-Nature Switzerland AG (2022)

Introduction to Quantum Communication

	L	T	P	C
Course Code: 251EC103	**3**	**0**	**0**	**3**

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

- **CO1** Explain the principles of polarization optics and photodetection relevant to quantum communication systems.
- **CO2** Analyze classical and quantum information concepts including entropy, noise, and channel capacity.
- **CO3** Explain and analyze quantum correlations, Bell measurements, and fundamental quantum communication protocols.
- **CO4** Analyze the working of quantum communication protocols such as teleportation, dense coding, and quantum key distribution.
- **CO5** Evaluate quantum communication architectures, hardware implementations, and the concept of quantum networks and internet.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3			2						2
CO3	3	3		2							2
CO4	3	3		2	2		1		2		2
CO5	2	2		2	3	2	1		2		2

Course Content and syllabus:

- Basics of Polarization optics
  - Quarter and half-wave plates
  - Polarizing beam splitters
- Basics of linear and square-law detectors
  - Quadrature amplitude modulation
  - Heterodyne and Homodyne demodulation and linear detectors
  - Intensity measurements and square law detectors
  - Photomultipliers, Avalanche Photo diodes
- Digital communication – information theory (basics)
  - Information entropy
  - Noiseless channel encoding
  - Noisy channel encoding
- No cloning theorem
- Quantum Memories
- Quantum repeaters
- Entanglement and Bell Theorems
- Bell Measurements and Tests
- Quantum Teleportation protocol

- Quantum Dense coding
- Quantum Key Distribution protocols
  - BB84
  - E91
  - BBM92.
  - B92
  - COW
  - DPS
- Quantum Networks and Quantum Internet
- Survey of Hardware implementations
  - Free space communications
  - Satellite based communications
  - Fibre optics-based communications

Course References:

1. Quantum computation and quantum information – Nielsen and Chuang Cambridge University Press, Cambridge (2010)
2. A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press (2015)

Introduction to Quantum Sensing

	L	T	P	C
Course Code: 251EC104	**3**	**0**	**0**	**3**

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

- **CO1** Explain the principles of classical sensing, noise mechanisms, and measurement sensitivity limits.
- **CO2** Analyze quantum measurement processes including projective, weak, and non-demolition measurements.
- **CO3** Apply information-theoretic bounds to quantify and optimize quantum sensing performance.
- **CO4** Analyze quantum states of light and photodetection techniques used in precision measurements.
- **CO5** Evaluate photon-, entanglement-, atomic-, and spin-based quantum sensing applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2							2
CO3	3	3		2	2						2
CO4	3	3		2	2				2		2
CO5	2	3		3	2	2			2		2

Course Content and syllabus:

- Classical sensing
  - photo detection
- Classical Noise
  - Johnson Noise, Telegraph noise, flicker or 1/f noise
- Sensitivity of classical measurements
  - Classical Fisher information
  - Cramer - Rao bounds (information theory basics may be required here).
- Quantum measurements
  - projective/orthogonal measurements
  - Approximate/non-orthogonal measurements
  - Weak continuous measurements
  - Error-disturbance relations
  - Standard quantum limits
  - Quantum non-demolition measurements
- States of light
  - fock states
  - Coherent states

- Squeezed states
- Tomography
- Wigner quasi-probability distribution
- P-distribution
- Husimi Q function

- Quantum photo detection
  - Square-law detectors, Intensity measurements and Photo-detection
  - Linear Detectors and Quadrature Measurements
- Quantum Cramer-Rao bounds
- Single photon-based sensing applications
- Entanglement based sensing applications
- Atomic state-based sensing, solid-state spin-based sensing applications (gravimetry, magnetometry)

Course References:

1. Quantum Measurement and Control , Howard Wiseman and David Milburn, Cambridge University Press (2014)
2. Quantum Measurement , Vladimir Braginsky and Farid Ya Khalili, Cambridge University Press (1995)
3. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)

Introduction to Quantum Materials

	L	T	P	C
Course Code: 251EC105	**3**	**0**	**0**	**3**

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

CO1 Explain the fundamental concepts of band theory and electronic structure in solids.
CO2 Analyze correlated systems and magnetic phenomena using basic experimental and theoretical principles.
CO3 Explain the principles of superconductivity and the operation of superconducting devices.
CO4 Analyze the electronic and optical properties of two-dimensional materials such as graphene and TMDCs.
CO5 Explain topological phases of matter and assess material growth techniques relevant to quantum technologies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2							2
CO3	3	2		2							2
CO4	3	3		2	2				2		2
CO5	2	2		2	2	2			2		2

Course Content and syllabus:

- Band theory basics
  - Metals, Semiconductors and Insulators
  - Band structure of solids
  - Survey of semiconducting devices for quantum technologies (electronic, quantum optical devices and principle of operation)
- Correlated systems
- Magnetism
  - Para, ferro magnetism basics
  - Magnetic measurements, hall effect, magnetoresistance
  - Faraday and Kerr effects
- Superconductivity
  - BCS theory
  - Ginzburg Landau
  - Josephson Effect – AC and DC Josephson effects
  - Survey of superconducting devices for quantum technologies
- 2D materials
  - Graphene and its properties – single and few layers

- Transition Metal Dichalcogenides – Electronic and Optical Properties

- Topological Phases of matter
  - Basics of Topology
  - Geometric phases - Berry Phase
  - Aharonov Bohm effect
  - Topological phases of matter
- Survey of material growth techniques
  - Molecular beam epitaxy
  - Chemical vapor deposition, MOVPE
  - Pulsed laser deposition, etc.
  - Crystal growth techniques

Course References:

1. Condensed Matter Physics , M P Marder, 2nd Edition, John Wiley and Sons, 2010
2. Introduction to Superconductivity, Michael Tinkham, standard ed., Medtech (2017)

Engineering Foundations of Quantum Technologies

	L	T	P	C
Course Code: 251EC106	**3**	**0**	**0**	**3**

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

- **CO1** Apply principles of electrical networks and transmission lines to analyze resonant circuits and signal propagation.
- **CO2** Explain abstract models of computation and analyze algorithmic complexity using classical computation theory.
- **CO3** Analyze analog and digital communication techniques with respect to modulation, noise, and information capacity.
- **CO4** Apply noise analysis and signal conditioning principles to evaluate system performance and quantum noise limits.
- **CO5** Explain cryptographic principles and analyze classical and post-quantum cryptographic protocols.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	2		2						2
CO2	3	3									2
CO3	3	3		2	2			2			2
CO4	3	3		2	2						2
CO5	2	3			2	2		2			2

Course Content and syllabus:

- Electrical Networks (4 hours)
  - Analog RLC circuits – resonances, impedances, quality factors
  - Transmission line basics (2 hours)
    - Telegrapher equations, wave impedance, impedance matching, transmission line resonators
- Computer Science (15 hours)
  - Basics of computer architecture (1 hour)
- Arithmetic Logic Unit
- Memory
  - Abstract models of computation (12 hours)
    - Finite State Machine
    - Turing Machines
    - Overview of Hierarchy of languages – Regular, Context-Free, Turing Decidable and Turing Recognisable
  - Complexity Theory (2 hours)
    - Time and Space complexity
    - P vs NP, NP-completeness

- Electrical Communications (1 hour)
    - Analog Communications (1 hour)
        - Quadrature amplitude modulation
        - Heterodyne and Homodyne demodulation
- Noise and Signals (6 hours)
    - Characterising Noise
    - Types of Noise
        - Shot Noise
        - Johnson-Nyquist Noise
        - Telegraphic noise or flicker or 1/f noise
- Signal conditioning and noise mitigation
- Amplification and Added Noise
        - Linear Amplifier theory
        - Signal-Noise Ratio, Added Noise, Noise Figure of amplification
        - Dynamic Range
        - Noise temperature
        - Quantum limits on noise in linear amplifiers
- Digital Communications (4 hours)
- Information entropy
- Noiseless channel encoding
- Noisy channel encoding
- Basics of cryptography (6 hours)
    - Basics of Number Theory
    - Random Number Generation
    - One time pad, Private key, public key, symmetric and asymmetric cryptography protocols
    - RSA and DH
    - Post Quantum Cryptography (PQC)

Course References:

1. Art of Electronics, Paul Horowitz and Winfield Hill, 3rd edition, Cambridge University Press (2015)
2. Digital Design, Morris Mano, Michael D. Cilletti, 6th edition, Pearson Education (2018)
3. Microwave Engineering, David Pozar, 4th edition, Wiley (2013)
4. Information Theory, Robert B. Ash, Dover Publications (2003)
5. Introduction to the Theory of Computation, Michael Sipser, 3rd edition, Cengage India Pvt. Ltd. (2014)
6. Protecting Information – From Classical error correction to quantum cryptography, Susan Loepp and William K. Wootters, Cambridge University Press (2006)

Solid State Physics for Quantum Technologies

	L	T	P	C
Course Code: 251EC107	3	0	0	3

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

CO1 Explain crystal structures, symmetry, diffraction principles, and bonding mechanisms in solids.

CO2 Analyze electronic properties of solids using free-electron, band theory, and tight-binding models.

CO3 Analyze lattice vibrations and phonon dynamics to explain vibrational and thermal properties of solids.

CO4 Explain and analyze magnetic phenomena in solids using classical and quantum models.

CO5 Explain superconducting phenomena and analyze superconducting materials and devices relevant to quantum technologies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2							2
CO3	3	3		2							2
CO4	3	2		2							2
CO5	3	3		2	2	2					2

Course Content and syllabus:

- Structure of solids –
  - Symmetry, Bravais lattices
  - Laue equations and Bragg's law,
  - Brillouin Zones
  - Atomic scattering and structure factors.
- Characterisation of crystal structures – XRD etc.
- Bonding in solids –
  - van der Waals and Repulsive interactions,
  - Lennard Jones potential,
  - Madelung constant
- The Drude theory of metals –
  - DC & AC electrical conductivity of a metal;
  - Hall effect & magnetoresistance,
  - Density of states, Fermi-Dirac distribution, Specific heat of degenerate electron gases
  - Free electron model
- Beyond the Free electron model

- Kronig-Penney Model
- Periodic potential – Bloch Theorem
- Band theory
- Tight binding model

- Phonons in Solids
  - One dimensional monoatomic and diatomic chains
  - Normal modes and Phonons
  - Phonon spectrum
  - Long wavelength acoustic phonons and elastic constants
  - Vibrational Properties- normal modes, acoustic and optical phonons.
- Magnetism
- Dia-, Para-, and Ferromagnetism
- Langevin's theory of paramagnetism
- Weiss Molecular theory
- Superconductivity:
  - Phenomenological description – Zero resistance, Meissner effect
  - London Theory
  - BCS theory
  - Ginzburg-Landau Theory
  - Type-I and type-II superconductors
  - Flux quantization
  - Josephson effect.
  - High Tc superconductivity

Course References:

1. Introduction to Solid State Physics, Charles Kittel, Wiley India Edition (2019)
2. Condensed Matter Physics, M P Marder, 2nd Edition, John Wiley and Sons (2010)
3. Introduction to Superconductivity, Michael Tinkham, standard edition, Medtech (2017)

Quantum Optics

	L	T	P	C
Course Code: 251EC108	**3**	**0**	**0**	**3**

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

- **CO1** Explain the quantization of the electromagnetic field and the properties of non-classical states of light.
- **CO2** Analyze optical coherence phenomena and interferometric techniques using quantum optical principles.
- **CO3** Analyze phase-space representations of quantum states of light to identify non-classical features.
- **CO4** Analyze classical, semi-classical, and quantum models of light–matter interaction in atomic systems.
- **CO5** Apply open quantum system models to describe decoherence and dissipation in quantum optical systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2									2
CO2	3	3		2					1		2
CO3	3	3		2					1		2
CO4	3	3		2	2				1		2
CO5	3	3		2	2				1		2

Course Content and syllabus:

- Quantization of the electromagnetic field
  - Number states, coherent states, squeezed states
  - Hanbury-Brown and Twiss experiments – Photon bunching, Photon anti bunching
  - Hong-Ou-Mandel interference
- Theory of Optical coherence
  - Young's double slit experiment and first order coherence
  - Coherence functions of arbitrary order
  - Normal ordering, symmetric ordering and ani-normal ordering of operators
  - Interferometry
- Phase-space representations of states of light
  - Wigner distribution
  - P-function and the notion of non-classicality with some examples of nonclassical states like squeezed states and their applications
  - Husimi Q function
- Light-matter interaction
  - Classical model of light-matter interaction

- Semi-classical model of light-matter interaction-
- Quantum light-matter interaction
- Rabi Model
- Jayne's-cummings model
- Open quantum systems
  - Fermi golden rule
  - Born-Markov Lindblad Master Equation

Course References:

1. Introductory Quantum Optics, Christopher Gerry and Peter Knight, Cambridge University Press (2004)
2. Quantum Optics, D. F. Walls, Gerard J. Milburn, 2nd Edition, Springer (2008)
3. Quantum Optics: An introduction, Mark Fox, Oxford University Publishers (2006)
4. Quantum Optics for Beginners, Z. Ficek and M. R. Wahiddin, 1st edition, Jenny Stanford Publishing (2014)