RAJALAKSHMI DEEMED TO BE UNIVERSITY

Programmes Offered

Rajalakshmi Deemed to be University proposes to offer the following programmes which will encompass interdisciplinary themes, promote strategic interests of the nation and ensure preservation of Indian cultural heritage, environment besides skill development.

Submitted by
Rajalakshmi University Trust
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M.Tech. Digital Agriculture

(PG - 2 years)

Course Objectives:

1. **Introduction to Digital Technologies in Agriculture**: Provide students with a foundational understanding of digital technologies, including IoT (Internet of Things), data analytics, remote sensing, and automation, and their applications in agriculture.
2. **Precision Agriculture and Data Analysis**: Teach students how to implement precision agriculture techniques, collect agricultural data, and analyze it to make informed decisions for crop management, resource optimization, and sustainability.
3. **Environmental and Economic Sustainability**: Emphasize the role of digital agriculture in achieving both environmental sustainability (such as reduced resource use and minimized environmental impact) and economic sustainability (increased yield and profitability) in farming practices.
4. **Ethical and Legal Considerations**: Address the ethical dilemmas, data privacy, and legal aspects related to digital agriculture, ensuring students understand the importance of responsible data use and compliance with regulations.
5. **Practical Application and Project Development**: Enable students to apply their knowledge by working on digital agriculture projects, developing hands-on skills, and gaining practical experience in implementing digital solutions for farming.

Year 1: Semester 1: **20 Credits**

- **Course 1: Introduction to Information Technology & Programming**

  Introduction to Information Technology - Computer Hardware and Software - Software Applications - Computer Networks and the Internet – Cyber security and Data Privacy -IT and Society - Information Technology Ethics. Introduction to Python Programming - Control Structures and Functions - Data Handling in Python - Introduction to Data Visualization - Working with Agricultural Data - Integrating Sensors and Data - Automation in Smart Agriculture

- **Course 2:Mathematics for Agriculture**

  Introduction to Agricultural Mathematics - Basic Arithmetic and Algebra - Geometry and Trigonometry in Agriculture - Calculus and Its Applications - Statistics for Agricultural Data Analysis - Agricultural Finance and Business Math - Applied Mathematics in Agricultural Research

- **Course 3:Soil Science and Management**

  Introduction to Soil Science - Soil Properties and Classification - Soil Water and Drainage - Soil Fertility and Nutrient Management - Soil Erosion and Conservation - Soil Pollution and Remediation - Sustainable Agriculture Practices -

- **Course 4:Fundamentals of Data Science**

  Introduction to Data Science for Smart Agriculture - Data Collection and Preprocessing in Agriculture - Data Visualization and Descriptive Statistics in Agriculture - Statistical Analysis in Agriculture - Machine Learning for Smart Agriculture - Predictive Modeling in Agriculture - Data Science Tools and Applications in Smart Agriculture

- **Course 5:Geographic Information Systems (GIS) in Agriculture**

  Introduction to GIS in Agriculture - GIS Data Sources and Types - GIS Data Collection and Management - Spatial Analysis in Agriculture - Crop Mapping and Precision Agriculture - Soil and Water Management with GIS - Soil and Water Management with GIS

- **Course 6:Agricultural Data Collection and Sensors**

  Introduction to Agricultural Data Collection - Types of Agricultural Sensors - Crop and Livestock Sensors - Data Acquisition and Management - Data Analysis and Interpretation - Integration with Precision Agriculture - Practical Applications

Year 1: Semester 2: 20 Credits

- **Course 1:Crop Physiology**

  Introduction to Crop Physiology - Plant Structure and Function - Crop Growth Stages and Development - Environmental Factors and Crop Physiology - Nutrient Uptake and Use Efficiency - Crop Genetics and Physiology - Crop Physiology and Management Practices

- **Course 2:Database Management and SQL**

  Introduction to Database Management and SQL - Database Design and Normalization - SQL Basics - Advanced SQL Queries - Data Manipulation and Transactions - Database Administration and Security - Database Integration in Smart Agriculture

- **Course 3:Livestock Management and Technology**

  Introduction to Livestock Management and Technology - Livestock Anatomy and Physiology - Livestock Health and Disease Management - Livestock Nutrition and Feed Technology - Livestock Housing and Welfare - Precision Livestock Farming - Sustainable Livestock Management

- **Course 4:Remote Sensing and Satellite Imagery in Agriculture**

  Introduction to Remote Sensing in Agriculture - Principles of Remote Sensing - Satellite Image Preprocessing - Vegetation Indices and Crop Monitoring - Crop Mapping and Land Use Classification - Precision Agriculture and Yield Prediction - Environmental Impact and Sustainability

- **Course 5:Internet of Things (IoT) in Agriculture**

  Introduction to IoT in Agriculture - IoT Fundamentals - IoT Devices and Sensors - Data Management and Analytics in Agriculture - Precision Agriculture with IoT - IoT for Livestock and Animal Farming - IoT and Environmental Monitoring

- **Course 6:Agricultural Robotics and Automation**

  Introduction to Agricultural Robotics and Automation - Fundamentals of Robotics - Automation and Control Systems - Robotics for Crop Management - Robotics for Livestock and Animal Farming - Autonomous Systems for Harvesting and Post-harvest Handling - Sustainability and Environmental Impact

Year 2: Semester 3: 17 Credits

- **Course 1:Machine Learning for Agriculture**

  Introduction to Machine Learning in Agriculture - Fundamentals of Machine Learning - Data Collection and Preparation for Agriculture - Crop Yield Prediction and Regression - Classification and Pest/Disease Detection - Precision Agriculture and Decision Support Systems - Sustainability and Environmental Impact correlation

- **Course 2:Crop Modeling and Simulation**

  Introduction to Crop Modeling and Simulation - Principles of Crop Growth Modeling - Crop Model Development - Environmental Factors and Crop Models - Crop Modeling for Decision Support - Advanced Topics in Crop Modeling - Sustainability and Crop Modeling

- **Course 3:Ethical and Legal Issues in Digital Agriculture**

  Introduction to Ethical and Legal Issues in Digital Agriculture - Ethical Frameworks and Principles - Privacy and Data Protection - Intellectual Property Rights - Regulatory Frameworks for Digital Agriculture - Transparency and Accountability - Social and Environmental Responsibility

- **Course 4:Capstone Project in Digital Agriculture phase 1**

Year 2: Semester 4: 13 Credits

- **Course 1:Agroeconomics**

  Production Economics - Farm Management - Agricultural Marketing - Rural Development - Agricultural Policy Analysis - Environmental and Resource Economics - Food Economics - International Agricultural Trade - Econometrics and Data Analysis - Risk and Uncertainty Management

- **Course 2:Internship or Industry Placement**
- **Course 3:Capstone Project in Digital Agriculture Phase II**

Teaching Pedagogy:

Class Room – with Hybrid Mode, Seminar, Group Discussion, Team Learning

Assessment Methods:

MCQ's 10%, Examination 50%, Oral presentation 20%, Practical 20%

M.Tech. Space Technology & Satellite Engineering
(Integrated Masters - 5 years)

The program objectives of M.Tech. in Space Technology and Satellite Engineering provides students with advanced knowledge and technical competence in satellite systems, fostering problem-solving abilities and research skills. It encourages interdisciplinary thinking, ethical practices, and a global perspective while emphasizing communication and leadership. The program aims to align with industry needs, ensuring graduates are well-prepared, innovative, and committed to lifelong learning in the dynamic field of space technology and satellite engineering, enabling them to contribute effectively to the space industry's advancements and sustainability.

I SEMESTER

S.No	Course Name	Credits
1	Mathematics for Space Technology	4
2	Physics of Space Environment	4
3	Engineering Drawing and Graphics	4
4	Communication Skills	2
5	Fundamentals of Computer Science	5
6	Physics Lab	2
	Total Credits	**21**

II SEMESTER

S.No	Course Name	Credits
1	Introduction to Space Science and Exploration	3
2	Fundamentals of Space Materials	3
3	Introduction to Electrical and Electronics Engineering	4
4	Basics of Satellite Engineering	3
5	Chemistry	3
6	Electrical and Electronics Lab	3
	Total Credits	**19**

Exit Option at the End of Year 1: At the end of the first year, students can opt for a **Certificate in Space Science and Engineering**, which is a one-year program. This can serve as an intermediate qualification for those who wish to exit the program early.

III Semester

S.No	Course Name	Credits
1	Orbital Mechanics and Celestial Mechanics	3
2	Thermodynamics and Heat Transfer	3
3	Analog and Digital Electronics	3
4	Electromagnetic Theory	3
5	Data Structures and Algorithms	4
6	Thermal Engineering Laboratory	2
7	Digital Logic Design Laboratory	2
	Total Credits	**20**

IV Semester

S.No	Course Name	Credits
1	Remote Sensing and Earth Observation	3
2	Satellite System and Communication Engineering	4
3	Avionics and Navigation	3
4	Radio wave Propagation & Antenna Applications	3
5	Statistics and Data Analytics/Numerical Methods	3
6	Remote Sensing Laboratory	2
7	Communication Systems Laboratory	2
	Total Credits	**20**

Exit Option at the End of Year 2: At the end of the second year, students can earn a Diploma and opt for an **Advance Diploma in Space Technology and Satellite Engineering,** which is a three-year program.

V Semester

S.No	Course Name	Credits
1	Mechanical Design of Spacecraft	4
2	Introduction to Earth, Atmosphere and Ocean Sciences	3
3	Aerospace Structures and Materials	3
4	Control Systems	3
5	Embedded Systems	3
6	Spacecraft Design Laboratory	2
7	Control System Laboratory	2
	Total Credits	**20**

VI Semester

S.No	Course Name	Credits
1	Spacecraft Design - Electronic Sub-systems	4
2	Launch Vehicle and Propulsion	4
3	Space Instrumentation and Applications	3
4	Digital Signal Processing	4
5	UG Elective - I	3
6	Digital Signal Processing Laboratory	2
	Total	**20**

Exit Option at the End of Year 3: At the end of the third year, students can exit to earn an **Advanced Diploma in Space Engineering** and further opt for a Bachelor's degree in Space Technology and Satellite Engineering, which is a 4-year program.

VII Semester

S.No	Course Name	Credits
1	Spacecraft Dynamics and Control	4
2	Space Robotics and Automation	3
3	Space Economics, Policy & Space Act and Benefits	3
4	UG Elective - II	3
5	Internship*	2
6	Spacecraft dynamics and control Laboratory	2
7	Space Launch Systems Laboratory	2
	Total Credits	**19**

Internship* - Students has to pursue the internship during the summer vacation

VIII Semester

S.No	Course Name	Credits
1	Space Entrepreneurship and Innovation	3
2	Project Work	18
	Total Credits	**21**

Exit Option at the End of Year 4: At the end of the fourth year, students can opt for a **Bachelor of Technology (B. Tech) degree in Space Technology and Satellite Engineering**, and further opt for a Masters's degree in Space Technology and Satellite Engineering, which is a 5-year program.

IX Semester

S.No	Course Name	Credits
1	Research Methodology	2
2	Space Systems Integration and Testing	3
3	Space Debris and Collision Avoidance	3
4	Human Spaceflight and Life Support Systems	3
5	PG Elective - I	3
6	Dissertation - Phase I	4
7	Systems Integration and Testing Laboratory	2
	Total Credits	**20**

X Semester

S.No	Course Name	Credits
1	Internship	2
2	Dissertation - Phase II	18
	Total Credits	**20**

Note: In the 5th year, the focus shifts to internships and research projects, and laboratory work may vary depending on the specific projects and institutions involved. These activities may not follow a traditional lab course structure.

Please note that the above list provides a general overview of the types of experiments that can be conducted in laboratory courses. The specific experiments and equipment used may vary depending on the availability of resources and the curriculum of the institution offering the program.

UG ELECTIVES

- Quantum Information Theory
- Advanced Sensors and Interface Electronics
- Machine Learning for Signal Processing
- Lasers and Optoelectronics
- Space Flight Mechanics
- Galaxies and Cosmology
- Meteorology and Climate Modelling
- Space Mission Analysis and Design
- Space Ethics and Sustainability
- Space Project Management
- Space Weather and Radiation Effects
- Introduction to Artificial Intelligence

PG ELECTIVES

- Satellite Attitude Dynamics and Control (https://archive.nptel.ac.in/courses/101/106/101106046/)
- Space Data Systems and Processing
- Spacecraft Thermal Systems
- Advanced Guidance, navigation, and control (Univ. Surrey)
- Ground Satellite Systems (https://www.bradford.ac.uk/courses/pg/satellite-systems-engineering/)
- Aerospace navigation and sensors
- Introduction to Artificial Intelligence

Semester 1:

1. **Mathematics for Space Technology**
   - Calculus
   - Linear Algebra
   - Differential Equations
   - Complex Numbers
   - Probability and Statistics
   - Vector Analysis

2. **Physics of Space Environments**
   - Introduction to Space Environment
   - Solar and Cosmic Radiation
   - Space Weather and Effects on Satellites
   - Space Plasma Physics
   - Magnetospheres and Ionospheres
   - Space Environment Modeling

3. **Engineering Drawing and Graphics**
   - Engineering Drawing Principles
   - CAD (Computer-Aided Design) Software
   - 2D and 3D Modeling
   - Technical Sketching and Blueprint Reading

4. **Communication Skills**
   - Introduction to English Communication
   - Listening and Speaking Skills
   - Writing Skills
   - Reading Comprehension
   - Non-verbal Communication
   - Group Communication and Presentations

5. **Fundamentals of Computer Science**
   - Introduction to Programming
   - Algorithms and Data Structures
   - Object-Oriented Programming
   - Software Development Tools
   - Problem Solving and Programming Exercises
   - Programming Languages (e.g., Python)

6. **Physics Laboratory**
   - Measurement of Basic Physical Constants
   - Experiments on Mechanics, including Motion and Forces
   - Study of Optics and Light
   - Measurement of Electrical Parameters

Semester :2

1. **Introduction to Space Science and Exploration**
   - Historical Overview of Space Exploration
   - Key Figures in Space Science
   - Basics of Astronomy
   - The Solar System
   - Space Agencies and Organizations
   - Space Missions and Discoveries

2. **Fundamentals of Space Materials**
   - Introduction to Space Environment and Material selection criteria.
   - Metals and Alloys in space
   - Polymers and composite
   - Ceramics and Glasses
   - Coatings for space application
   - Advanced Materials for space.

3. **Introduction to Electrical and Electronic Engineering**
   - Basic Electrical Circuits
   - Electronic Components and Devices
   - Circuit Analysis
   - Digital Electronics
   - Power Systems
   - Electric Machines

4. **Basics of Satellite Engineering**
   - Introduction to Satellite Engineerin
   - Orbital Mechanics and Satellite Orbits
   - Satellite Subsystems and Design
   - Satellite Communication and Payload
   - Spacecraft Operations and Launch

5. **Chemistry**
    - Chemical Kinetics
    - Electro chemical Systems
    - Corrosion Science
    - Spectroscopy
    - Propellants

6. **Electrical and Electronics Engineering**
    - Circuit Analysis
    - Series and Parallel Resistor Circuits
    - RC Time Constant Measurement
    - Basic Electronics Component Identification and Testing
    - Breadboarding and Circuit Building
    - Use of Oscilloscopes and Multimeters
    - Simple Electronic Circuit Experiments

Semester 3:

1. **Orbital Mechanics and Celestial Mechanics**
    - Kepler's Laws of Planetary Motion
    - Orbital Parameters and Coordinate Systems
    - Satellite Orbits and Perturbations
    - Hohmann Transfer Orbits
    - Lunar and Interplanetary Trajectories

2. **Thermodynamics and Heat Transfer**
    - Laws of Thermodynamics
    - Heat and Mass Transfer
    - Thermodynamic Cycles
    - Fluid Mechanics
    - Thermal Analysis in Spacecraft

3. **Analog and Digital Electronics**
    - Semiconductor Devices
    - Analog Electronics Circuits
    - Digital Logic Circuits
    - Microcontrollers and Embedded Systems
    - Electronic Circuit Design

4. **Electromagnetic Theory**
    - Maxwell's Equations
    - Electromagnetic Waves
    - Antennas and Radiation
    - Wave Propagation in Space
    - Satellite Communication

5. **Data Structures and Algorithms**
   - Data Structures (Arrays, Linked Lists, Trees)
   - Sorting and Searching Algorithms
   - Algorithm Analysis
   - Graph Algorithms
   - Dynamic Programming

6. **Thermal Engineering Laboratory**
   - Thermal Analysis of Materials
   - Heat Transfer Experiments
   - Thermal Control System Testing
   - Thermal Stress Analysis

7. **Digital Logic Design Laboratory**
   - Logic Gates and Truth Tables
   - Combinational Logic Circuit Design
   - Flip-Flops and Sequential Logic Circuits
   - Experiment with Digital Logic Simulators

Semester: 4

1. Remote Sensing and Earth Observation
   - Remote Sensing Principles
   - Satellite Remote Sensing
   - Image Processing Techniques
   - Earth Observation Applications
   - GIS (Geographic Information Systems

2. Satellite System and Communication Engineering
   - Introduction to satellite systems
   - Satellite Communication Systems
   - Satellite Subsystems and Operations
   - Satellite control and telemetry
   - Emerging Trends and Applications

3. Avionics and Navigation
   - Avionics Components
   - Inertial Navigation Systems
   - GPS and Satellite Navigation
   - Navigation Algorithms
   - Flight Control Systems

4. Radio Wave Propagation and Antenna Application
   - Introduction to Radio Wave Propagation
   - Antenna Fundamentals
   - Radio Wave Propagation Models
   - Antenna Design
   - Advancement in Radio Wave Propagation

5. **Numerical Methods**
   - Numerical Solution of Equations
   - Interpolation and Approximation
   - Numerical Integration and Differentiation
   - Ordinary Differential Equations
   - Finite Element Analysis

6. Statistics and Data Analytics
   - Introduction to Statistics and Data Analysis
   - Exploratory Data Analysis (EDA)
   - Statistical Inference
   - Data Analytics and Visualization
   - Regression Analysis and Predictive Modeling

7. Remote Sensing Laboratory
   - Image Processing using Remote Sensing Data
   - Analysis of Remote Sensing Images
   - Interpretation of Satellite Imagery
   - GIS Applications

8. Communication System Laboratory
   - RF Signal Measurement and Analysis
   - Antenna Design and Testing
   - Satellite Link Budget Calculations
   - Implementation of Modulation and Demodulation Techniques

Semester: 5

1. Mechanical Design of Spacecraft
- Spacecraft configurations
- Mechanical design
- Foundations of stress analysis and mechanics of materials
- Launch loads
- Introduction to vibration theory for space systems
- Testing of space hardware
- Mechanism and its types

2. Introduction to Earth, Atmosphere and Ocean Sciences
- Earth's Structure and Composition
- Atmospheric Science
- Oceanography
- Geological Processes
- Interactions Between Earth, Atmosphere, and Oceans

3. Aerospace Structures and Materials

- Structural Analysis
- Aircraft and Spacecraft Structures
- Composite Materials
- Stress and Strain Analysis
- Finite Element Analysis in Aerospace

4. Control System

- Control System Components
- Feedback Control Systems
- Laplace Transforms
- Stability Analysis
- Control System Design

5. Embedded Systems

- Embedded Systems Architecture
- Microcontroller Programming
- Real-Time Operating Systems
- Interface and Peripheral Integration
- Embedded Systems Applications

6. Spacecraft Design Laboratory

- Spacecraft Design Software Utilization
- Preliminary Design of a CubeSat
- Subsystem Integration
- Risk Assessment and Mitigation

7. Control System Laboratory

- Open and closed loop control system
- Transfer Function Analysis
- Stability Analysis
- PID Controller Tuning
- Root Locus Analysis
- State Space Analysis
- Control system Simulation

Semester:6

1. Spacecraft Design – Electronic systems

- Power Systems
- Attitude sensing and control
- Harnesses
- Reliability
- Analogue design

2. **Launch Vehicle and Propulsion**

- Introduction to Launch Vehicle Engineering
- Rocket Propulsion Fundamentals
- Launch Vehicle Design and Performance
- Propulsion Technologies

3. Space Instrumentation and Applications

- Spacecraft as observation platforms
- Spacecraft-environment interactions
- In-situ plasma measurements
- Detectors and sensors for in-situ measurements
- Atmospheric measurements
- Astronomical observations

4. Digital Signal Processing

- Signal Sampling and Transformations
- Filter Design and Analysis
- Image and Audio Processing
- DSP Applications in Space
- Real-time DSP Systems

5. Digital Signal Processing Laboratory

- Signal Processing using Software Tools
- Design and Analysis of Filters
- Real-time DSP Applications
- Image and Audio Processing

Semester: 7

1. Spacecraft Dynamics and Control

- Orbital Maneuvers and Control
- Attitude Dynamics
- Control Systems for Spacecraft
- Autonomous Navigation
- Spacecraft Mission Operations

2. **Space Robotics and Automation**

- Robotic Manipulators and Kinematics
- Robot Control and Programming
- Space Robotics Applications
- Autonomous Robotic Systems
- Human-Robot Interaction

3**. Space Economics, Policy, Act and Benefits**

- Introduction to Space Economics and Policy
- Space Policy and Legal Framework
- Space Industry Economics
- Space Benefits and Applications
- Future Trends and Space Sustainability

4. Spacecraft Dynamics and Control Laboratory

- Experimentation with Attitude Control Systems
- Simulation of Orbit Maneuvers
- Development of Control Algorithms
- Control System Testing

5. Space Launch System Laboratory

- Rocket Propulsion Testing
- Structural Analysis
- Aerodynamic Testing
- Payload Integration
- Guidance, Navigation, and Control (GNC)
- Avionics and Telemetry

Semester:8

1. **Space Entrepreneurship and Innovation**

- Entrepreneurship in Space Industry
- Start-up Fundamentals
- Technology Commercialization
- Space Industry Trends and Opportunities
- Business Plan Development

Semester: 9

1. Research Methodology

- Introduction to Research and Research Design
- Data Collection and Analysis
- Ethical Considerations
- Research Reporting and Presentation

2. Space System Integration and Testing

- Spacecraft Integration and Testing Process
- Environmental Testing (Vibration, Thermal, Vacuum)
- Qualification and Acceptance Testing
- Test Facilities and Equipment
- Test Data Analysis

3. **Space Debris and Collision Avoidance**

- Space Debris Characterization
- Space Traffic Management
- Collision Risk Assessment
- Active and Passive Debris Removal
- International Guidelines

4. Human Spaceflight and Life Support Systems

- Human Factors in Space
- Life Support Systems
- Space Medicine and Physiology
- Space Habitats and Life Support Design
- Crewed Space Missions

5. Space System Integration and Testing Laboratory

- Full-scale Spacecraft Integration
- Environmental Testing (Vibration, Thermal, Vacuum)
- Electrical Integration and Testing
- Test Data Analysis and Reporting

UG ELECTIVES

1. Quantum Information Theory

- Introduction to Quantum Mechanics
- Quantum Entanglement
- Quantum Information and Quantum Bits
- Quantum Cryptography and Quantum Key Distribution
- Quantum Computing and Quantum Error Correction

2. Advanced Sensors and Interface Electronics

- Introduction to Advanced Sensors
- Sensor Signal Conditioning and Amplification
- Digital Signal Processing (DSP) for Sensors
- Wireless Sensor Networks

3. **Machine Learning for Signal Processing**

- Introduction to Machine Learning and Signal Processing
- Feature Extraction and Preprocessing
- Supervised Learning for Signal Processing
- Unsupervised Learning and Deep Learning
- Time-series analysis and forecasting using machine learning

4. Lasers and Optoelectronics

- Introduction to Lasers and Optoelectronics
- Laser Types and Operation
- Optoelectronic Devices
- Laser Applications
- Optical Communication and Photonics

5. Space Flight Mechanics

- Introduction to Space Flight Mechanics
- Orbit Determination and Propagation
- Trajectory Optimization
- Attitude Dynamics and Control
- Multi-body dynamics and n-body problems in space mechanics

6. Galaxies and Cosmology

- Introduction to Galaxies and Universe
- Stellar Populations and Galaxy Formation
- Galaxy Structures and Dynamics
- Cosmology and the Expanding Universe
- Modern Observational Techniques and Discoveries

7. Meteorology and Climate Modelling

- Meteorology and Climate Science
- Atmospheric Dynamics and Weather Pattern
- Climate Modeling and Climate Change
- Data Collection and Analysis
- Mitigation and Adaptation Strategies

8. Space Mission Analysis and Design

- Mission Planning and Objectives
- Mission Analysis Tools and Software
- Trajectory Design and Optimization
- Payload Selection and Integration
- Mission Risk Assessment

9. Space Ethics and Sustainability

- Ethical Considerations in Space Exploration
- Space Debris and Space Traffic Management
- Sustainable Space Operations
- International Space Cooperation
- Space Law and Policy

10. Space Project Management

- Project Management Principles
- Project Planning and Scheduling
- Risk Management in Space Projects
- Cost Estimation and Budgeting
- Case Studies in Space Project Management

11. Space Weather and Radiation Effects

- Space Weather Phenomena
- Radiation Environment in Space
- Effects on Electronics and Materials
- Radiation Shielding
- Mitigation and Hardening Techniques

12. Introduction to Artificial Intelligence

- Machine Learning Fundamentals
- Neural Networks and Deep Learning
- AI Algorithms and Applications
- AI in Space Technology
- Ethics in AI

PG ELECTIVES

1. **Satellite Attitude Dynamics and Control**

- Kinematics of Rotation
- Rigid Body Dynamics
- Stability of torque free rotation
- Gravity gradient Satellite
- Spin stabilisation

2. **Space Data System and Processing**

- Positioning
- Solar-Terrestrial Relationships
- Telecommunications
- Earth Observations (EO) and Global Change
- Time Domain Analysis for Astronomy

3. Spacecraft Thermal system

- Heat Transfer in Space
- Thermal Control Methods
- Radiative and Conductive Heat Transfer
- Thermal Protection Systems
- Spacecraft Thermal Analysis

4. Advanced Guidance, Navigation and Control

- Review of Attitude dynamics and coordinates
- Attitude determination and estimation
- Attitude control
- Overview of Satellite orbits
- Atmospheric drag modelling

5. Ground Satellite System

- Introduction to Ground Satellite Systems
- Antennas and RF Systems
- Satellite Tracking and Orbit Determination
- Ground Station Operations and Control
- Data Reception and Processing
- Satellite Constellations and Network Management

6. **Aerospace Navigation and Sensors**

- Overview of navigation principles
- GNSS
- Sensors and Data Fusion

7. Introduction to Artificial Intelligence

- Machine Learning Fundamentals
- Neural Networks and Deep Learning
- AI Algorithms and Applications
- AI in Space Technology
- Ethics in AI

Pedagogical Methods:

1. Lectures
2. Laboratory Work
3. Project-Based Learning
4. Guest Lectures
5. Case Studies
6. Seminars and Workshops
7. Group Discussions
8. Field Visits
9. Online Learning

Assessment Methods:

1.Examinations.
2. Assignments and Reports.
3. Presentations
4. Laboratory Assessments
5. Quizzes and Tests
6. Peer Assessment
7. Midterm and Final Assessments.
8. Viva Voce
9. Project Evaluation:
10. Continuous Assessment:

The United Nations Sustainable Development Goals (SDGs) provide a framework for addressing global challenges and promoting sustainability. Here is how the pedagogy and assessment methods in an M.Tech. program in Space Technology and Satellite Engineering can align with specific SDGs:

1. Lectures and Workshops (Pedagogy):
- SDG 4 (Quality Education): Providing quality education by delivering informative lectures and workshops to equip students with advanced knowledge and skills.

2. Laboratory Work and Project-Based Learning (Pedagogy):
- SDG 9 (Industry, Innovation, and Infrastructure): Promoting innovation and infrastructure development through hands-on laboratory work and project-based learning.

3. Guest Lectures (Pedagogy):
- SDG 17 (Partnerships for the Goals): Fostering partnerships with industry experts to share insights and collaborate on research aligned with SDGs.

4. Case Studies (Pedagogy):
- SDG 13 (Climate Action): Analyzing satellite missions and climate-related data to understand the impact of climate change.

5. Seminars and Workshops (Pedagogy)
- SDG 4 (Quality Education): Enhancing education quality through interactive seminars and workshops on advanced topics.

6. Group Discussions (Pedagogy):
- SDG 4 (Quality Education): Encouraging peer learning and collaboration to improve the overall education experience.

7. Field Visits (Pedagogy):
- SDG 9 (Industry, Innovation, and Infrastructure): Promoting innovation in satellite technology through visits to manufacturing facilities.

8. Online Learning (Pedagogy):
- SDG 4 (Quality Education): Expanding access to education resources through online learning platforms.

9. Examinations and Assignments (Assessment):
- SDG 4 (Quality Education): Assessing students' knowledge and understanding to ensure quality education.

10. Presentations (Assessment):
- SDG 4 (Quality Education): Evaluating students' communication skills and ability to convey complex ideas.

11. Project Evaluation (Assessment):
- SDG 9 (Industry, Innovation, and Infrastructure): Assessing innovation and research outcomes in satellite technology.

12. Continuous Assessment (Assessment):
- SDG 4 (Quality Education): Ensuring ongoing assessment to monitor and support students' progress.

By aligning the pedagogical and assessment methods with the SDGs, the M.Tech. program not only equips students with knowledge and skills but also contributes to global sustainability goals, particularly in areas related to education, innovation, and industry development.

M.Tech. Medical Devices Engineering

(Integrated Masters - 5 Years)

CHOICE BASED CREDIT SYSTEM (CBCS)

CURRICULUM AND SYLLABUS

CREDIT DISTRIBUTION

SDG 3: Good Health and Well Being

CATEGORY	CREDITS AS PER SEMESTER										CREDITS TOTAL
	I	II	III	IV	V	VI	VII	VIII	IX	X	
Humanities and Social sciences (HS)	3										**3**
Basic Sciences (BS)	8	8	4	4							**24**
Engineering Sciences (ES)	5	12		2	2						**21**
Professional Core (PC)			19	12	21	6	10	12	5		**88**
Professional Elective (PE)						6	6	6	6	6	**30**
Open Elective (OE)						3	3				**6**
Project, Seminar & Internship (EEC)				1	1	6	4	3	4	12	**28**
Mandatory Courses											**Non-Credited**
TOTAL	**16**	**20**	**23**	**19**	**24**	**21**	**23**	**21**	**15**	**18**	**200**

CURRICULUM

Semester I

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	HS	Technical English	2	1	0	3	3
2	BS	Linear Algebra and Calculus	3	1	0	4	4
3	BS	Physics for Bioscience	3	0	2	5	4
4	ES	Engineering Graphics	2	2	0	4	4
5	ES	Engineering Practices - Civil & Mechanical	0	0	2	2	1
6	MC	Environmental Science and Engineering	3	0	0	3	0
			13	**4**	**4**	**21**	
						TOTAL CREDITS	**16**

Semester II

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	BS	Differential Equations and Complex Variables	3	1	0	4	4
2	BS	Chemistry For Electronics Engineering	3	0	2	5	4
3	ES	Basic Electrical Engineering	3	0	2	5	4
4	ES	Engineering Mechanics for Biomedical Engineers	2	1	0	3	3
5	ES	Fundamentals of Data Structures using C	3	0	4	7	5
6	MC	Indian Constitution and Freedom Movement	3	0	0	3	0
			17	**2**	**8**	**27**	
						TOTAL CREDITS	**20**

Semester III

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	BS	Fourier series and Number theory	3	1	0	4	4
2	PC	Human Anatomy and Physiology	3	0	0	3	3
3	PC	Electron Devices & Circuits	2	0	2	4	3
4	PC	Sensors and Measurements	2	0	2	4	3
5	PC	Analog and Digital Integrated Circuits	3	0	0	3	3
6	PC	Biochemical Science	3	0	0	3	3
7	PC	Biochemistry and Physiology Laboratory	0	0	4	4	2
8	PC	Analog and Digital Integrated Circuits	0	0	4	4	2
			16	**1**	**12**	**29**	
						TOTAL CREDITS	**23**

Semester IV

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	BS	Probability and Random Process	3	1	0	4	4
2	PC	Biomedical Instrumentation	3	0	0	3	3
3	PC	Pathology and Microbiology	2	0	2	4	3
4	ES	Problem Solving and Programming in Python	1	0	2	3	2
5	PC	Principles of Communication Systems	2	0	0	2	2
6	PC	PCB Design	1	0	2	3	2
8	EEC	Soft Skills-I	0	0	2	2	1
9	MC	Essence of Indian Traditional knowledge	3	0	0	3	0
10	PC	Biomedical Instrumentation Laboratory	0	0	4	4	2
			15	**1**	**12**	**28**	
						TOTAL CREDITS	**19**

Semester V

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	PC	Biocontrol Systems	3	0	0	3	3
2	PC	Digital Signal Processing	3	1	0	4	4
3	PC	Microprocessor, Microcontroller and Embedded System Design	3	0	2	5	4
4	ES	Python Programming for Machine learning	1	0	2	3	2
5	PC	Diagnostic Equipment	3	0	0	3	3
6	PC	Therapeutic Equipment	3	0	0	3	3
7	PC	Diagnostic and Therapeutic Equipment Laboratory	0	0	4	4	2
8	PC	Digital Signal Processing Laboratory	0	0	4	4	2
9	EEC	Soft Skills –II	0	0	2	2	1
			16	**1**	**14**	**31**	
						TOTAL CREDITS	**24**

Semester VI

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	PC	Radiological Equipment	3	0	0	3	3
2	PC	Biomechanics	3	0	0	3	3
3	PC	PE 1	3	0	0	3	3
4	PE	PE 2	3	0	0	3	3
5	OE	OE 1	3	0	0	3	3
6	EEC	Innovation and Design thinking for Biomedical Engineers	0	1	2	3	2
7	EEC	Problem solving techniques	0	0	2	2	1
8	EEC	Medical Industrial Training (Internship)	0	0	6	6	3
			15	**1**	**10**	**26**	
		TOTAL CREDITS					**21**

Semester VII

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	PC	Digital Image Processing Techniques	2	1	2	5	4
2	PC	Hospital Engineering and Management	2	0	0	2	2
3	OE	OE- 2	3	0	0	3	3
4	PE	PE- 3	3	0	0	3	3
5	PE	PE – 4	3	0	0	3	3
6	EEC	AI-ML-DL in Healthcare	0	0	6	6	3
7	EEC	Hospital Training	0	0	2	2	1
8	PC	Rapid Prototyping	3	0	2	5	4
			15	**1**	**12**	**29**	
						TOTAL CREDITS	**23**

Semester VIII

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	PC	Human Assist Devices	3	0	0	3	3
2	PC	ICU & OT Equipment	2	0	0	2	2
3	PC	Medical Device Design	3	0	0	3	3
4	PC	Medical Device Regulations	2	0	0	2	2
5	PE	PE-5	3	0	0	3	3
6	PE	PE-6	3	0	0	3	3
7	PC	Medical Device Design Laboratory	0	0	4	4	2
8	EEC	Mini Project	0	0	6	6	3
			16	**0**	**10**	**26**	
						TOTAL CREDITS	**21**

Semester IX

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	PC	Patient safety, Standards and Ethics	2	0	0	2	2
2	PE	PE- 7	3	0	0	3	3
3	PE	PE-8	3	0	0	3	3
4	PC	Wearable Devices	3	0	0	3	3
5	EEC	Technical Term Paper Writing	0	0	2	2	1
6	EEC	Project Work – Phase I	0	0	6	6	3
			14	**0**	**10**	**24**	
						TOTAL CREDITS	**15**

Semester X

SL. No	Category	Course Title	L	T	P	Contact Periods	Credits
1	PE	PE-9	3	0	0	3	3
2	PE	PE-10	3	0	0	3	3
3	EEC	Project Work – Phase II	0	0	24	24	12
			6	**0**	**24**	**30**	
						TOTAL CREDITS	**18**

TOTAL CREDITS: 200

Innovative Teaching Pedagogy

- Live-in Lab
- Flipped classes
- Demonstration
- Mini / Capstone Project
- Group Activities
- Virtual Lab experience
- Rapid/ Online Quiz
- Survey Study
- Project based assignment
- Case Study
- Padlet

PROFESSIONAL ELECTIVES (PE)

BIO-ENGINEERING (PE 1)								
SL No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1		Medical Physics	PE	3	3	0	0	3
2		Biomaterials and Artificial Organs	PE	3	3	0	0	3
3		Medical Optics	PE	3	3	0	0	3
4		Neural Engineering	PE	3	3	0	0	3
5		Tissue Engineering	PE	3	3	0	0	3

HEALTHCARE MANAGEMENT (PE 2)								
1		Business Economics and Financial Analysis	PE	3	3	0	0	3
2		Statistics for Health Sciences	PE	3	3	0	0	3
3		Health Policy and Equipment Management	PE	3	3	0	0	3
4		Human Resource Management in Hospitals	PE	3	3	0	0	3
5		Medical waste Management	PE	3	3	0	0	3
SIGNAL, IMAGE AND INFORMATION PROCESSING (PE 3)								
1		Biosignal Processing	PE	3	3	0	0	3
2		Speech Processing	PE	3	3	0	0	3
3		Pattern Recognition and Neural Networks	PE	3	3	0	0	3
4		Biometrics	PE	3	3	0	0	3
5		Medical Informatics	PE	3	3	0	0	3
MEDICAL DEVICE DEVELOPMENT (PE 4)								
1		Foundation Skills in integrated product Development	PE	3	3	0	0	3
2		Medical Innovation and Entrepreneurship	PE	3	3	0	0	3
3		Additive Manufacturing	PE	3	3	0	0	3
4		Research Methodology and IPR	PE	3	3	0	0	3
5		Hardware Software Co-design	PE	3	3	0	0	3
ASSISTIVE TECHNOLOGIES (PE 5)								
1		Rehabilitation Engineering	PE	3	3	0	0	3
2		Medical Robotics	PE	3	3	0	0	3
3		VR, AR and Mixed Reality	PE	3	3	0	0	3
4		Ergonomics	PE	3	3	0	0	3
5		Haptics	PE	3	3	0	0	3

ADVANCED TECHNOLOGIES (PE 6)								
1		MEMS and Microfludics	PE	3	3	0	0	3
2		Nanotechnology and Applications	PE	3	0	0	3	3
3		Embedded System and Internet of Things for Biomedical Applications	PE	3	3	0	0	3
4		Tele Health Technology	PE	3	3	0	0	3
5		Data Analytics for Health Care Technologies	PE	3	3	0	0	3
MIXED TECHNOLOGIES (PE 7)								
1		Physiological Modelling	PE	3	3	0	0	3
2		Genetic Engineering	PE	3	3	0	0	3
3		Wavelet Transforms and Its Applications	PE	3	3	0	0	3
4		Biofluid Dynamics	PE	3	3	0	0	3
5		PSYCHOLOGY AND SOCIAL ISSUES	PE	3	3	0	0	3
Professional Elective (PE 8)								
1		Body Area Networks	PE	3	3	0	0	3
2		Forensic Science in healthcare	PE	3	3	0	0	3
3		Reliability Engineering	PE	3	3	0	0	3
4		Smart Sensors for Healthcare	PE	3	3	0	0	3
Professional Elective (PE 9)								
1		Human Factors in Engineering & Design	PE	3	3	0	0	3
2		Biocompatibility and Electromagnetic Interference	PE	3	3	0	0	3
3		Virtual Bioinstrumentation	PE	3	3	0	0	3
4		Bioinformatics and Drug Design	PE	3	3	0	0	3

Professional Elective (PE 10)								
1		Introduction to Data Base Management Systems	PE	3	3	0	0	3
2		Brain Computer Interface and Applications	PE	3	3	0	0	3
3		Medical Textiles	PE	3	3	0	0	3
4		Graphical System Design for Biomedical Engineers	PE	3	3	0	0	3

M.Tech. MEDICAL DEVICES ENGINEERING

(5 YEARS INTEGRATED PROGRAMME)

CHOICE BASED CREDIT SYSTEM (CBCS)

SYLLABUS

SEMESTER I

SL. No	Category	Course Title	L	T	P	Contact Periods	Credits
1	HS	Technical English	2	1	0	3	3
2	BS	Linear Algebra and Calculus	3	1	0	4	4
3	BS	Physics for Bioscience	3	0	2	5	4
4	ES	Engineering Graphics	2	2	0	4	4
5	ES	Engineering Practices - Civil & Mechanical	0	0	2	2	1
6	MC	Environmental Science and Engineering	3	0	0	3	0
			13	**4**	**4**	**21**	
		TOTAL CREDITS					**16**

Technical English **L T P C**
2 1 0 3

UNIT I VOCABULARY BUILDING

The concept of word formation - Root words from foreign languages and their use in English - Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives - Synonyms, antonyms, and standard abbreviations. Compound words – abbreviation – single word substitution – Listening: Listening comprehension, listening to motivational speeches, podcasts and poetry. Speaking: Short talks on incidents - place of visit – admiring personalities, etc.

UNIT II BASIC WRITING SKILLS

Sentence structures - Use of phrases and clauses in sentences - punctuation - coherence - Organizing principles of paragraphs in documents - Techniques for writing precisely. Reading & Writing – Free writing – paragraphs - article reading and writing criticism - change of tense forms in short text or story – inferential reading – rewrite or interpret text - prepare questions based on the text. Speaking: Everyday situations – conversations and dialogues, speaking for and against.

UNIT III GRAMMAR AND LANGUAGE DEVELOPMENT

Subject-verb agreement- Noun-pronoun agreement - Articles – Prepositions – Redundancies. Reading & Writing: Read from innovation and ideas that changed the world, newspaper column writing – Speaking: Demonstrative speaking practice using visual aids (charts, graphs, maps, pictures, etc.).

UNIT IV WRITING FOR FORMAL PRESENTATION

Nature and Style of sensible Writing - Describing – Defining – Classifying - Providing examples or evidence - Writing introduction and conclusion. Reading & Writing – Read from Literary pieces – identify different parts text – difference between print and digital writing. Writing: Recommendations - Foreword - Review of book. Speaking- Formal Presentations – Debate on social issues/taboos and solutions.

UNIT V EXTENDED WRITING AND SPEAKING

Writing: Précis writing – Essay writing – workplace communication: Resume – Business letters and emails – Proposals. Speaking: Panel discussion – reporting an event – mock interview – Master Ceremony.

Linear Algebra and Calculus **L T P C**

3 0 1 4

UNIT I MATRICES

Symmetric and skew – symmetric matrices , orthogonal matrices – Eigen values and Eigen vectors - Cayley – Hamilton theorem (without proof) and applications - orthogonal transformation and quadratic forms to canonical forms - Nature of quadratic forms.

UNIT II VECTOR SPACES

Vector space – Linear dependence and independence of vectors, bases, dimensions - range and kernel of a linear map, rank and nullity – matrix of Linear transformation - inverse of a linear transformation - rank nullity theorem – composition of Linear maps – Matrix Associated with Linear Map - inner products and norms – Gram – Schmidt orthogonalisation.

UNIT III DIFFERENTIAL CALCULUS AND APPLICATIONS

Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes and Envelopes - Partial derivatives: Definitions and Simple problems - Jacobian and properties – Taylor's series for functions of two variables – Lagrange's method of undetermined multipliers.

UNIT IV APPLICATION OF INTEGRATION AND IMPROPER INTEGRALS

Evaluation of area, surface area and volume of revolution - Centre of Gravity – Moment of inertia – Improper integrals: Beta and Gamma integrals and their properties. UNIT V MULTIPLE INTEGRAL 12 Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

Physics for Bioscience **L T P C**
3 0 2 4

UNIT I PROPERTIES OF MATTER

Elasticity – Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple - torsion pendulum: theory and experiment - bending of beams –area moment of inertia - bending moment – cantilever - applications – uniform and non-uniform bending- I-shaped girders - stress due to bending in beams.

UNIT II QUANTUM PHYSICS AND SUPERCONDUCTIVITY

Introduction to wave function - derivation of Schrodinger wave equation -Particle in a three dimensional box – degenerate states – Fermi- Dirac statistics – Density of energy states – Electron in periodic potential – Energy bands in solids - Tunneling -scanning tunneling microscope. - Introduction of Superconductivity - Properties of Superconductors - Meissner Effect - BCS theory (qualitative) - Type-I and Type II Superconductors -Magnetic Levitation and SQUID.

UNIT III MAGNETIC AND DIELECTRIC MATERIALS

Magnetism in materials – magnetic field and induction – magnetization - magnetic permeability and susceptibility–types of magnetic materials – microscopic classification of magnetic materials – Ferromagnetism origin and exchange interaction- saturation magnetization and Curie temperature – Domain Theory- M versus H behaviour – Hard and soft magnetic materials - Introduction electrostatics and EM waves – Tissue as a leaky dielectric - Relaxation processes: Debye model, Cole–Cole model.

UNIT IV WAVES, OPTICS, AND SOUND

Oscillatory motion – forced and damped oscillations: differential equation and its solution – plane progressive waves – wave equation -Physics of light-Measurement of light and its unit – an overview of limits of vision and colour vision - Physics of sound, Normal sound levels – ultrasound fundamentals – Generation of ultrasound (Ultrasound Transducer) Nondestructive Testing – pulse echo system through transmission and reflection modes - A,B and C – scan displays, Medical applications – Sonogram.

UNIT V NUCLEAR AND PARTICLE PHYSICS

Radioactivity - characteristics of radioactive material – isotopes - probing by isotopes, reactions involved in the preparation of radioisotopes, the Szilard-Chalmer's reaction – radiochemical principles in the use of tracers - nuclear medicines – Interaction of charged particles with matter –Specific ionization, Linear energy transfer, range, Bremsstrahlung, Annihilation. Gamma-Ray Spectrometry- Liquid Scintillation Counters-Characteristics of Counting Systems-Gamma Well Counters

LIST OF EXPERIMENTS: PHYSICS LABORATORY (Any 10 experiments)

1. Determination of Young's Modulus of the given material by Uniform bending
2. Determination of Young's Modulus of the given material by Non Uniform bending
3. Determination of Rigidity Modulus of the given material by Torsion pendulum

4. Determination of Band gap of given Semiconducting material.
5. To determine the work function and threshold frequency using Einstein's Photoelectric effect.
6. Experiments on electromagnetic induction – B-H Curve experiment to determine magnetic parameter.
7. Determination of free space permeability using Helmholtz coil.
8. Diffraction- Determination of wavelength of diode laser.
9. Measurement of speed of light using fiber cable.
10. Spectrometer - Minimum deviation of a prism.
11. Determination of Resonance frequency of LC circuit and LCR circuits.
12. Detection of ionizing radiation using Geiger Muller Counter

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Engineering Graphics **L T P C**
2 2 0 4

UNIT I PLANE CURVES AND FREE HAND SKETCH

Curves used in engineering practices: Conics–Construction of ellipse, parabola and hyperbola by eccentricity method– Construction of cycloids, Construction of involutes of square and circle–Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE

Orthographic projection- principles-Principal planes- projection of points. First angle projection - Projection of straight lines inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method- Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

UNIT V ISOMETRIC, PERSPECTIVE PROJECTIONS AND FREEHAND SKETCHING

Principles of isometric projection–isometric scale–Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

Engineering Practices - Civil & Mechanical **L T P C**
0 0 2 1

I CIVIL ENGINEERING PRACTICE

Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects. Plumbing Works: (a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings. (b) Preparation of basic plumbing line sketches for wash basins, water heaters, etc. (c) Hands-on-exercise: Basic pipe connections – Pipe connections with different joining components. Carpentry Works: (a) Study of joints in roofs, doors, windows and furniture. (b) Hands-on-exercise: Woodwork, joints by sawing, planning and chiseling.

II MECHANICAL ENGINEERING PRACTICE

Welding: (a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding. (b) Gas welding practice. Basic Machining: (a) Simple Turning and Taper turning. (b) Drilling Practice. Sheet Metal Work: (a) Forming & Bending: (b) Model making – Trays and funnels. (c) Different type of joints. Machine assembly practice: (a) Study of centrifugal pump (b) Study of air conditioner

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ENVIRONMENTAL SCIENCE AND ENGINEERING

L T P C
3 0 0 0

UNIT I NATURAL RESOURCES

Environment -definition - scope and importance - forest resources -use and overexploitation -water resources -use and over utilization - dams - benefits and problems - water conservation -energy resources - growing energy needs - renewable and non renewable energy sources - use of alternate energy sources -land resources - land degradation - role of an individual in conservation of natural resources.

UNIT II ENVIRONMENTAL POLLUTION

Definition - causes, effects and control measures of air pollution -chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, and ozone depletion- noise pollution -mitigation procedures - control of particulate and gaseous emission(Control of SO2, NOX, CO and HC). Water pollution - definition-causes-effects of water pollutants–marine pollution-thermal pollution-radioactive pollution-control of water pollution by physical, chemical and biological processes–waste water treatment-primary, secondary and tertiary treatment. Soil pollution: definition-causes-effects and control of soil pollution.

UNIT III SOLID WASTE MANAGEMENT

Solid wastes - sources and classification of solid wastes -solid waste management options - sanitary landfill, recycling, composting, incineration, energy recovery options from wastes. Hazardous waste -definition -sources of hazardous waste-classification (biomedical waste, radioactive waste, chemical waste, household hazardous waste)-

characteristics of hazardous waste ignitability (flammable) reactivity, corrosivity, toxicity -effects of hazardous waste -case study- bhopal gas tragedy - disposal of hazardous waste-recycling , neutralization, incineration, pyrolysis, secured landfill - E-waste management -definitionsources-effects -electronic waste recycling technology.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT

Sustainable development -concept, components and strategies - social impact of growing human population and affluence, food security, hunger, poverty, malnutrition, famine - consumerism and waste products - environment and human health - role of information technology in environment and human health -disaster management– floods, earthquake, cyclone and landslide.

UNIT V TOOLS FOR ENVIRONMENTAL MANAGEMENT

Environmental impact assessment (EIA) structure -strategies for risk assessment– EISenvironmental audit-ISO 14000-precautionary principle and polluter pays principleconstitutional provisions- - pollution control boards and pollution control acts-environmental protection act 1986- role of non-government organizations-international conventions and protocols.

Semester II

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	BS	Differential Equations and Complex Variables	3	1	0	4	4
2	BS	Chemistry For Electronics	3	0	2	5	4
3	ES	Basic Electrical Engineering	3	0	2	5	4
4	ES	Engineering Mechanics for Biomedical Engineers	2	1	0	3	3
5	ES	Fundamentals of Data Structures using C	3	0	4	7	5
6	MC	Indian Constitution and Freedom Movement	3	0	0	3	0
			17	**2**	**8**	**27**	
		TOTAL CREDITS					**20**

DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES **L T P C**
3 0 1 4

UNIT I SECOND AND HIGHER ORDER DIFFERENTIAL EQUATIONS

Second and higher order Linear differential equations with constant coefficients - Method of variation of parameters –Legendre's linear equations - Formation of partial differential equations - Solutions of standard types of first order partial differential equations - Lagrange's linear equation – Linear homogenous partial differential equations of second and higher order with constant coefficients.

UNIT II VECTOR CALCULUS

Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration –Green's theorem, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelepipeds.

UNIT III ANALYTIC FUNCTIONS

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions - Bilinear transformation.

UNIT IV COMPLEX INTEGRATION

Cauchy's integral theorem – Cauchy's integral formula (excluding proof) – Taylor's and Laurent's series – Singularities – Residues – Residue theorem (excluding proof) – Application of residue theorem for evaluation of real integrals - Evaluation of real definite integrals as contour integrals around semi-circle (excluding poles on the real axis).

UNIT V LAPLACE TRANSFORM

Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms of unit step function and impulse functions, periodic functions - Inverse Laplace transform – Problems using Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

ENGINEERING MECHANICS FOR BIOMEDICAL ENGINEERS **L T P C**
3 1 0 4

UNIT I BASICS AND STATICS OF PARTICLES

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces –– Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility.

UNIT II EQUILIBRIUM OF RIGID BODIES

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force - Equilibrium of Rigid bodies in two and three dimensions.

UNIT III DYNAMICS OF PARTICLES

Displacements, Velocity and acceleration, their relationship – Relative motion – Newton's laws of motion – Work Energy Equation– Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction.

UNIT IV MECHANICS OF SOLIDS

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of rigid and non-rigid bodies - Centroids and centre of mass- Centroids of lines and areas - Rectangular, circular, triangular areas by integration – Principal moments of inertia of plane areas – Principal axes of inertia - Mass moment of inertia – mass moment of inertia for prismatic, cylindrical and spherical solids from first principle.

UNIT V BASICS OF MECHANICS OF FLUIDS

Fluids – density – pressure – blood pressure and gravity – buoyancy – moments of force and stability – movement in water –Newton's laws of viscosity – Definitions and simple problems on Newtonian fluid, Non-Newtonian fluid, Euler equations and Navier Stoke's equations, Viscoelasticity, laminar flow, Couette flow, turbulent flow and Hagen-Poiseuille equation.

CHEMISTRY FOR ELECTRONICS ENGINEERING **L T P C**

3 0 2 4

UNIT I ELECTROCHEMISTRY

Electrode potential – Electrodes– standard and reference electrodes, glass electrode. Nernst equation, emf series–applications. Galvanic and concentration cells.-applications - pH measurement, acid- base titration-potentiometric redox titration- conductometric titrations - potentiometric sensors -chemical biosignals- glucose sensor, gas sensor-blood oxygen level.

UNIT II CORROSION AND ELECTROCHEMICAL PROCESSES

Cause and effects of corrosion – theories of chemical and electrochemical corrosion – types of corrosion: galvanic, stress, intergranular corrosion and pitting corrosion – factors affecting rate of corrosion. Electroplating (copper)- electroless plating (Nickel) - electropolishing, electrochemical machining- electrochemical etching - surface preparation – etching – drying -electrochemical etching of Cu from PCB - electrophoretic painting

UNIT III BATTERIES AND FUEL CELLS

Batteries- types - battery characteristics-fabrication and working of lead- acid batteryNICAD - lithium ion batteries – supercapacitors – introduction – types – electrochemical double layer capacitor – activated carbon – carbon aerogels - Fuel cells – classification – principle – components - applications of hydrogen-oxygen fuel

cell,solid oxide fuel cell, direct methanol, proton exchange membrane fuel cells and biofuel cells.

UNIT IV ADVANCED MATERIALS

Introduction to thermoplastics and thermosetting plastics- preparation and applications of polypropylene (PP), polyvinylchloride (PVC), polyurethanes,polyamide (Nylon 6,6), polyacrylates (PAN), silicone rubber, Biodegradable polymers(PGA and PLA) - conducting polymers – introduction and examples- polyaniline. Metallic and ceramic implant materials : Composition ,properties and applications of stainless steel, titanium based alloys, cobalt – chromium alloys- ceramics – hydroxy apatite – medical applications - membranes for plasma separation and blood oxygenationintroduction.

UNIT V NANO MATERIALS

Nanomaterials: Basics-distinction between nanoparticles and bulk materials- size-dependent properties – synthesis of nanoparticles – chemical methods -metal nanocrystals by reduction, solvothermal synthesis, photochemical synthesis, sonochemical synthesis and chemical vapour deposition - applications in electronics and medicine.

LIST OF EXPERIMENTS: CHEMISTRY LABORATORY (Any 10 experiments)

1. Construction and determination of EMF of simple electrochemical cells and concentration cells

2. Estimation of acids by pH metry

3. Determination of corrosion rate on mild steel by weight loss method

4. Estimation of mixture of acids by conductometry

5. Estimation of extent of corrosion of iron pieces by potentiometry

6. Estimation of copper / ferrous ions by spectrophotometry

7. Estimation of DO by winkler's method

8. Determination of total, temporary and permanent hardness by EDTA method.

9. Estimation of alkalinity by indicator method

10. Estimation of chloride by argentometric method

11. Determination of molecular weight of a polymer by viscometry method.

12. Determination of phase change temperature of a solid.

Basic Electrical Engineering **L T P C**

3 0 2 4

UNIT-I: DC CIRCUITS

Electrical circuit elements (R, L and C), Ohms law, voltage and current sources, Kirchhoff's current and voltage laws, resistance in series-parallel, voltage and current division rule, Nodal and Mesh analysis, star-delta transformations, analysis of simple circuits with dc excitation (Independent sources only). Superposition, Thevenin's and Norton's Theorems.

UNIT-II: AC CIRCUITS

Representation of sinusoidal waveforms, average, peak and rms values, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), phasor representation, real power, reactive power, apparent power, power factor.

UNIT-III: THREE PHASE CIRCUITS & SINGLE PHASE TRANSFORMERS

Three-Phase balanced circuits: Generation of three phase voltage, voltage and current relations in star and delta connections. Single Phase Transformers: Ideal and practical transformer, EMF equation, equivalent circuit, phasor diagram, losses in transformers, regulation and efficiency.

UNIT-IV: DC MACHINES

Construction, working principle of DC generator and motors, EMF equation of DC generator, Torque equation of DC motor, classification of DC generators and motors. Torque-speed characteristics – speed control of DC shunt motor using armature and flux control methods – Applications of DC machines, Stepper Motor.

UNIT-V: SYNCHRONOUS & ASYNCHRONOUS MACHINES

Generation of rotating magnetic fields, construction and working of a three-phase induction motor, significance of torque-slip characteristics. Losses and efficiency, Principle and operation of synchronous generators.

Lab

1. Transient Response of series R-L and R-C Circuits
2. Verification of super position Theorem.
3. Verification of Thevenin's Theorems.
4. Verification of Norton's Theorems.
5. Resonance in series R-L-C circuits.
6. Torque – speed characteristics of DC shunt motor.
7. Speed control of DC shunt motor –Armature Control.
8. Speed control of DC shunt motor- Field control.

9. Calculation of synchronous speed of four-pole three-phase induction motors. Reversal of direction by changing phase-sequence. Speed-torque characteristic of an induction motor.
10. Synchronous Machine operating as a generator: stand-alone operation with a load, Control of voltage through field excitation.

FUNDAMENTALS OF DATA STRUCTURES USING C **L T P C**
3 0 4 5

UNIT I PROGRAMMING BASICS

Structure of a C program – Constants, Variables – Data Types – Expressions using operators in C – Managing Input and Output operations – Decision Making and Branching – Looping statements. Arrays – Initialization – Declaration – One dimensional and Two dimensional arrays. Strings - String operations.

UNIT II FUNCTIONS, POINTERS AND STRUCTURES

Functions – Pass by value – Pass by reference – Recursion – Pointers - Definition – Initialization – Structures and unions - definition – Structure within a structure - Programs using structures.

UNIT III LINEAR DATA STRUCTURES – LIST

Abstract Data Types (ADTs) – List ADT – array-based implementation – linked list implementation –– singly linked lists– applications of lists –Polynomial Manipulation – All operation (Insertion, Deletion, Merge, Traversal)

UNIT IV LINEAR DATA STRUCTURES – STACKS, QUEUES

Stack ADT – Evaluating arithmetic expressions- Balancing Symbols- Queue ADT – circular queue implementation – applications of queues

UNIT V SORTING, SEARCHING AND HASH TECHNIQUES

Sorting algorithms: Insertion sort – Selection sort – Bubble sort – Quick sort – Merge sort – Searching: Linear search – Binary Search Hashing: Hash Functions – Separate Chaining – Open Addressing – Rehashing

LIST OF EXPERIMENTS

1 Programs using I/O statements and expressions.

2 Programs using decision-making statements

3 Programs using Arrays and Strings

4 Programs using Functions

5 Programs using Structures

6 Linked list implementation of List

7 Array implementation of Stack and Queue ADTs

8 Linked list implementation of Stack and Queue ADTs

9 Applications of List, Stack and Queue ADTs

10 Implementation of Searching and Sorting algorithms

11 Hashing –Linear probing

INDIAN CONSTITUTION AND FREEDOM MOVEMENT **L T P C**
3 0 0 0

UNIT I INTRODUCTION

Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens. Constitution' meaning of the term, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy

UNIT II STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT

Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

UNIT III STRUCTURE AND FUNCTION OF STATE GOVERNMENT AND LOCAL BODY

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts- Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati Raj: Introduction, Elected officials and their roles, Village level: Role of Elected and Appointed officials,

UNIT IV CONSTITUTIONAL FUNCTIONS AND BODIES

Indian Federal System – Center – State Relations – President's Rule – Constitutional Functionaries – Assessment of working of the Parliamentary System in India- CAG, Election Commission, UPSC, GST Council and other Constitutional bodies-. NITI Aayog, Lokpal, National Development Council and other Non –Constitutional bodies.

UNIT V INDIAN FREEDOM MOVEMENT

British Colonialism in India-Colonial administration till 1857- Revolt of 1857- Early Resistance to British Rule-Rise of Nationalism in India-Indian Freedom Struggle under Mahatma Gandhi-Non- Cooperation Movement-Civil Disobedience Movement- Quit India Movement-British Official response to National movement- Independence of India Act 1947- Freedom and Partition.

Semester III

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	BS	Fourier series and Number theory	3	1	0	4	4
2	PC	Human Anatomy and Physiology	3	0	0	3	3
3	PC	Electron Devices & Circuits	2	0	2	4	3
4	PC	Sensors and Measurements	2	0	2	4	3
5	PC	Analog and Digital Integrated Circuits	3	0	0	3	3
6	PC	Biochemical Science	3	0	0	3	3
7	PC	Biochemistry and Physiology Laboratory	0	0	4	4	2
8	PC	Analog and Digital Integrated Circuits Laboratory	0	0	4	4	2
			16	**1**	**12**	**29**	
		TOTAL CREDITS					**23**

Fourier series and Number Theory **L T P C**
3 1 0 4

UNIT I FOURIER SERIES

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series –Half range cosine series – Parseval's identity – Harmonic analysis.

UNIT II BOUNDARY VALUE PROBLEMS

Classification of PDE – Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (excluding insulated edges).

UNIT III FOURIER TRANSFORMS

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity - Application to boundary value problems

UNIT IV Z - TRANSFORMS AND DIFFERENCE EQUATIONS

Z- transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) –Convolution theorem - Formation of difference equations – Solution of difference equations using Z- transform.

UNIT V BESSELS FUNCTION

Bessel Equation – Bessel functions of first kind – Recurrence relations – Bessel's Integral for Jn (x) – Orthogonality.

HUMAN ANATOMY AND PHYSIOLOGY **L T P C**
3 0 0 3

UNIT I BASICS OF HUMAN BODY

Anatomical terms, positions, planes and levels of organization. Cell: Structure and its organelles with functions. Cell Membrane – Transport across Cell Membrane - Membrane Potential – Origin and propagation of potential. Homeostasis. Tissues: Types and functions. Integumentary system.

UNIT II SKELETAL AND MUSCULAR SYSTEM

Skeletal System: Structure and types of Bone and its functions – Physiology of Bone formation – Division of Skeleton – Types of joints and functions – Types of cartilage and functions. Muscular System: Types and functions of Muscles – Structure and activity of skeletal muscles – Sliding Filament Theory – Types of muscle contraction.

UNIT III CARDIOVASCULAR AND RESPIRATORY SYSTEM

Blood: Composition – Functions - Haemostasis – Blood groups and typing. Cardiovascular System: Structure – Conduction System of heart – Cardiac Cycle – Cardiac output. Blood Vessels – Structure and types - Blood pressure Respiratory system: Parts of respiratory system – Respiratory physiology – Lung volumes and capacities – Gaseous exchange.

UNIT IV NERVOUS AND SPECIAL SENSORY SYSTEM

Nervous System: Cells of Nervous systems – Types of Neuron and Synapses – CSF: Composition and function– Brain: structure and function – Spinal Cord – Tract and Pathways – Reflex Mechanism. Autonomic Nervous systems and its functions. Sense Organs: Eye and Ear.

UNIT V ENDOCRINE, DIGESTIVE AND URINARY SYSTEM

Endocrine Glands: major endocrine glands and their hormonal functions. Digestive System: Organs of Digestive system – Mechanism of Digestion and Absorption. Urinary System: Structure of urinary system – Mechanisms of Urine formation – Homeostasis and Acid base Regulation by Urinary System – Micturition reflex.

BIOCHEMICAL SCIENCE **L T P C**
3 0 0 3

UNIT I INTRODUCTION TO BIOCHEMISTRY

Introduction to Biochemistry, water as a biological solvent, weak acid and bases, electrolytes, pH, buffers, Henderson – Hassel balch equation, physiological buffers in living systems, Properties of water and their applications in biological systems.

UNIT II CARBOHYDRATES

Classification of carbohydrates - mono, di, oligo and polysaccharides. Structure, physical and chemical properties of carbohydrates. Metabolic pathways – Glycolysis, glycogenesis, glycogenolysis, and its hormonal regulation. TCA cycle – amphibolic pathway.ETC and Oxidative Phosphorylation.Biochemical aspect of Diabetes mellitus.

UNIT III LIPIDS

Classification of lipids- simple, compound and derived lipids. Nomenclature of fatty acid, physical and chemical properties of fat. Metabolic pathways: synthesis and degradation of fatty acid (beta oxidation), Hormonal regulation of fatty acid metabolism. Cholesterol biosynthesis, regulation, and its transport (HDL & LDL role). Disorders of lipid metabolism

UNIT IV NUCLEIC ACID & PROTEIN

Nucleic Acid: DNA - Watson and crick model of DNA, types, DNA as genetic material. Structure and types of RNA. Amino acid: Classification and properties. Protein: structural organisation and classification. Inborn Metabolic error of amino acid metabolism and urea cycle.

UNIT V CLINICAL BIOCHEMISTRY

Enzymes: Classification - Factors affecting enzymatic activity – Kinetics - Mode of action - allosteric and covalent regulation. Clinical significance of enzymes. Renal and liver function test (LFT and RFT). Normal Values of major biochemical parameters.

Electron Devices & Circuits **L T P C**

2 0 2 3

UNIT I RECTIFIERS AND VOLTAGE REGULATORS

Rectifiers – Half wave – Full wave – Bridge - with and without capacitor filter – voltage multiplier circuits – Voltage regulation – Shunt Regulators – Series Regulators – Current limiting technique – Three terminal IC regulators (78XX and 79XX)

UNIT II BIASING AND SMALL SIGNAL ANALYSIS OF BJT

BJT – Biasing of BJT – Fixed Bias – Voltage Divider Bias – Emitter bias - Two port network – h parameters - small signal analysis of BJT (CE configuration) - Frequency response of BJT (CE configuration)

UNIT III BIASING AND SMALL SIGNAL ANALYSIS OF FET

JFET–– Biasing of FET – Fixed Bias – Self Bias – Voltage Divider Bias - Small signal analysis of JFET (CS configuration) – Frequency response of FET – Difference between BJT and FET

UNIT IV FEEDBACK AMPLIFIERS, OSCILLATORS & POWER AMPLIFIERS

Basics of Feedback system - Types of Feedback Amplifiers (Block diagram approach), Principle of oscillators – Condition for oscillation – Audio Oscillators – RC Phase shit and Wien Bridge oscillators RF oscillators-Hartley and Colpitts, Multivibrators – Astable and Monostable Definition – Types of Power Amplifiers – Class A (series fed and transformer coupled)

UNIT V APPLICATION OF ELECTRONIC CIRCUITS IN MEDICAL FIELD

Application of LED and photo transistor for blood volume measurement, Applications of rectifier and SMPS

LAB EXPERIMENTS:

1. VI characteristics of PN junction diode
2. VI characteristics of Zener Diode
3. Input and output characteristics of Common emitter configuration
4. Input and output characteristics of Common base configuration
5. Drain and transfer characteristics of FET
6. Demonstrate the working of RC phase shift oscillator
7. Develop and demonstrate the working of astable multivibrator
8. Design a class A power amplifier circuit and analyse the waveform

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SENSORS AND MEASUREMENTS **L T P C**

2 0 2 3

UNIT I FUNDAMENTALS OF MEASUREMENTS

Functional elements of a generalized instrument–classification of measuring instruments, definition of sensor/transducer-classification of sensors/transducers-selection criteria, performance characteristics: static and dynamic characteristics. SI units, types of errors, methods of error analysis,-uncertainty analysis-expression of uncertainty: accuracy and precision index, propagation of errors-calibration and standards.

UNIT II RESISTIVE & TEMPERATURE TRANSDUCERS

Measurement principle, characteristics, design and clinical applications of: resistive transducers: resistance potentiometer, loading effect, strain gauge-gauge factor-types of strain gauges, thermoelectric sensors-resistance thermometers, thermistor, thermocouples, and semi-conductor and fiber optics based temperature sensor. Non-contact type temperature measurement techniques: radiation thermography, total radiation pyrometer, optical pyrometer.

UNIT III INDUCTIVE & CAPACITIVE, DIGITAL TRANSDUCERS

Concepts of self-inductance and mutual inductance, linear variable differential transformer, rotary variable differential transformer, induction potentiometer, variable reluctance transducer. Capacitive: Basic principle-variable area type-variable air gap type-variable permittivity type-capacitive pressure sensors-biomedical applications, Hall magnetic sensorclinical applications. Digital displacement transducers: incremental type, tachometer type, absolute type.

UNIT IV PIEZOELECTRIC, OPTICAL & PROXIMITY SENSORS

Introduction of piezoelectricity- piezoelectric crystals-clinical applications-Basic principles characteristics and clinical applications of PIN and avalanche photo diode (APD), photo emissive cell, photovoltaic cell-photo conductive cell-light dependent resistors. Proximity sensors-classification-working and clinical applications.

UNIT V MEASUREMENT, DISPLAY DEVICES & OTHER SENSORS

Bridge circuits: classification, Wheatstone's and Kelvins Bridge. Display Devices: cathode ray oscilloscope (CRO), digital storage oscilloscope (DSO), light emitting diode (LED) and liquid crystal (LC) displays. Recorders: magnetic tape-inkjet-thermal-Recorder-photographic recorders. Biosensors: transduction mechanism in a biosensor and Classification. Introduction to microelectromechanical systems (MEMS), wearable and smart sensors, electronic nose.

LIST OF EXPERIMENTS:

1. Characteristics of Thermocouple.
2. Characteristics of RTD
3. Strain measurement.
4. Characteristics of optical sensor.
5. Measurement of resistance using Wheat Stone and Kelvin's Bridge.
6. Measurement of inductance using Maxwell's & Hay's Bridge.
7. Measurement of Capacitance using Schering's bridge.
8. Demonstration of CRO & DSO.

ANALOG & DIGITAL INTEGRATED CIRCUITS

L T P C

3 0 0 3

UNIT I INTRODUCTION TO DIGITAL SYSTEM

Introduction to number system and Boolean algebra; Boolean identities, basic logic functions, standard form, Minimization of Boolean functions using K map, Arithmetic circuits, decoders, encoders, multiplexers, de-multiplexers, Magnitude Comparator

UNIT II SEQUENTIAL CIRCUITS

Latches and Flip Flops (SR, D, JK, T); Timing in sequential circuits; Shift register; Counters – synchronous, asynchronous; Basic concepts and design; Moore and Mealy machines examples; State minimization/reduction, state assignment; USR, Semiconductor Memories – ROM, SRAM, DRAM.

UNIT III OPAMP BASICS AND APPLICATIONS

Basic OPAMP configurations and characteristics, Linear & Non Linear Applications - difference amplifier, adder, subtractor, integrator, differentiator, instrumentation amplifier, buffer, precision amplifier, logarithmic amplifier, square-root amplifier, comparators, Schmitt trigger.

UNIT IV FILTER AND TIMERS

Active Ist order LPF, HPF, BPF, BSF circuits using IC741, Introduction to higher order filters. Oscillators – criteria for oscillation, RC and Wein Bridge Oscillators, Astable and monostable multivibrator circuits; internal structure of 555 and its applications, clock circuits.

UNIT V REAL TIME APPLICATIONS

Basic Function Generator, Digital stethoscope and digital blood pressure monitor, Digital blood glucose monitor and thermometer, Rejection of power line interference using notch filter, Drug Delivery System using 555 timer, Analog and Digital interface circuits: A/D, D/A Converters.

BIOCHEMISTRY AND PHYSIOLOGY LABORATORY

L T P C

0 0 4 2

LIST OF EXPERIMENTS:

1. General guidelines for working and functional component of biochemistry lab

2. Preparation of solutions: 1) percentage solutions, 2) molar solutions, 3) normal solutions

3. Spectroscopy: Determination of absorption maxima (λmax) of a given solution

4. General tests for carbohydrates, proteins and lipids.

5. Preparation of serum and plasma from blood.

6. Estimation of blood glucose.

7. Estimation of creatinine.

8. Estimation of urea.

9. Estimation of cholesterol

10. Assay of SGOT/SGPT.

11. Separation of proteins by SDS electrophoresis(Demo)

12. Separation of amino acids by thin layer chromatography

13. Identification of Blood groups

14. Estimation of Hemoglobin

15. Determination of ESR

16. PCV, MCH, MCV,MCHC

ANALOG & DIGITAL INTEGRATED CIRCUITS LABORATORY **L T P C**

0 0 4 2

LIST OF EXPERIMENTS:

1. Study of logic gates, half adder and Full adder
2. Encoder and BCD to 7 segment decoder
3. Multiplexer and demultiplexer using digital ICs
4. Universal shift register using flip flops
5. Design of mod-N counter
6. Inverting, non-inverting amplifier and comparator
7. Integrator and Differentiator
8. Active filter – first order and second order LPF and HPF
9. Current to Voltage convertor and Voltage to Current Convertor
10. Instrumentation amplifier using IC741
11. Wein bridge oscillator
12. Multivibrator using IC555 Timer

Semester IV

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	BS	Probability and Random Process	3	1	0	4	4
2	PC	Biomedical Instrumentation	3	0	0	3	3
3	PC	Pathology and Microbiology	2	0	2	4	3
4	ES	Problem Solving and Programming in Python	1	0	2	3	2
5	PC	Principles of Communication Systems	2	0	0	2	2
6	PC	PCB Design	1	0	2	3	2
8	EEC	Soft Skills-I	0	0	2	2	1
9	MC	Essence of Indian Traditional knowledge	3	0	0	3	0
10	PC	Biomedical Instrumentation Laboratory	0	0	4	4	2
			15	**1**	**12**	**28**	
		TOTAL CREDITS					**19**

PROBABILITY AND RANDOM PROCESSES **L T P C**
3 1 0 4

UNIT I ONE – DIMENSIONAL RANDOM VARIABLE

Discrete and continuous random variables – Moments – Moment generating function – Binomial, Poisson, Geometric, Uniform, Exponential, and Normal distributions.

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables-Applications of Central Limit Theorem.

UNIT III RANDOM PROCESSES

Classification – Stationary process – Markov process - Poisson process and its properties – Discrete parameter Markov chain – Chapman Kolmogorov Theorem (without proof) – Limiting distributions.

UNIT IV CORRELATION AND SPECTRAL DENSITIES

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

UNIT V LINEAR SYSTEMS WITH RANDOM INPUTS

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and Cross correlation functions of input and output.

BIOMEDICAL INSTRUMENTATION **L T P C**
3 0 0 3

UNIT I BIOPOTENTIAL ELECTRODES

Origin of bio potential and its propagation: Nernst equation for membrane Resting Potential Generation and Propagation of Action Potential, Conduction through nerve to neuromuscular junction. Bio Electrodes: Electrode-electrolyte interface, electrode– skin interface, half-cell potential, impedance, polarization effects of electrode – non polarizable electrodes, Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - measurement with two electrodes.

UNIT II BIOPOTENTIAL MEASUREMENTS

Bio signal characteristics– frequency and amplitude ranges, Cardiac Instrumentation: Electrical Conduction system of the heart. Cardiac cycle. Relation between electrical and mechanical activities of the heart, Specification of ECG machine. Einthoven triangle, Standard 12-lead configurations, Interpretation of ECG waveform with respect to electro mechanical activity of the heart. Measurements of heart sounds - PCG. Neuro-Muscular Instrumentation: Specification of EEG and EMG machines, EEG - 10-20 electrode system, unipolar, bipolar and average mode, Functional block diagram , EMG - unipolar and bipolar mode, block diagram. Interpretation of EEG and EMG. Ophthalmic

Instrumentation: Specification of EOG and ERG machines, Electrode placement for EOG and ERG recording. Interpretation of EOG and ERG.

UNIT III BIOPOTENTIAL AMPLIFIER

Need for bio-amplifier - single ended bio-amplifier, Instrumentation amplifier, differential bioamplifier, Right leg driven ECG amplifier. Band pass filtering, isolation amplifiers – transformer, optical isolation, isolated DC amplifier and AC carrier amplifier, Artifacts and removal.

UNIT IV NON ELECTRICAL PHYSIOLOGICAL PARAMETER MEASUREMENT

Temperature, respiration rate and pulse rate measurements, Plethysmography, Pulse oximetry, Blood Pressure: direct methods - Pressure amplifiers - systolic, diastolic, mean detector circuit, indirect methods - auscultatory method, oscillometric method, ultrasonic method. Blood flow - Electromagnetic and ultrasound blood flow measurement. Cardiac output measurement- Indicator dilution, dye dilution and thermodilution method.

UNIT V BIOCHEMICAL MEASUREMENT

Biochemical sensors - pH, pO2 and pCO2, Ion selective Field Effect Transistor (ISFET), immunologically sensitive FET (IMFET), Blood glucose sensors - Blood gas analyzers, spectrophotometer, blood cell counter, auto analyzer.

PATHOLOGY AND MICROBIOLOGY **L T P C**
2 0 2 3

UNIT I CELL DEGENERATION, REPAIR AND NEOPLASIA

Cellular adaptation, Reversible and Irreversible cell injury, Necrosis, Gangrene, Apoptosis. Inflammation and Repair. Neoplasia - Benign and Malignant tumours - carcinogenesis.

UNIT II FLUID AND HEMODYNAMIC DERANGEMENTS

Edema, Hyperemia/Ischemia, thrombosis, embolism, shock, anemia, Bleeding disorders.

UNIT III SYSTEMIC PATHOLOGY

Life Style Diseases: Atherosclerosis, Myocardial Infarction, Diabetes Mellitus, Hypertension, COPD, Reflux Gastritis and PCOD. Infectious Disease: Hepatitis, Pneumonia.

UNIT IV MICROBIOLOGY

Normal flora of the human body. Routes of infection and spread; endogenous and exogenous infections, Morphological features and structural organization of bacteria, growth curve, identification of bacteria.

UNIT V IMMUNOPATHOLOGY AND MICROSCOPY

Basic structure of Antigen, Antibody. Immunity - Innate and Acquired. Hypersensitivity reactions. Light microscope – bright field, dark field, and phase contrast, fluorescence, Electron microscope (TEM & SEM).

LIST OF EXPERIMENTS:

1. Demonstration of bright field microscope

2. Simple staining

3. Gram's Staining

4. AFB Staining

5. Determination of Bleeding time and clotting time

PROBLEM SOLVING AND PROGRAMMING IN PYTHON **L T P C**
1 0 2 2

LIST OF EXPERIMENTS:

1. Study of algorithms, flowcharts and pseudocodes.

2. Introduction to Python Programming and Demo on Python IDLE / Anaconda distribution.

3. Experiments based on Variables, Datatypes and Operators in Python.

4. Coding Standards and Formatting Output.

5. Algorithmic Approach: Selection control structures.

6. Algorithmic Approach: Iteration control structures.

7. Experiments based on Strings and its operations.

8. Experiments based on Lists and its operations.

9. Experiments based on Tuples and its operations.

10. Experiments based on Sets and its operations.

11. Experiments based on Dictionary and its operations.

12. Functions: Built-in functions.

13. Functions: User-defined functions.

14. Functions: Recursive functions.

15. Searching techniques: Linear and Binary.

16. Sorting techniques: Bubble, Selection and Insertion.

17. Experiments based on files and its operations.

PRINCIPLES OF COMMUNICATION SYSTEMS **L T P C**
2 0 0 2

UNIT I ANALOG MODULATION

Introduction to Communication Systems - Modulation –Types - Need for Modulation, Theory of Amplitude Modulation -Evolution and Description of SSB Techniques - Generation of FMVaractor diode Modulator-Armstrong modulator, FM detection using PLL-Phase Modulation –Comparison of Analog Communication Systems (AM –FM –PM).

UNIT II DIGITAL MODULATION

Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) Minimum Shift Keying (MSK) – Phase Shift Keying (PSK) – BPSK – QPSK – 8 PSK – 16 PSK – Quadrature Amplitude Modulation (QAM) – 8 QAM – 16 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK – FSK – PSK – QAM).

UNIT III PULSE MODULATION AND MULTI USER COMMUNICATION

Pulse Modulation: Types of Pulse modulation, PAM (Single polarity, double polarity) PWM: Generation and demodulation of PWM, PPM, Generation and demodulation of PPM, Application of PM techniques, TDMA, FDMA, CDMA, Global System for Mobile Communications (GSM), Cellular Concept and Frequency Reuse - Channel Assignment and Hand off.

PCB Design **L T P C**
1 0 2 2

UNIT I INTRODUCTION TO PRINTED CIRCUIT BOARD

Introduction to Printed circuit board: fundamental of electronic components, basic electronic circuits, Basics of printed circuit board designing: Layout planning, general rules and parameters, ground conductor considerations, thermal issues, check and inspection of artwork.

UNIT II DESIGN RULES FOR PCB

Design rules for PCB: Design rules for Digital circuit PCBs, Analog circuit PCBs, high frequency and fast pulse applications, Power electronic applications, Microwave applications, PCB Technology Trends: Multilayer PCBs. Multiwire PCB, Flexible PCBs, Surface mount PCBs, Reflow soldering, Introduction to High-Density Interconnection (HDI) Technology.

LIST OF EXPERIMENTS:

1. Introduction to PCB, industrial software and its applications
2. Design of PCB schematic and layout for HWR and FWR
3. Design of PCB schematic and layout for generating 5V,12V supply.
4. Design of PCB schematic and layout for digital trainer kit.
5. Introduction to chemical etching

6. Creation of effective routing(manual & automatic) and generation of gerber file

7. Soldering and Desoldering of components

8. PCB assembly and testing

SOFT SKILLS-I **L T P C**
0 0 2 1

Learning and Teaching Strategy: The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use of technology and brief trainer input.

ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE **L T P C**
3 0 0 0

UNIT I INTRODUCTION TO INDIAN KNOWLEDGE SYSTEM

Basic structure of the Indian Knowledge System –Veda – Upaveda - Ayurveda, DhanurvedaGandharvaveda, Sthapathyaveda and Arthasasthra. Vedanga (Six forms of Veda) – Shiksha, Kalpa, Nirukta, Vyakarana, Jyothisha and Chandas- Four Shasthras - Dharmashastra, Mimamsa, Purana and Tharkashastra

UNIT II MODERN SCIENCE AND YOGA

Modern Science and the Indian Knowledge System – a comparison - Merits and demerits of Modern Science and the Indian Knowledge System - the science of Yoga- different styles of Yoga – types of Yogaasana, Pranayam, Mudras, Meditation techniques and their health benefits – Yoga and holistic healthcare – Case studies

UNIT III INDIAN PHILOSOPHICAL TRADITION

Sarvadharshan/Sadhdharshan – Six systems (dharshans) of Indian philosophy - Nyaya, Vaisheshika, Sankhya, Yoga, Mimamsa, Vedanta-Other systems- Chavarka, Jain (Jainism), Boudh (Buddhism) – Case Studies

UNIT IV INDIAN LINGUISTIC TRADITION

Introduction to Linguistics in ancient India – history – Phonetics and Phonology – Morphology –Syntax and Semantics-Case Studies.

UNIT V INDIAN ARTISTIC TRADITION

Introduction to traditional Indian art forms – Chitrakala (Painting), Murthikala / Shilpakala (Sculptures), Vaasthukala, Sthaapathya kala (Architecture), Sangeeth (Music), Nruthya (Dance) and Sahithya (Literature) – Case Studies

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BIOMEDICAL INSTRUMENTATION LABORATORY **L T P C**
0 0 4 2

LIST OF EXPERIMENTS:

1. Acquisition of ECG signals using 3 channel and 12 channel ECG machine.
2. Real time EEG Acquisition and Measurement of Evoked Potential.
3. Recording of EMG and Measurement of NCV
4. Construction and testing of pre amplifier to acquire bio signal
5. Measurement of Blood Flow Velocity using Ultrasonic blood flow Monitor
6. Study of EMG /ECG Isolation amplifier using analog circuit
7. Study of Galvanic Skin Resistance using GSR System
8. Measurement of pH and conductivity.
9. Study of biotelemetry Unit
10. To measure the blood pressure levels using Sphygmomanometer.
11. Simulation of ECG – detection of QRS complex and heart rate
12. Design a suitable filter for bio signal Acquisition
13. Timer circuits: ON delay and OFF delay study
14. Design PCB schematic and layout for bio amplifier

Semester V

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	PC	Biocontrol Systems	3	0	0	3	3
2	PC	Digital Signal Processing	3	1	0	4	4
3	PC	Microprocessor, Microcontroller and Embedded System Design	3	0	2	5	4
4	ES	Python Programming for Machine learning	1	0	2	3	2
5	PC	Diagnostic Equipment	3	0	0	3	3
6	PC	Therapeutic Equipment	3	0	0	3	3
7	PC	Diagnostic and Therapeutic Equipment Laboratory	0	0	4	4	2
8	PC	Digital Signal Processing Laboratory	0	0	4	4	2
9	EEC	Soft Skills -II	0	0	2	2	1
			16	**1**	**14**	**31**	
		TOTAL CREDITS					**24**

BIOCONTROL SYSTEMS **L T P C**
3 0 0 3

UNIT I CONTROL SYSTEM MODELING

Terminology and basic structure of control system, example of a closed loop system, transfer function, modeling of electrical systems, translational and rotational mechanical systems, and electromechanical systems, block diagram and signal flow graph representation of systems, reduction of block diagram and signal flow graph, conversion of block diagram to signal flow graph. Need for modeling physiological system.

UNIT II TIME RESPONSE ANALYSIS

Step and impulse responses of first order and second order systems, determination of time domain specifications of first and second order systems from its output responses, definition of steady state error constants and its computations.

UNIT III STABILITY ANALYSIS

Definition of stability, Routh- Hurwitz criteria of stability, root locus technique, construction of root locus and study of stability, definition of dominant poles and relative stability.

UNIT IV FREQUENCY RESPONSE ANALYSIS

Frequency response, Nyquist stability criterion, Nyquist plot and determination of closed loop stability, definition of gain margin and phase margin, Bode plot, determination of gain margin and phase margin using Bode plot, use of Nichol's chart to compute frequency and bandwidth.

UNIT V PHYSIOLOGICAL CONTROL SYSTEM

Difference between engineering and physiological control systems, generalized system properties, models with combination of system elements, linear models of physiological systems-Examples, Introduction to simulation. Examples of Biological control Systems: Cardiovascular Control System, Skeletal Muscle Servomechanism.

Digital Signal Processing **L T P C**
3 1 0 4

UNIT I FUNDAMENTALS OF SIGNALS AND SYSTEMS

Classification of systems: Continuous, discrete, linear, causal, stability, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect.

UNIT II ANALYSIS OF LTI SYSTEMS

Fourier Series - Fourier Transform and Properties, Analysis of Continuous Time LTI Systems - Z Transform - Properties of ROC– Inverse Z Transform – DTFT - Analysis of Discrete Time LTI Systems

UNIT III DISCRETE FOURIER TRANSFORM

DFT and its properties, magnitude and phase representation-Linear Convolution-Correlation-Circular Convolution, Overlap-add and overlap-save methods. FFT - Decimation in Time Algorithm, Decimation in Frequency Algorithm. Use of FFT in Linear Filtering.

UNIT IV INFINITE IMPULSE RESPONSE FILTERS

Analog filters – Butterworth filters, Chebyshev Type I filters (upto 3rd order), Analog Transformation of prototype LPF to BPF /BSF/ HPF. Transformation of analog filters into equivalent digital filters using Impulse invariant method and Bilinear Z transform method - Realization structures for IIR filters – direct, cascade and parallel forms.

UNIT V FINITE IMPULSE RESPONSE FILTERS AND MULTIRATE SIGNAL PROCESSING

Design of linear phase FIR filters - windowing and Frequency sampling methods. Realization structures for FIR filters – Transversal and Linear phase structures, Comparison of FIR and IIR. Introduction to DSP processors. Introduction to Multirate signal Processing – Decimation and Interpolation.

MICROPROCESSOR, MICROCONTROLLER & EMBEDDED SYSTEM DESIGN L T P C
3 0 2 4

UNIT I THE 8086 MICROPROCESSOR

Introduction to 8086 – Microprocessor architecture – Addressing modes - Instruction set and assembler directives – Assembly language programming – Stacks – Interrupts and interrupt service routines.

UNIT II THE 8086 INTERFACING WITH I/O

Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface – D/A and A/D Interface - Timer –Interrupt controller– Interfacing 8086 with LED, Seven segment LED display, LCD display. Programming and applications for Case study: Traffic Light control

UNIT III MICROCONTROLLER

Architecture of 8051 – Special Function Registers(SFRs) - I/O Pins Ports and Circuits - Instruction set- Addressing modes - Assembly language programming- Timer programming - Serial Port Programming - Interrupts Programming

UNIT IV MICROCONTROLLER INTERFACING

LED and 7 segment LED interfacing, Keyboard Interfacing with 8051 microcontroller– ADC interfacing with 8051 microcontroller and DAC interfacing with 8051 microcontroller for wave generation, LCD interfacing with 8051 microcontroller

UNIT V MICROCONTROLLER FOR EMBEDDED SYSTEM APPLICATIONS

Temperature Sensor Interfacing in Digital thermometer using 8051, Non contact temperature measurement using 8051. Motors for syringe pumps, Infusion pump

LIST OF EXPERIMENTS:

8086 Programs using kits and MASM

1. Basic arithmetic and Logical operations

2. Move a data block without overlap

3. Code conversion, decimal arithmetic

Peripherals and Interfacing Experiments with 8086

4. Traffic light control

5. Stepper motor control

6. Parallel interface

7. A/D and D/A interface for Waveform Generation

8051 Experiments using kits and MASM

8. Basic arithmetic and Logical operations

9. Square and Cube program, Find 2's complement of a number 8051 interfacing with Peripherals

10. Temperature sensor interfacing with 8051 microcontroller

PYTHON PROGRAMMING FOR MACHINE LEARNING **L T P C**
1 0 2 3

LIST OF EXPERIMENTS:

1. NumPy Basics: Arrays and Vectorized Computation

2. Getting Started with pandas

3. Data Loading, Storage, and File Formats

4. Data Cleaning and Preparation

5. Data Wrangling: Join, Combine, and Reshape

6. Plotting and Visualization

7. Data Aggregation and Group Operations

8. Time Series

9. Supervised Learning

10. Unsupervised Learning and Preprocessing

11. Representing Data and Engineering Features

12. Model Evaluation and Improvement

Diagnostic Equipment **L T P C**
3 0 0 3

UNIT I CARDIAC EQUIPMENT

Electrocardiograph, Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Phonocardiography, Plethysmography. Cardiac Pacemaker- Internal and External Pacemaker–Batteries, AC and DC Defibrillator- Internal and External

UNIT II NEUROLOGICAL EQUIPMENT

Clinical significance of EEG, Multi channel EEG recording system, Epilepsy, EvokedPotential–Visual, Auditory and Somatosensory, MEG (Magneto Encephalo Graph). EEG Bio Feedback Instrumentation.

UNIT III SKELETAL MUSCULAR EQUIPMENT

Generation of EMG, recording and analysis of EMG waveforms, fatigue characteristics, Muscle stimulators, nerve stimulators, Nerve conduction velocity measurement, EMG Bio Feedback Instrumentation.

UNIT IV PATIENT MONITORING AND BIOTELEMETRY

Patient monitoring systems, ICU/CCU Equipments, Infusion pumps, bed side monitors, Central consoling controls. Radio Telemetry (single, multi), Portable and Landline Telemetry unit, Applications in ECG and EEG Transmission.

UNIT V EXTRA CORPOREAL DEVICES AND SPECIAL DIAGNOSTIC TECHNIQUES

Need for heart lung machine, functioning of bubble, disc type and membrane type oxygenerators, finger pump, roller pump, electronic monitoring of functional parameter. Hemo Dialyser unit, Lithotripsy, Principles of Cryogenic technique and application, Endoscopy, Laproscopy.

Thermography – Recording and clinical application, ophthalmic instruments.

Therapeutic Equipment **L T P C**
3 0 0 3

UNIT I RESPIRATORY MEASUREMENT STSTEM

Instrumentation for measuring the mechanics of breathing – Spirometer -Lung Volume and vital capacity, measurements of residual volume, pneumotachometer – Airway resistance measurement, Whole body plethysmography, Intra-Alveolar and Thoracic pressure measurements, Apnea Monitor. Types of Ventilators – Pressure, Volume, Time controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.

UNIT II SENSORY MEASUREMENT

Psycho Physiological Measurements-for testing and sensory Responses, Electro occulograph, Electro retinograph, Audiometer-Pure tone, Speech. EGG (Electrogastrograph), galvanic skin resistance (GSR).

UNIT III DIATHERMY

IR and UV lamp and its application. Short wave diathermy, ultrasonic diathermy, Microwave diathermy, Electro surgery machine - Current waveforms, Tissue Responses, Electro surgical current level, Hazards and safety procedures.

UNIT IV ULTRASONIC TECHNIQUE

Diagnosis: Tissue Reaction, Basic principles of Echo technique, display techniques A, B and M mode, B Scan, Application of ultrasound as diagnostic tool – Echocardiogram, Echoencephalogram, abdomen, obstetrics and gynecology, ophthalmology.

UNIT V PATIENT SAFETY

Physiological effects of electricity – important susceptibility parameters – Macro shock – Micro shock hazards – Patient's electrical environment – Isolated Power system – Conductive surfaces – Electrical safety codes and standards – Basic Approaches to Protection against shock, Protection equipment design, Electrical safety analyzer – Testing the Electric system

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DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY **L T P C**
0 0 4 2

LIST OF EXPERIMENTS

1. Analyze EMG and EEG signals using LabVIEW / Matlab.

2. Heart rate variability Analysis (HRV) using Kubios HRV software

3. Recording of lung flow, volume and capacities graph using PC based Spirometer.

4. To plot the human auditory response using Audiometer.

5. Recording of PCG (Phonocardiograph) for measurement of heart sound.

6. Analysis of physiological parameters recorded using patient monitoring system using R lab

7. Study of surgical diathermy.

8. Study and simulation of pacemaker & defibrillator using VI LABS.

9. To study and demonstrate the working of a haemodialysis machine.

10. To study and demonstrate the working of a respiratory ventilator.

11. Study of shortwave and ultrasonic diathermy.

12. Design and demonstrate the working of TENS. 13. Mini project (Should include hardware and software).

DIGITAL SIGNAL PROCESSING LABORATORY **L T P C**
0 0 4 2

LIST OF EXPERIMENTS:

MATLAB / EQUIVALENT SOFTWARE PACKAGE

1. Generation of sequences (functional & random) & correlation

2. Linear and Circular Convolutions

3. Spectrum Analysis using DFT

4. FIR filter design

5. IIR filter design

6. Multirate Filters

7. Equalization

DSP PROCESSOR BASED IMPLEMENTATION

8. Study of architecture of Digital Signal Processor

9. MAC operation using various addressing modes

10. Linear Convolution

11. Circular Convolution

12. FFT Implementation

13. Waveform generation

14. IIR and FIR Implementation

15. Finite Word Length Effect

SOFT SKILLS II **L T P C**
0 0 4 2

The News hour, Court Case, The ultimate weekend, The Four Corners – Debate

Grand Master – Debate

Turn Tables– Debate

Fiction AD – Debate

Talent Hunt

Semester VI

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	PC	Radiological Equipment	3	0	0	3	3
2	PC	Biomechanics	3	0	0	3	3
3	PC	PE 1	3	0	0	3	3
4	PE	PE 2	3	0	0	3	3
5	OE	OE 1	3	0	0	3	3
6	EEC	Innovation and Design thinking for Biomedical Engineers	0	1	2	3	2
7	EEC	Problem solving techniques	0	0	2	2	1
8	EEC	Medical Industrial Training (Internship)	0	0	6	6	3
			15	**1**	**10**	**26**	
		TOTAL CREDITS					**21**

RADIOLOGICAL EQUIPMENT **L T P C**
3 0 0 3

UNIT I MEDICAL X-RAY EQUIPMENT

Nature of X-rays- X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – X-Ray Tube, the collimator, Bucky Grid, power supply, Digital Radiography-discrete digital detectors, storage phosphor and film scanning, X-ray Image Intensifier tubes – Fluoroscopy – Digital Fluoroscopy. Angiography, cine Angiography. Digital subtraction Angiography. Mammography.

UNIT II COMPUTED TOMOGRAPHY

Principles of tomography, CT Generations, X- Ray sources- collimation- X- Ray detectors-Viewing systems- spiral CT scanning – Ultra fast CT scanners. Image reconstruction techniques-back projection and iterative method.

UNIT III MAGNETIC RESONANCE IMAGING

Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession – Induction of magnetic resonance signals – bulk magnetization – Relaxation processes T1 and T2. Block Diagram approach of MRI system- system magnet (Permanent, Electromagnet and Super conductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), shim coils, Electronic components, fMRI.

UNIT IV NUCLEAR MEDICINE SYSTEM

Radio Isotopes- alpha, beta, and gamma radiations. Radio Pharmaceuticals. Radiation detectors – gas filled, ionization chambers, proportional counter, GM counter and scintillation Detectors, Gamma camera- Principle of operation, collimator, photo multiplier tube, X-Y positioning circuit, pulse height analyzer. Principles of SPECT and PET.

UNIT V RADIATION THERAPY AND RADIATION SAFETY

Radiation therapy – linear accelerator, Telegamma Machine. SRS –SRT,-Recent Techniques in radiation therapy - 3DCRT – IMRT – IGRT and Cyber knife- radiation measuring instruments-Dosimeter, film badges, Thermo Luminescent dosimeters-electronic dosimeter- Radiation protection in medicine- radiation protection principles.

BIOMECHANICS **L T P C**
3 0 0 3

UNIT I INTRODUCTION TO MECHANICS

Introduction- Scalars and vectors, Statics: Force types, Resolution and composition of forces, Resultant of forces, moments of force and couple, vector method for resultant force determination, Dynamics: Basic principles- Linear motion, Newton's laws of motion, Impulse and Momentum, Work and Energy Kinetics: Calculation of velocity and acceleration, Kinematics: Link segment models, Force transducers and force plates. Introduction to Constitutive equations.

UNIT II MECHANICS OFBIOFLUIDS

Intrinsic fluid properties: Density, Viscosity, Compressibility and Surface Tension; Viscometers: Capillary, Coaxial cylinder and cone and plate; Rheological properties of blood, Pressure-flow relationship for Non-Newtonian Fluids: Power law fluid, Bingham Plastic, Casson's fluid; Structure of blood vessels, material properties and modelling of Blood vessels, Remodeling of Blood vessels; Heart: Material characterization of cardiac muscle, Native heart valves: Mechanical properties and valve dynamics, Prosthetic heart valve fluid dynamics. Case study: A computational model of blood vessel.

UNIT III MECHANICS OFBIOSOLIDS

Constitutive equation of visco elasticity: Maxwell & Voight models, anisotropy. Hard Tissues: Structure, function and properties of bones, Bone fracture mechanics, Implants for bone fractures. Soft Tissues: Structure, functions, material properties and modelling of Soft Tissues: Cartilage, Tendons and Ligaments Skeletal Muscle: Muscle action, Hill's models.

UNIT IV BIOMECHANICS OFJOINTS

Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, Free body diagrams, Structure of joints, Types of joints, Biomechanical analysis of elbow, shoulder, spinal column, hip, knee and ankle. Biotribology: Lubrication of synovial joints, Total knee and hip joint replacement.

UNIT V APPLICATIONS OF BIOMECHANICS

Introduction to Finite Element Analysis, finite element analysis of lumbar spine; Ergonomics: Musculoskeletal disorders, Ergonomic principles contributing to good workplace design, Design of a Computer work station; Whole body vibrations, Hand transmitted vibrations. Gait analysis, Kinesiological EMG; Sports biomechanics: Motion analysis using video, Isokinetic dynamometry, Computer simulation modeling in sports. Case study: Biomechanical analysis of any one Paralympic sport

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INNOVATION AND DESIGN THINKING FOR BIOMEDICAL ENGINEERS **L T P C**
0 1 2 2

Innovations in biomedical engineering field Referring journals and magazine like Nature, scientist magazine, Elsevier journal and IEEE journal for innovation techniques in biomedical engineering field

Assessment 1: A write up for new innovation in biomedical engineering field Design aspects of equipments and products used in biomedical engineering field Design aspects of Biomedical instrumentation and analysis - its limitations - Drawbacks of it by the customer feedbacks - Overcome the drawbacks by new design approach.

Assessment 2: To propose a new design approach for any one the equipment for overcoming the drawbacks faced by the users

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PROBLEM SOLVING TECHNIQUES **L T P C**
0 0 2 1

1 Numbers system

2 Reading comprehension

3 Data arrangements and Blood relations

4 Time and Work

5 Sentence correction

6 Coding & Decoding, Series, Analogy, Odd man out and Visual reasoning

7 Percentages, Simple interest and Compound interest

8 Sentence completion and Para-jumbles

9 Profit and Loss, Partnerships and Averages

10 Permutation, Combination and Probability

11 Data interpretation and Data sufficiency

12 Logarithms, Progressions, Geometry and Quadratic equations.

13 Time, Speed and Distance

Medical Industrial Training (Internship) **L T P C**
0 0 6 3

Industrial Training

Students will undergo one month of Industrial Training during fifth semester in biomedical industries or R&D centres and should produce the certificate from the industries or research centres. In addition to that each student will be required to submit a report. Reports are to represent the observations of the students after the training with their personal comments/ suggestions.

Viva-Voce will be conducted in the end semester examinations

Internal Continuous Assessment

20% - Certificate from industries

30% - Presentation

30% - Report

20% - Regularity in the class

Semester VII

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	PC	Digital Image Processing Techniques	2	1	2	5	4
2	PC	Hospital Engineering and Management	2	0	0	2	2
3	OE	OE- 2	3	0	0	3	3
4	PE	PE- 3	3	0	0	3	3
5	PE	PE - 4	3	0	0	3	3
6	EEC	AI-ML-DL in Healthcare	0	0	6	6	3
7	EEC	Hospital Training	0	0	2	2	1
8	PC	Rapid Prototyping	3	0	2	5	4
			15	**1**	**12**	**29**	
		TOTAL CREDITS					**23**

DIGITAL IMAGE PROCESSING TECHNIQUES **L T P C**
2 1 2 4

UNIT I FUNDAMENTALS OF IMAGE PROCESSING

Image Analysis and Computer Vision- Overview. Image acquisition system- Film and digital camera. Imaging systems: Image formation and sensing, Image representation, Characteristics of grey-level digital images-Discrete sampling model, Quantization, Relationship between the pixels, Colour fundamentals and models.

UNIT II IMAGE PREPROCESSING AND IMAGE TRANSFORMS

Basic gray level transformation- Log transformation, Power - law transformation, Piece wise linear transformation. Histogram processing. Image Transforms- DFT – DCT– Walsh - Hadamard – Haar –Wavelet - Slant – KL –and their properties.

UNIT III IMAGE ENHANCEMENT AND RESTORATION

Spatial Domain- Basics of Spatial Filtering–Smoothing and Sharpening Spatial Filtering Frequency Domain- Introduction to Fourier Transform – Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic Filtering. Image Restoration-Noise models– Restoration in the presence of Noise – Inverse filterWeiner filtering. Case study: Enhancement of a medical image affected by noise

UNIT IV IMAGE SEGMENTATION AND COMPRESSION

Segmentation- Detection of discontinuities–Edge linking and boundary detection – Region based segmentation- Morphological processing - erosion and dilation. Image compression- Introduction- Image compression models, Lossless and lossy compression methods, Image compression standards Case Study: Segmentation of any medical image and identify the abnormality present

UNIT V IMAGE REPRESENTATION, DESCRIPTION AND DEEP LEARNING TECHNIQUES

Boundary representation – Chain Code – Polygonal approximation, signature, boundary segments – Boundary description – Shape number – Fourier descriptor, momentsRegional Descriptors –Topological feature, Texture - Patterns and pattern classes – Deep learning applications in image processing. Case study: Automated recognition of an image and display the output.

LIST OF EXPERIMENTS:

1. Image sampling and quantization
2. Intensity transformation of images.
3. Transforms (DFT, DCT, Walsh, Hadamard, Haar)
4. Histogram Processing and Basic thresholding functions
5. Image Enhancement-Spatial filtering
6. Image Enhancement- Filtering in frequency domain
7. Image restoration – Inverse and wiener filtering
8. Basic Morphological operations.
9. Analysis of images with different colour models.

HOSPITAL ENGINEERING AND MANAGEMENT **L T P C**
2 0 0 2

UNIT I INTRODUCTION TO HOSPITAL ENGINEERING

Distinction between Hospital and Industry, History of engineering and technology in health care – Health care environment – Educational responsibilities – Staff structure in hospitals – Careers, roles and responsibilities. Hospital Planning- Equipment Planning – Functional Planning - Management Decisions and Related Information Requirement - Clinical Information Systems - Administrative Information systems. Case study: Use of e-governance in medical field by Tamil Nadu Government

UNIT II MANAGEMENT AND MARKETING RESEARCH PROCESS

Manpower Planning - Different Departments of Hospital, Recruitment, Selection, Training Guidelines –Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion – Transfer, Communication, Current Issues in Hospital Management. Marketing information systems – Consumer Markets & Consumer Buyer Behaviour - Model of consumer behaviour - The buyer decision process - Model of business buyer behaviour - WTO and its implications. Case study: Role of WHO and WTO in Indian Medical Device market

UNIT III ROLES AND RESPONSIBILITIES OF ENGINEERS IN HOSPITAL

Biomedical equipment procurement procedure - purchase & contract procedures, selection testing calibration and installation, Training to medical staffs - operating instructions. Management of medical equipment. Planned preventive maintenance system, preventive maintenance & repair. Requirements of inter departmental computerization. DBMS in hospital, computerized medical record evaluation, Database approach to laboratory computerization. Case study: Bridging the gap between medical equipment requirements and biomedical engineers

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AI-ML-DL IN HEALTHCARE **L T P C**
0 0 6 3

1. Initial phase of this course covers the fundamentals of AI and ML & DL algorithms

2. Subsequently, covers the importance of data pre-processing stages such as curation, outlier detection and removal and exploratory data analysis for algorithm selection as well as importance of 'ground truth' and gold reference

3. Hands-on implementation using IDEs such as Anaconda where Python, Open CV and TensorFlow for implementation.

4. Each student will be working on independent mini project

HOSPITAL TRAINING **L T P C**
0 0 2 1

Students need to complete training in any leading Multi-speciality hospital for a period of 15 days. They need to prepare an extensive report and submit to their respective course in- charges during the session.

Out of all the departments, it is mandatory to complete training in any 10. The students can give a presentation of the remaining departments during laboratory hours.

Rapid Prototyping **L T P C**
3 0 2 4

UNIT I INTRODUCTION

Overview –Need -Development of Additive Manufacturing Technology -Principle – AM Process Chain-Classification –Rapid Prototyping-Rapid Tooling –Rapid Manufacturing – Applications-Benefits –Case studies.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING
Design tools: Data processing -CAD model preparation –Part orientation and support structure generation –Model slicing –Tool path generation-Design for Additive Manufacturing: Concepts and objectives-AM unique capabilities –DFAM for part quality improvement-Customised design and fabrication for medical applications.

UNIT III PHOTO POLYMERIZATION AND POWDER BED FUSION PROCESSES
Photo polymerization: SLA-Photo curable materials –Process -Advantages and Applications. Powder Bed Fusion: SLS-Process description –powder fusion mechanism –Process Parameters –Typical Materials and Application. Electron Beam Melting.

UNIT IV EXTRUSION BASED AND SHEET LAMINATION PROCESSES
Extrusion Based System: FDM-Introduction –Basic Principle –Materials –Applications and Limitations –Bio extrusion. Sheet Lamination Process: LOM-Gluing or Adhesive bonding –Thermal bonding.

UNIT V PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES
Droplet formation technologies –Continuous mode –Drop on Demand mode –Three Dimensional Printing –Advantages –Bioplotter -Beam Deposition Process: LENS-Process description –Material delivery –Process parameters –Materials –Benefits –Applications

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Semester VIII

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	PC	Human Assist Devices	3	0	0	3	3
2	PC	ICU & OT Equipment	2	0	0	2	2
3	PC	Medical Device Design	3	0	0	3	3
4	PC	Medical Device Regulations	2	0	0	2	2
5	PE	PE-5	3	0	0	3	3
6	PE	PE-6	3	0	0	3	3
7	PC	Medical Device Design Laboratory	0	0	4	4	2
8	EEC	Mini Project	0	0	6	6	3
			16	**0**	**10**	**26**	
		TOTAL CREDITS					**21**

Human Assist Devices **L T P C**

3 0 0 3

UNIT I HEART LUNG MACHINE AND ARTIFICIAL HEART

Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Mock test setup for assessing its Functions

UNIT II CARDIAC ASSIST DEVICES

Synchronous Counter pulsation, Assisted through Respiration Right Ventricular Bypass Pump, Left Ventricular Bypass Pump, Open Chest and closed Chest type, Intra Aortic Balloon Pumping Veno Arterial Pumping, Prosthetic Cardiac Valves, Principle and problem, Biomaterials for implantable purposes, its characteristics and testing.

UNIT III ARTIFICIAL KIDNEY

Indication and Principle of Haemodialysis, Membrane, Dialysate, Different types of hemodialyzers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type

UNIT IV PROSTHETIC AND ORTHOTIC DEVICES

Spinal orthotics and Prosthesis, Splint – Static and Dynamic. Hand and Arm Replacement - Different Types of Models Externally Powered Limb Prosthesis, Intelligent prosthesis, Lower Limb and Upper limb orthotic devices, Functional Electrical Stimulation, Sensory Assist Devices, Materials for Prosthetic and orthotic devices, Haptic Devices, Transcutaneous electrical nerve stimulator.

UNIT V RESPIRATORY AND HEARING AIDS

Ventilator and its types-Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Types of Deafness, Hearing Aids, Construction and Functional Characteristics.

ICU & OT Equipment **L T P C**

3 0 0 3

UNIT I INTENSIVE CARE UNIT EQUIPMENT

Suction apparatus, Different types; Sterilizers, Chemical, Radiation, Steam for small and large units. ICU ventilators. Automated drug delivery systems, Infusion pumps, components of drug infusion system, closed loop control infusion system, implantable infusion system. BMD Measurements – SXA – DXA - Quantitative ultrasound bone densitometer

UNIT II CRITICAL CARE EQUIPMENT

Defibrillators, Hemodialysis Machine, Different types of Dialyzers, Membranes, Machine controls and measurements. Heart Lung Machine, different types of oxygenators, peristaltic pumps, Incubators.

UNIT III OPERATION THEATRE EQUIPMENT
Craniotomy, Electrosurgical Machines (ESU), electrosurgical analyzers, surgical aspirator,, Instruments for operation. Anesthesia Machine, Humidification, Sterilization aspects, Boyles apparatus. Endoscopy – Laparoscopy - Cryogenic Equipment - Anesthesia gas, Anesthesia gas monitor, - surgical microscope.

UNIT IV CENTRALISED SYSTEMS
Centralized Oxygen, Nitrogen, Air supply & Suction. Centralized Air Conditioning, Operation Theatre table & Lighting. C Arm.

UNIT V PATIENT SAFETY
Patient electrical safety, Types of hazards, Natural protective mechanisms against electricity, Leakage current, Inspection of grounding and patient isolation, Hazards in operation rooms, ICCU and IMCUs, Opto couplers and Pulse transformers.

Medical Device Design **L T P C**
3 0 0 3

UNIT I INTRODUCTION
Needs finding, problem identification, prior art searches, strategy and concept generation, estimation, sketching, sketch modelling, machine elements, ergonomics and prototyping.

UNIT II DESIGN OF MEDICAL DEVICES & SYSTEM
Medical device classification, bioethics, and privacy, biocompatibility and sterilization techniques, design of clinical , trials, design control and regulatory requirements, introduction to specific, medical technologies: biopotentials measurement (EMG, EOG, ECG, EEG), medical diagnostics (In-vitro diagnostics), medical diagnostics (Imaging), minimally invasive devices, surgical tools and implants

UNIT III DEVELOPMENT STRATEGY AND PLANNING
Intellectual property strategy – research and development strategy – clinical strategy – regulatory strategy – quality and process management – reimbursement strategy – marketing and stakeholder strategy – sales and distribution strategy – competitive advantage and business strategy.

UNIT IV HARDWARE AND SOFTWARE DESIGN
Hardware design, Hardware risk analysis, Design and project merits, Design for six sigma, software design, software coding, software risk analysis, software metrics, licensing and alternate pathways

UNIT V DESIGN TRANSFER AND IPR
Transfer to manufacturing, documents and deliverables. Standard-ISO, IES, Intellectual Property - Patents, Copy rights, Trademarks, Trade secrets.

Medical Device Regulations **L T P C**
2 0 0 2

UNIT III MEDICAL EQUIPMENT ESSENTIAL REQUIREMENTS

General requirements for basic safety & essential performance of medical equipment, IEC 60601 standards- Base Standard-general requirement of electrical medical devices, Collateral Standards- EMC radiation protection &programmable medical device system, Particular Standards-type of medical device.

UNIT IV MEDICAL DEVICE REGULATION

Medical device and in vitro diagnostics: Introduction & types of devices including combination devices. Medical Device Rules, 2017: Implications on medical devices. Classification of medical devices. Labelling of medical devices and in vitro diagnostics

UNIT V MEDICAL DEVICE RISK ASSESSMENT

Inspection of medical device and IVD establishments. ISO 14971 (Medical devices: Application of risk management to medical devices). Regulatory requirements of biocompatibility of medical devices and ISO 10993. Clinical investigation of medical devices, regulation of investigational medical devices. Medical device regulation: International practices.

Medical Device Design Laboratory **L T P C**
0 0 4 2

LIST OF EXPERIMENTS:

1. Simulation of over voltage protection circuit
2. Simulation of under voltage protection circuit
3. Simulation of instrumentation amplifier
4. Accelerometer data acquisition and displaying system
5. Multichannel data acquisition for EEG recording
6. Simulation of switched capacitor system
7. Modeling and simulation of internal noise cancellation circuit.
8. Cross talk cancellation system
9. Serial Interfacing to DSP
10. Parallel interfacing to DSP

Mini Project **L T P C**
0 0 6 3

The Mini project can be undertaken in an industrial / research organization or Institute in consultation with the faculty guide. In case of Project work at industrial / research organization, the same shall be jointly supervised by a faculty guide and an expert from the organization. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Controller of Examinations.

Semester IX

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	PC	Patient safety, Standards and Ethics	2	0	0	2	2
2	PE	PE- 7	3	0	0	3	3
3	PE	PE-8	3	0	0	3	3
4	PC	Wearable Devices	3	0	0	3	3
5	EEC	Technical Term Paper Writing	0	0	2	2	1
6	EEC	Project Work – Phase I	0	0	6	6	3
			14	**0**	**10**	**24**	
		TOTAL CREDITS					**15**

Patient safety, Standards and Ethics **L T P C**
2 0 0 2

STANDRADS AND SAFETY
Quality management system for medical devices (ISO 9001 and ISO13485), safety and standardization for risk management (ISO 14971), European standard conformity (CE marking), FDA guidelines for medical devices approval and classification based on risk assessment

HOSPITAL SAFETY STANDARDS
Life Safety Standards- Protecting Occupants, Protecting the Hospital From Fire, Smoke, and Heat, Protecting Individuals From Fire and Smoke, Providing and Maintaining Fire Alarm Systems, Systems for Extinguishing Fires Environment of Care Standards- Minimizing EC Risks, Smoking Prohibitions, Managing Hazardous Material and Waste, Maintaining Fire Safety Equipment, Features, Testing, Maintaining, and Inspecting Medical Equipment.

Wearable Devices **L T P C**
3 0 0 3

UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS
Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor.

UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES
Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption,

Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

UNIT III WIRELESS HEALTH SYSTEMS

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.

UNIT IV SMART TEXTILE

Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques- Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks.Case study- smart fabric for monitoring biological parameters - ECG, respiration.

UNIT V APPLICATIONS OF WEARABLE SYSTEMS

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine

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Technical Term Paper Writing **L T P C**
0 0 2 1

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (atleast 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Project Work – Phase I **L T P C**
0 0 6 3

The Project work can be undertaken in an industrial / research organization or Institute in consultation with the faculty guide. In case of Project work at industrial / research organization, the same shall be jointly supervised by a faculty guide and an expert from the organization. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Controller of Examinations.

Semester X

S. No.	Category	Course Title	L	T	P	Contact Periods	Credits
1	PE	PE-9	3	0	0	3	3
2	PE	PE-10	3	0	0	3	3
3	EEC	Project Work – Phase II	0	0	24	24	12
			6	**0**	**24**	**30**	
		TOTAL CREDITS					**18**

Project Work – Phase II **L T P C**
0 0 24 12

"Solving a real life problem" should be the focus of U.G. project. The project could be classified as hardware, software, modeling, and simulation. It should involve one or many elements of techniques such as analysis, design and synthesis.

The Head of the Department will appoint a project coordinator who will coordinate the following:
• Grouping of students (Maximum 4 in a group)
• Allotment of projects and projects guides (Supervisors)
• Project monitoring at regular intervals All projects allotment is to be completed by the 2nd week of 7th semester, so that students get sufficient time for completion of the project.

All projects will be monitored at least twice in a semester through students' presentation. Sessional marks will be awarded by a monitoring committee comprising of faculty members as well as by the supervisor. Each student will be required to
1. Submit a one page synopsis before the seminar for display on notice board.
2. Give a 20 minutes presentation followed by 10 minutes discussion.
3. Submit a technical write-up on the talk delivered.
4. Actively participate in the oral presentations.

Each project group should maintain a log book of activities of the project. It should have entries related to the work done, problems faced, solution evolved etc. There shall be at least an Interim Evaluation and a final evaluation of the project in the 8th semester. Each project group has to submit an interim report in the prescribed format for the interim evaluation. Students should execute the project work using the facilities of the institute. However, external projects can be taken up in reputed industries, if that work solves a technical problem of the external firm. Prior sanction should be obtained from the head of department before taking up external project work and there must be an internal guide for such projects. Each project group should complete the project work in the 8th semester. Each student is expected to prepare a report and a technical paper in the prescribed format, based on the project work. The paper may be prepared as per IEEE standard and can have a maximum of six pages. The project work is evaluated based on oral presentation, technical paper and the project report jointly by external and internal examiners constituted by the Controller of Examinations

Internal Continuous Assessment

40% - Literature Survey, Design and development/Simulation and analysis
30% - Presentation & demonstration of results
20% - Report
10% - Regularity in the class

M.Tech. Assistive Technologies and Rehabilitation Engineering

PG – 2 Years

SDG : 3

About the course

Rehabilitation Engineering is a multidisciplinary field that focuses on enhancing the independence, capabilities, and quality of life of individuals with disabilities through the development and application of assistive technologies and innovative solutions. This branch of engineering combines principles from various disciplines, including mechanical engineering, electrical engineering, biomedical engineering, and healthcare, to create devices, systems, and strategies that help people with disabilities overcome physical, sensory, cognitive, and communication challenges.

A Master's course in Assistive Technologies and Rehabilitation Engineering is designed to equip students with the knowledge and skills needed to develop and implement innovative technologies that assist individuals with disabilities and enhance their quality of life. This multidisciplinary field combines elements of engineering, healthcare, and technology to create devices and solutions that address the unique needs of individuals with disabilities.

Course Objectives:

- In-depth understanding of how state-of-the-art technologies can be developed and translated into clinical practice.
- The knowledge needed to tackle real problems faced by people with complex and challenging medical conditions, such as spinal cord injuries and stroke.
- Specialist theoretical knowledge with opportunities to put this into practice through research-based learning activities.
- A highly interdisciplinary research focus that will give you experience of the academic, clinical and third sectors.
- Networking opportunities throughout the course.

Curriculum

Semester I

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1		Introduction to Evidence-based Practice & Research Methodologies	PC	5	3	0	2	4
2		Introduction to Assistive Technologies	PC	3	3	0	0	3
3		Rehabilitation Engineering Principles	PC	3	3	0	0	3
4		Human Anatomy and Physiology	PC	3	3	0	0	3
5		Biomechanics and Biomaterials	PC	5	3	0	0	4
6		Inclusive design and universal accessibility.	PC	3	3	0	0	3
Total								**20**

Semester II

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1		Assistive Technology Devices and Rehabilitation Robotics	PC	5	3	0	2	4
2		Individual & Social Experience of Disability	PC	3	3	0	0	3
3		Clinical Applications of Seating and Mobility	PC	3	3	0	0	3
4		Emerging Technologies	PC	3	3	0	0	3
5		Elective I	PE	3	3	0	0	3
6		Elective II	PE	3	3	0	0	3
7		CLINICAL INTERNSHIP	EEC	6	0	0	6	3
Total								**22**

Semester III

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1		Elective III	PC	3	3	0	0	3
2		Elective IV	PE	3	3	0	0	3
3		Elective V	PE	3	3	0	0	3
4		Scholarly Paper Writing	PE	3	3	0	0	3
5		Project Work (Phase I)	EEC	12	0	0	12	6
Total								**18**

Semester IV

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1		Project Work (Phase II)	EEC	24	0	0	24	12
Total				24	0	0	24	12

Total Credits : 72

PROFESSIONAL ELECTIVES (PE)

Semester II (Elective I & Elective II)

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1		Medical electronics and Neural Engineering	PE	3	3	0	0	3
2		Digital Health	PE	3	3	0	0	3
3		Ethical Issues in healthcar	PE	3	3	0	0	3
4		Soft Tissue Biomechanics	PE	3	3	0	0	3
5		Applications of Biomedical Engineering	PE	3	3	0	0	3
6		Implanted Human-Machine Interfaces	PE	3	3	0	0	3
7		Entrepreneurship: Theory and Practice	PE	3	3	0	0	3
8		Disability Interaction	PE	3	3	0	0	3

Semester III (Elective III & Elective IV)

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1		Key Principles of Health Economics	PE	3	3	0	0	3
2		Advanced Human-Machine Interfaces	PE	3	3	0	0	3
3		Managing Innovation and Technology	PE	3	3	0	0	3
4		Fundamentals of Rehabilitation & Assistive Technology Applications	Pe	3	3	0	0	3
5		Assistive Technology Funding, Policy, & Management	PE	3	3	0	0	3
6		Wheel chair Biomechanics	PE	3	3	0	0	3
7		Client Centered Rehabilitation & Assistive Technology Design	PE	3	3	0	0	3
8		Medical Aspects of Disability	PE	3	3	0	0	3

Course Outcomes:

The course outcomes of a program in Assistive Technology and Rehabilitation Engineering are:

- In-depth understanding of how state-of-the-art technologies can be developed and translated into clinical practice.
- The knowledge needed to tackle real problems faced by people with complex and challenging medical conditions, such as spinal cord injuries and stroke.
- Specialist theoretical knowledge with opportunities to put this into practice through research-based learning activities.
- A highly interdisciplinary research focus that will give you experience of the academic, clinical and third sectors.

After completing this program, graduates can pursue careers as Assistive Technology Specialists, Rehabilitation Engineers, Clinical Assistive Technologists, or work in research and development roles for companies or organizations dedicated to improving the lives of individuals with disabilities. It's essential to check with specific universities or institutions offering this program for the most up-to-date curriculum and admission requirements.

M.Tech. Assistive Technologies and Rehabilitation Engineering

Syllabus

Introduction to Evidence-based Practice & Research Methodologies This course focuses on developing general research skills in health and rehabilitation sciences. The course will introduce the student to key concepts of evidence-based practice and review the basics of different research designs including experimental design (e.g., RCT, quasiexperimental design, small-N design), observational design, and developing outcome measures. Students will have the opportunity to conduct a mini systematic review on topics of their interests and implement the practice of asking research questions, conducting literature search, selecting the literature, appraising the literature, and interpreting the results. The lectures will be accentuated with hands- on class exercises where the student learns to critically appraise journal articles and interpret results.
Introduction to Assistive Technologies This course provides an understanding of assistive technology and application in instructional programs, career tasks, and life skills for individuals with disabilities. Enables students to better use assistive technology in education, work, community, and home environments. Offered by School of Education. Limited to three attempts.

Rehabilitation Engineering Principles

Rehabilitation Engineering -Neurophysiology and basic concepts of Motor Control and Motor Learning- Orthotics & prosthetic design-Analysis of Movement - Clinical gait and motion analysis-Advanced techniques for biomedical signal processing- Rehabilitation and assistive technologies-Universal Design:

Human Anatomy and Physiology

This course is designed to give students with a varied range of backgrounds core notions of anatomy and physiology, and for all to learn, through the critical analysis of case studies, the impact of rehabilitative or assistive technologies on patients. The course is divided in two parts: Anatomy and Physiology, and Applications of Rehabilitation Engineering.

Biomechanics and Biomaterials

This module covers the mechanics of hard and soft tissue, joint-articulation surface motion, joint lubrication, musculoskeletal structures, movement and energy, movement patterns and analysis of gait, exercise physiology (including healthy and impaired systems), factors affecting mechanical work in humans, biodynamics, and functional biomechanics (gait, sitting and standing, walking aids, wheelchairs, orthotics, prosthetics and exoskeletons). The module aims to develop a student's understanding of the mechanics of the human body by studying, defining and quantifying interactions that take place between the human body, the environment and the assistive technology. The students will thus gain an appreciation for the techniques that have been and continue to be developed to monitor physiologic function, to process the data thus accumulated, to formulate inductively theories that explain the data, and to diagnose why the human system malfunctions as a result of disease (pathology), aging (gerontology), ordinary wear and tear from normal use (fatigue), and/or accidental impairment from unusual abuse (emergency medicine).

Inclusive design and universal accessibility.

This course aims to teach students the value and benefits an inclusive design approach brings to projects with an emphasis on the planning, design, construction and operation of the built environment - the world around us.

Assistive Technology Devices and Rehabilitation Robotics

This course introduces existing assistive technologies and then moves on to explore how robotics can help in various rehabilitation therapies. Students will become sensitive to the needs of people with a wide range of functional impairments and will understand the trade-offs and selection criteria to choose appropriate assistive technologies, which fulfil the needs of individuals with different and complex disabilities, such as spinal cord injuries, motor neuron disease and stroke. The module will cover the underlying theory, technology and operating paradigms of key assistive technologies and state-of-the-art robotic rehabilitation systems.

Individual & Social Experience of Disability

This course helps the students to analyze the role of disability and people with disabilities within the structure and practice of society. Students will interact with a wide variety of disciplinary perspectives on individual, social, and cultural experience of disability, gaining familiarity with key debates in these fields. Students will also develop disability consciousness, vocabulary for discussing and writing about disability, and confidence in engaging with others in conversations on issues of disability in society. Students will develop skills in research, practice, policy, and advocacy.

Clinical Applications of Seating and Mobility

The purpose of this course is for students to develop knowledge and hands-on skill in the process of identifying and providing wheeled mobility and seating interventions to people of all ages and disability type. The course builds on previous coursework in the RST program. The class will be carried our specifically through a case based and evidence based practice learning approach. Students are required to attend clinics and work with clinical faculty.

Emerging Technologies

Artificial Intelligence-Machine Learning-Deep Learning-NLP - Chatbot -Big Data Anaytics -AR- VR- Immersive Technology -Cloud Computing

PROFESSIONAL ELECTIVES

Medical electronics and Neural Engineering

This course brings together material from engineering, physics, and physiology relevant to situations in which electronic devices are in direct contact with the body. Body contact is common in clinical practice with medical devices being used for biosensing, recording biopotentials, and stimulating the body. The course focuses on interaction with the nervous system. This course is relevant to rehabilitation, intensive care, clinical neurophysiology, neuroprosthetics.

Digital Health

This course aims to help learners unlock digital health's potential to improve health care by providing a framework to enable learners to think strategically about digital solutions, develop and deploy them in health care's unique culture and ecosystem, and navigate the sometimes competing needs of health care's multiple stakeholders. Explore the potential benefits and risks for digital solutions in health care • Understand systemic barriers to technology innovation in health care • Introduce key stakeholders for digital solutions.

Ethical Issues in healthcare Learn a process of analytic thought and prudent behavior that will lead to resolution of ethical dilemmas that rehabilitation practitioners, researchers and educators experience in their careers. Students have the opportunity to (1) explore problems they are likely to face in their research and/or practice careers, identify related ethical principles and theories; and consider arguments for various courses of action and decisions; demonstrate techniques and resources for problem solving; (2) learn the basis in moral norms for policies, standards and requirements in law/regulations, professional codes, and university IRB compliance structure and procedures; (3) develop a sensitivity to multiple perspectives when problem solving, including those involving culture/ethnicity, religion, sexual orientation, individuals with disabilities and in business and health professional domains; and (4) recognize the controversial nature of many ethical issues and the need to consider opposing points of view.
Soft Tissue Biomechanics The courses will cover the intrinsic and extrinsic factors leading to pressure ulcer development, the state of the science related to the prevention of pressure ulcers, the techniques used to evaluate and study tissue integrity related pressure ulcer development, and the evidence for the three primary theories of pressure ulcer etiology.
Applications of Biomedical Engineering This course illustrates how the foundation knowledge of biomedical engineering is used in the provision of clinical services. Topics include: 1. Electrophysiology: electroencephalography (EEG), electrical impedance tomography (EIT) and eletromyography (EMG); 2. Urology: lower urinary tract, bladder, incontinence technology; 3. Rehabilitation robotics and assistive technology: control theory, robots and Arduino programming; 4. Rehabilitation engineering: functional electrical stimulation, motion capture and gait analysis.
Implanted Human-Machine Interfaces The course reviews the existing technology behind neural implants. The module addresses four main themes: Recording and stimulating the nervous system-Manufacturing and failure-Neural tissue interactions and safety-Implant electronics.
Entrepreneurship: Theory and Practice This course is designed for students who have studied management topics previously. The content will cover complex topics which are not suited to students with no prior knowledge of subjects related to the field.

Disability Interaction

This course focuses on the design of technologies for people who have a disability; this can be through the process of creating assistive technologies, how we get assistive technologies to people and train them in use or making mainstream technologies and places more inclusive.

Key Principles of Health Economics

The course introduces key concepts in health economics using the foundations of economic theory and then applying that theory to health and health markets. It aims to enable participants to understand how demand and supply interact, how markets work and why they fail and to identify the main methods of health financing and issues around equity and efficiency in health care. Students will also learn how best to engage with economic evaluation studies (cost effectiveness analyses).

Advanced Human-Machine Interfaces

This course will introduce students to the user-centred design process and will focus on advanced human-machine interfaces, exploring brain-machine interfaces in depth, as well as considering other bio-signal interfaces and eye-trackers. The underlying theory and techniques such as signal processing, machine learning and shared control will be covered, as well as considerations for recording electrophysiological signals. This module aims to introduce students to cutting edge human-machine interfaces, with a view to driving these technologies forward and helping to transition them out of the lab. Apart from the physical interface and associated signal processing, students will be challenged to think carefully about the interaction protocol so that complex interfaces can be functional, intuitive and easy to use. The students' attention is drawn towards design paradigms such as user centred design and inclusive design, which, complementary to the engineering considerations, include aspects of human factors, psychology and market analysis.

Managing Innovation and Technology

The course aims to introduce students to key theories and concepts in the strategic management of technology and innovation, and help them understand:

- The strategic implications of technological change
- The features and enabling power of technological platforms
- The transformative impact of technology on a firm's business model

Fundamentals of Rehabilitation & Assistive Technology Applications

This course provides an introduction to the fundamental principles and practices related to multiple areas of assistive technology. This includes: wheelchair seating and mobility, adaptive sports and recreation, augmentative communication, environmental control and home automation, computer and Smartphone access, cognitive aids, low vision and hearing loss devices, adaptive driving, vehicle modifications, transportation safety, environmental accessibility as well as prosthetics and orthotics. In addition, common terminology, disability etiquette, ethics, and the service delivery process are discussed throughout. The course also includes various hands-on labs to further learn the applications of various assistive technologies.

Assistive Technology Funding, Policy, & Management

This course focuses on the components necessary for people with disabilities to access Assistive Technology and Assistive Technology Services. Students will be able to apply experience from previous coursework and experience with AT devices from a context of policy (legislative and non-legislative), funding, and organizational management that surrounds services. Content will focus on funding sources, legislative policy, clinical assessment, documentation procedures, use of evidence, and advocacy efforts. Examples of systems change activities and current topics will also be reviewed and discussed. Advocacy and procedures for due process and policy change will also be reviewed for situations when funding sources and policies are limited. Students will prepare and present a policy/funding case study. The management portion will focus on the essential components of a service delivery program or business model that includes strategic planning, human resource/organizational behavior, policies and procedures, accreditation, budgets, quality improvement, business planning and resource management. Students will work as a group(s) to prepare a business plan that includes these essentials.

Wheel chair Biomechanics

This course covers manual wheelchair setup and design, propulsion biomechanics and physiology, upper limb muscular demands and biomechanical models for determining upper limb joint forces and moments. Students will conduct three projects involving biomechanics data analysis. Clinical correlates to the biomechanical studies will also be presented. Students should have a general knowledge of physics (e.g. introductory undergraduate course).

Client Centered Rehabilitation & Assistive Technology Design

In this course, students seek input from clinicians and end users related to problems that could be in part be solved by assistive technology. Student teams will interview clients/end users, solicit their feedback through the design process, prototype the design, and ultimately, present this design to the end user(s), with the goal of providing them with a usable product. This course is a project-based design course in which students use design methods and tools. Follow an iterative design and testing process with clients and experts, and develop assistive technology device prototypes for their clients.

Medical Aspects of Disability
This course is designed to provide a general overview of the pre-disposing factors and direct causes of disease, as well as their effects on the human body. It will also include a systemic approach to the basic disease process in terms of etiology, symptomatology, general pathological changes, diagnostic procedures. Students will examine major chronic illnesses, diseases, and disabilities in order to obtain a practical understanding of the implications of these conditions on all areas of functioning and participation to prepare for clinical rehabilitation technology applications. Case scenarios will be utilized to enhance student learning and interaction with individuals with varying types of disabilities. Students will prepare a paper and present on a specific disease or disability focusing on both the pathophysiology and the functional considerations that may be affected by use of rehabilitation and assistive technology. This course will also cover a basic introduction to medical terminology and universal precautions.
Clinical Internship
The clinical internship is a supervised practical experience, usually in a clinical facility or agency, permitting the student to observe and participate in existing specialized programs and to develop, apply, and evaluate new clinical procedures.

Pedagogy:

The course combines online discussions, presentations by guest lecturers, individual and team projects, site visits to medical and engineering facilities, an assistive technology faire, and project presentations by students.

Activities:

1. **Quiz**
2. **Forum discussion**
3. **Case studies**
4. **Site experience/observation**

B.Tech. Sustainable Engineering and Management

(UG – 4 Years)

Program Duration: 4 years (8 semesters)

Program Description: This program aims to produce graduates who can apply engineering principles to solve complex sustainability challenges while also understanding management principles to ensure the effective implementation of sustainable solutions in various industries. There is a high demand for such professionals, owing to the Paris Agreement and pressing needs towards the fulfilment of the United Nations Sustainable Development Goals (SDGs).

The program provides an opportunity for students to get widespread knowledge and train with the tools and techniques, and economics and policy involving sustainability management. Graduates will be skilled to address sustainability issues and become leaders in their fields. They will also be exposed to interdisciplinary research and approaches to SDGs.

Year 1: Semester 1

Course Code	Course Name	Credit
1	Technical Communication	2
2	Algebra and Calculus	4
3	Engineering Graphics	4
4	Basic Electronics Engineering	3
5	Physics of Materials	4
6	Engineering Practices	2
Total		**19**

Year 1: Semester 2

Course Code	Course Name	Credit
7	English for Professional Competence	2
8	Critical Thinking and Writing	2
9	Applied Chemistry	4
10	Differential Equations and Complex Variables	4
11	Basic Electrical Engineering	4
12	Problem solving and Python Programming	4
Total		**20**

Year 2: Semester 3

Course Code	Course Name	Credit
13	Fundamentals of Sustainability Engineering	3
14	Introduction to Environmental Engineering	3
15	Stress Management	3
16	Ecology and Eco-system Engineering	3
17	Fundamentals of Management	3
18	Environmental Instrumentation Analysis	3
19	Engineering Thermodynamics	3
20	Thermodynamics Lab	2
Total		**23**

Year 2: Semester 4

Course Code	Course Name	Credit
21	Energy, Environment and Climate Change	3
22	Sustainable Construction Materials	3
23	Sustainable Audit Management	3
24	Environmental Economics	3
25	Total Quality Management	4
26	Computer Applications in EnvironmentalEngineering	2
27	Environmental Engineering Lab	2
28	Regulatory Framework & Legal Aspects in Sustainability (Report Writing)	2
29	Energy Resources Lab	2
Total		**24**

Year 3: Semester 5

Course Code	Course Name	Credit
30	Energy audit and management	3
31	Sustainable Design and Innovation	3
32	Innovative Entrepreneurship	3
33	Life Cycle Assessment	3
34	International Energy Markets	3
35	Sustainable Project Management	3
36	Energy Resources Lab	2
37	Research Project – Climate Change	2
Total		**22**

Year 3: Semester 6

Course Code	Course Name	Credit
38	Business Ethics and Corporate Social Responsibility	3
39	Sustainable Transportation andInfrastructure	3
40	Renewable Energy Technologies	3
41	Marketing Management	3
42	Engineering economics for sustainability	3
43	Advanced Eco design	3
44	Research Project - SOCIAL THEMES	2
45	Sustainable Business Lab (S-Lab)	2
Total		**22**

Year 4: Semester 7

Course Code	Course Name	Credit
46	Financial Management	3
47	Integrated Product Service Engineering	3
48	Management Systems and Sustainability	3
49	Human Resource Management & Sustainability	3
50	Emission Trading and Management	3
51	Circular economy	3
Total		**18**

Year 4: Semester 8

Course Code	Course Name	Credit
52	Capstone Project	12
Total		**12**

Total Credits - 160

Year 1: Semester 1

Course1 - Technical Communication

UNIT-I - DEVELOPING COMPREHENSION SKILLS

Listening: Reading: Speaking: Writing: Grammar: Vocabulary

UNIT-II LISTENING AND EXTENDED READING

Listening: Reading: Speaking: Writing: Grammar: Vocabulary

UNIT-III - FORMAL WRITING AND VERBAL ABILITY

Listening: Reading: Speaking: Writing: Grammar: Vocabulary

UNIT-IV - ENHANCING SPEAKING ABILITY

Listening: Reading: Speaking: Writing: Grammar: Vocabulary

UNIT-V - LANGUAGE FOR WORKPLACE

Listening: Reading: Speaking: Writing: Grammar: Vocabulary

Reference Books(s)

1. Basic Vocabulary in Use: 60 Units of Vocabulary Practice in North American English with Answers 2nd Edition by Michael McCarthy (Author), Felicity O'Dell (Author), John D. Bunting (Contributor)
2. The 7 Habits of Highly Effective People by Stephen Covey, Simon and Schuster, UK
3. Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine ChuenMeng Goh, Cambridge University Press

Year 1: Semester 1

Course 2 - Algebra and Calculus

UNIT-I – MATRICES

Matrices, Cayley- Hamilton Theorem - Quadratic forms- Numerical computation

UNIT-II - FUNCTIONS OF SEVERAL VARIABLES

Partial differentiation - Taylor‟s series for functions of two variables–Maxima andminima of functions

UNIT-III - INTEGRAL CALCULUS

Integral Calculus - Applications of integration to area

UNIT-IV - MULTIPLE INTEGRALS

Double integrals - Triple integrals - Numerical computation of double integrals:Trapezoidal rule.

UNIT-V – REGRESSION

Scatter diagram - Karl Pearson coefficient of correlation for raw data –Spearman rank correlation coefficient - Lines of regression - Regression equation X on Y and Y on X- Curve fitting by Principle of least squares.

Reference Books

1. A . Goon, M. Gupta and B.Dasgupta , ”Fundamentals of Statistics “,Vol. I & Vol.II, World Press, 2019.
2. T Veerarajan ,Fundamentals of Mathematical Statistics , yesdee publications, 2017.
3. Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill EducationPvt. Ltd, New Delhi, 2018.

Year 1: Semester 1

Course 3 - Engineering Graphics

UNIT-I PLANE CURVES AND PROJECTION OF POINTS

Curves used in engineering practices: Conics - Cycloidal Curves–Construction ofcycloid - Principles of Projection.

UNIT-II PROJECTION OF LINES AND PLANE SURFACES

Projection of straight lines - Determination of true lengths and true inclination -Projection of planes.

UNIT-III PROJECTION OF SOLIDS AND PROJECTION OF SECTIONED SOLIDS

Projection of simple solids like prisms - Sectioning of solids in simple vertical position - Practicing three-dimensional modeling of simple objects by CAD software.

UNIT-IV DEVELOPMENT OF SURFACE AND ISOMETRIC PROJECTIONS

Development of lateral surfaces of simple and sectioned solids - Principles of isometric projection.

UNIT-V FREE HAND SKETCHING AND PERSPECTIVE PROJECTIONS

Free Hand sketching - Perspective projection of simple solids.

REFERENCE BOOKS

1. V.B Sikka "Civil Engineering Drawing", S.K Kataria & Sons, New Delhi.
2. Venugopal K. and PrabhuRaja V., "Engineering Graphics", New Age International (P)Limited, 2008.
3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2017.
4. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill Publishing Company Limited, New Delhi, 2018.

Year 1: Semester 1

Course 4 - Basic Electronics Engineering

UNIT-I - SEMICONDUCTOR DEVICES AND APPLICATIONS

Introduction to P-N junction Diode and V-I, Zener diode - Introduction to BJT.

UNIT-II - OPERATIONAL AMPLIFIER AND APPLICATIONS

Introduction to operational amplifiers, Op-amp input modes and parameters, Op-ampin open loop configuration, study of practical Op-amp IC 741, difference amplifier.

UNIT-III - TIMING CIRCUITS AND OSCILLATORS

RC-timing circuits, IC 555 and its applications as astable and mono-stable multi-vibrators, positive feedback, Barkhausen criteria for oscillation, R-C phase shift and Wein bridge oscillator.

UNIT-IV - DIGITAL ELECTRONICS FUNDAMENTALS

Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Block diagram of 8086 microprocessor and 8051 microcontroller and their applications.

UNIT-V - MODERN WIRELESS COMMUNICATION SYSTEMS

The elements of communication system, Transmission media, Mobile communication systems: cellular concept and block diagram of GSM system.

Reference Books

1. David A., "Bell Electronic Devices and Circuits", Oxford Higher Education Press, 5th Edition, 2010
2. M. Morris Mano, "Digital Design", 4th Edition, Prentice Hall of India Pvt. Ltd., 2008 Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003.

Year 1: Semester 1

Course5 - Physics of Materials

UNIT-I - PROPERTIES OF MATTER

Elasticity–Hooke‟s law-stress– Poisson‟s ratio-rigidity modulustwisting - Young‟smodulus determination - Viscosity-flow of motion-Reynolds number.

UNIT-II - THERMAL PHYSICS

Transfer of heat energy - bimetallic strips - thermal conductivity - thermal insulation – applications.

UNIT-III - PHASE DIAGRAMS

Solid solutions - Hume-Rothery‟s rules –Gibb‟s phase rule - formation of microstructures-homogeneous and non-homogenous cooling – nucleation (Qualitative)– ironcarbon phase diagram - eutectoid steel – hypo-eutectoid and hyper-eutectoid steel – diffusion - Fick‟s laws – T-T-T diagrams.

UNIT-IV - CRYSTAL PHYSICS

Basis – lattices – unit cell-crystal systems – Bravais lattices - packing fraction - SC, BCC, FCC, HCP lattices and diamond structure - Bridgmann and Czochralski - crystaldefects..

UNIT-V- ADVANCED MATERIALS & TESTING

Metallic glasses – preparation, properties and applications, ball milling- properties applications - Tensile strength – Hardness – Fatigue - Impact strength – Creep - Fracture – types of fracture.

Reference Books

1. Balasubramaniam, R. *"Callister's Materials Science and Engineering".*WileyIndia Pvt. Ltd., 2017
2. Raghavan, V. *"Materials Science and Engineering: A First course"*. PHILearning, 2019.

Year 1: Semester 1

Course6 - Engineering Practices

List of Experiments

- CIVIL ENGINEERING PRACTICE
- Carpentry works
- MECHANICAL ENGINEERING PRACTICE
- Basic Machining Sheet
- Metal Work
- Machine Assembly
- Practice

Year 1: Semester 2

Course 7 - English for Professional Competence

UNIT-I - RECEPTIVE SKILLS

Listening: Reading

UNIT-II - PRODUCTIVE SKILLS

Speaking: Writing

UNIT-III - ENGLISH FOR COMPETITIVE EXAMS

International English Language Testing System (IELTS) – Test of English as a Foreign Language (TOEFL) – Graduate Record Examination (GRE) – Civil Service, Indian Economic Service Examination, Indian Statistical Service Examination, Combined Defence Services Examination, Staff Selection- (Language Related) – Aptitude tests.

UNIT-IV - CORPORATE SKILLS

Critical Thinking and Problem Solving – Case Study, Brainstorming, Q & A Discussion – Team work and Collaboration – Activities like Office Debates, Perfect Square, Blind Retriever, etc. – Professionalism and Strong Work Ethics

UNIT-V - PROJECT WORK

Case Study based on the challenges faced by the employers and the employees – Devise Plan, Provide Solution.

Reference Books

1. Michael McCarthy (Author), Felicity O'Dell (Author), John D. Bunting (Contributor), "Basic Vocabulary in Use: 60 Units of Vocabulary Practice in NorthAmerican English With Answers" 2nd Edition
2. Jack C. Richards & Theodore S. Rodgers, " Approaches and Methods in LanguageTeaching, Second Edition, Cambridge University Press.

Year 1: Semester 2

Course 8 - Critical Thinking and Writing

- Topics
- Critical Thinking
- Argument
- Fallacies and Biases
- Developing critical thinking skills in the areas of reading, writing, speaking and listening
- Constructing an academic argument
- Critical review
- Characteristics of critical and analytical writing
- Issue writing

Reference Books

1. Rossenwasser, David, Jill Stephen. Writing Analytically. Sixth Edition. Boston: Wadsworth. Cengage Learning, 2012.
2. Anderson, Marilyn. Critical Reasoning, Academic Writing and Presentation Skills. New Delhi: Pearson Education, 2010.

Year 1: Semester 2

Course9 - Applied Chemistry

UNIT-I - Chemical kinematics and catalysis:

Introduction to rate equation and reaction order, reaction mechanism, relation between rate equation and reaction mechanism, First order & Second order. Arrhenius theory, collision theory, Transition – state theory, Physical adsorption, chemisorption, Freundlich's expression.

UNIT-II - Coordination Chemistry & Organic Reaction Mechanism

Coordination chemistry, coordination number, chelate effect, coordination complexes and their applications. Name reactions viz. Hoffman's rearrangement, Beckman's reaction, Riemer-Tiemann reaction, Skraup synthesis, etc.

UNIT-III - Thermodynamics and electrochemical Phenomenon:

Heat, work and energy, reversible and irreversible processes, work done in an isothermal reversible expansion of ideal gas. Enthalpy. Entropy. Electrochemical and galvanic series, polarization, decomposition potential, over voltage.

UNIT-IV - Analytical aspects of water

Sources, conservation of water, impurities in water and their effects. WHO guideline and BIS guideline for drinking water.

UNIT-V - Engineering Materials

Glass, ceramics, refractory, composites, magnetic materials, Polymers & structure property relationship

Reference Books

1. Barrow, M. Gordon; Physical Chemistry (Fifth edition); McGraw-Hill, 1992.
2. March, Jerry.; Advance Organic Chemistry Reaction Mechanism and Structure (Fourth edition); John Wiley & Sons New York, 2004.
3. W. Kemp; Organic spectroscopy (III Edition) PALGRAVE, 2002

Year 1: Semester 2

Course10 - Differential Equations and Complex Variables

UNIT-I - ORDINARY DIFFERENTIAL EQUATIONS

Second and higher order Linear differential equations with constant coefficients Legendre‟s linear equations – Numerical solution of ODE - Single Step methods: Taylor‟s series method, Euler‟s method.

UNIT-II - PARTIAL DIFFERENTIAL EQUATIONS

Formation of partial differential equations - Classification of PDE – Solutions of standard types of first order partial differential equations - Lagrange‟s linear equation.

UNIT-III - LAPLACE TRANSFORM

Laplace transform –Basic properties - Inverse Laplace transform - Laplacetransformation techniques.

UNIT-IV - VECTOR CALCULUS

Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidalvector fields - Gauss divergence theorem and Stokes‟ theorem.

UNIT-V - COMPLEX VARIABLES

Analytic functions –– Construction of analytic function - Bilinear transformation – Singularities – Cauchy‟s integral theorem (without proof) - Residues – Residue theorem.

Reference Books

1. Ramana. B.V., "Higher Engineering Mathematics ", McGraw Hill EducationPvt. Ltd, New Delhi, 2016.
2. T Veerarajan, Transforms and Partial Differential Equations, Third Edition, 2018.
3. Peter V.O‟Neil, “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi, 2012.

Year 1: Semester 2

Course 11 - Basic Electrical Engineering

UNIT-I - DC CIRCUITS

Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff‟s laws,Mesh and Nodal Analysis.

UNIT-II - AC CIRCUITS

Representation of sinusoidal waveforms, Power and Power factor. Analysis of single-phase ac circuits consisting of RL, C, RL, RC, RLC combinations.

UNIT-III - DC MOTORS AND TRANSFORMERS

Construction, working and characteristics of DC motors. Construction, principle of operation of single-phase Transformer, EMF Equation.

UNIT-IV - AC ROTATING MACHINES

Construction and basic working of three phase Alternators and Induction motors, Construction and Types of single phase induction motors.

UNIT-V - ELECTRICAL SAFETY MEASURES

Primary and secondary hazards- arc, blast, shocks-causes and effects-safety equipment-flash and thermal protection - Safety in the use of portable tools - Preventive maintenance-Types of earthing and its importance-Safety precautions.

Reference Books

1. Joseph A. Edminister, Mahmood, Nahri, “Electric Circuits” – Shaum Series and Systems”, Schaum‟s Outlines, Tata McGrawHill, Indian. 5th Edison , 2017
2. E G Janardanan, —Special Electrical Machines||, Prentice Hall India Limited, 2013.

Year 1: Semester 2

Course12 - Problem solving and Python Programming

UNIT-I - ALGORITHMIC PROBLEM SOLVING

Introduction to computers-characteristics-basic organization of a computer–algorithms-building blocks of algorithms

UNIT-II - DATA, EXPRESSIONS, STATEMENTS AND CONTROL FLOW

Python interpreter and interactive mode - I/O - operators- precedenceof operators–comments. Conditionals.

UNIT-III - CONTROL FLOW – II AND FUNCTIONS

Iteration: while – for - break – continue – pass. Function calls - Fruitful functions.

UNIT-IV – STRINGS

Strings: string slices – immutability - string functions and methods – string comparison. GCD– exponentiation.

UNIT-V - LISTS, TUPLES AND DICTIONARIES

Lists - list operations - list slices - list methods - list loop – mutability – aliasing - cloning lists - listparameters. Tuples – immutable - tuple assignment - tuple as return value.

Dictionaries.

Reference Books

1. JohnVGuttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press,2013.
2. Timothy A.Budd, Exploring Python, Mc-Graw Hill Education (India) Private Ltd., 2015.

Year 2: Semester 3

Course 13 - Fundamentals of Sustainability Engineering

UNIT-I - Introduction to Sustainable Engineering

Sustainable development, concepts of sustainable development: three pillar model, egg of sustainability model, Atkisson's pyramid model, multilateral environmental agreements and protocols, enforcement of environmental laws in India – The Water Act, The Air Act, The Environment Act.

UNIT- II Sustainable Engineering and Concepts, Principles and Frame Work

Green Economy and Low Carbon Economy, Eco Efficiency, Triple bottom Line, Guiding principles of sustainable engineering, Frameworks for sustainable Engineering.

UNIT- III - Tools for sustainability Assessment:

Environmental Management System, Environmental Auditing, Cleaner Production Assessment, Environmental Impact Assessment, Strategic Environmental

UNIT- IV - Local Environmental Issues, Global Environmental Issues

Solid waste, impact of solid waste on natural resources, zero waste concept and three R concept, waste to energy technology, Resource degradation: deterioration of water resources, land degradation, air pollution, climate change and global warming, ozone layer depletion, carbon footprint, carbon trading.

UNIT-V - Integrating Sustainability in Engineering Design

Problems Solving in Engineering, conventional to Sustainable Engineering Design Process, Design for Life Guidelines and Strategies, Measuring Sustainability, Sustainable Design through sustainable procurement criteria, Case studies on sustainable Engineering Design Process – Sustainable Process Design, Sustainable Production Design Sustainable product design in Electronic Engineering.

Reference Books

- Introduction to Sustainability for Engineers, ToolseeramRamjeawon, CRC Press, 1stEdn., 2020
- Sustainability Engineering: Concepts, Design and Case studies, Prentice Hall, 1stEdn,2015
- System Analysis for sustainable Engineering: Theory and applications, Ni bin Chang,McGraw Hill Publications, 1stEdn., 2010
- Engineering for Sustainable development: Delivery a sustainable development goals,UNESCO, International Centre for Engineering Education, France, 1stEdn., 2021

Year 2: Semester 3

Course14 - Introduction to Environmental engineering

Unit I - Fundamentals of Environmental Sciences

Definition, Principles and Scope of Environmental Science. Meteorological parameters, Interaction between Earth, Man and Environment.

UNIT-II - Energy and Environment

Sun as source of energy, Principles of generation of hydro-power, Nuclear energy, Bioenergy.

UNIT-III - Environmental Pollution and Control

Causes of air pollution, Analysis of Air Pollutants, Methods &Approach of Air Pollution Control. Water Sources - different sources of water pollution- water pollution& its control.

UNIT-IV - Solid and Hazardous Waste Management

Solid Waste - Solid waste collection and transportation - Solid waste processing and recovery- Hazardous waste - e-waste - Fly ash - Plastic waste.

UNIT-V - Contemporary Environmental Issues

Global Environmental Issues - National Action Plan on Climate Change - Current Environmental Issues in India

Reference Books

1. Sawyer,C.N., MacCarty, P.L. and Parkin, G.F., "Chemistry for Environmental Engineering and Science", Tata McGraw – Hill, Fifth edition, New Delhi 2003.
2. Colin Baird „Environmental Chemistry‟, Freeman and company, New York, 1997.
3. Manahan, S.E., "Environmental Chemistry", Eighth Edition, CRC press,2005. 4. Ronbald A. Hites ,"Elements of Environmental Chemistry", Wiley, 2007.

Year 2: Semester 3

Course 15 – Stress Management

Unit I Meaning and nature of stress:

Difference between eustress and distress; Frustration, conflict and pressure; Meaning of stressors; common stressors at work place: Stressors unique to age and gender. General adaptation to stress; Consequences of stress; Physiological and psychological changes associated with the stress response.

Unit II Behavioural aspects of Stress

Adaptive and Maladaptive Behaviour; Individual and Cultural Differences: Sources ofStress-Across the Lifespan; College and Occupational Stress.

Unit III - Stress and Work performance

Role of communication in managing stress and work performance: Emotional regulation and coping; Emotional intelligence and conflict management: Emotional Basis and Stress; Stress and Conflict in Relationships. Stress intervention – interpersonal, Management Standards and Management Competencies.

Unit IV Strategies of Stress Management

Prevention of stress Challenging Stressful Thinking; Problem Solving; Emotional and cognitive coping styles: Strategies of Synthesis and Prevention: Resilience and Stress; Optimal functioning; Making changes last; Small changes and large rewards.

Unit V Preparing for the Future

Care of the Self: Nutrition and Other Lifestyle Issues: Stress reduction practices: Time management; Exercise; Relaxation techniques; yoga; meditation.

Reference Books:

1. Baron .L & Feist.J (2000) Health Psychology 4th edition, USA Brooks/Cole

2. Barlow, Rapee, and Perini(2014), 10 Steps to Mastering Stress: A Lifestyle Approach, USA

3. Clayton,M, (2011).Brilliant stressmanagement How to manage stress in any situation's 1st edition, Greart Britain Pearson Education

4. Cooper,C,& Palmer,S, (2000)Conquer Your Stress, London: Institute of personal development Universities Press

5. Dutta, P,K, (2010) Stress management Himalaya, Himalaya Publishing House

6. Lee, K. (2014). Reset: Make the Most of Your Stress: Your 24-7 Plan for Well-being. Universe Publishing.

Year 2: Semester 3

Course16 - Ecology and Eco-system Engineering

Course Objectives

- Describe the fundamentals of ecology and ecosystems along with the ecological engineering
- Impart the knowledge on the functional interaction of the environmental systems,which helps in realizing the importance of the ecosystems integrity.

Course Outcomes

The Student should be able to

- Describe the ecosystems and its structure along with the key functions /services of theecosystems
- Realize the importance of ecological engineering in addressing the issues and challenges in environmental management
- Apply technology to manage ecosystems efficiently by understanding the essentialworkings of natural ecological systems
- Understand and develop the mathematical concepts and models to use for the environmental systems such as wetlands, lakes, reservoirs etc

Unit I Development and Evolution of ecosystems

Principles and concepts - Energy flow and material cycling – productivity –Classification of ecotechnology – ecological engineering.

Unit II Classification of systems

Principles and components of Systems Structural and functional interactions of environmental systems and Modeling. Modeling and ecotechnology – Classification of ecological models – Applications Ecological economics- Self-organizing design and processes – Multi seeded microcosms.

Unit III Self-organizing processes

Multiple seeded microcosms- Interface coupling in ecological systems - Concept of energy - Adapting ecological engineering systems to potentially catastrophic events – Agro ecosystems - Determination of sustainable loading of ecosystems.

Unit IV Interface coupling in the ecological systems

Concepts or energy- determination of sustainable loading of ecosystems.

Unit V Eco-sanitation

Soil infiltration systems- Wetlands and ponds- Source Separation systems- Aqua cultural systems- Agro ecosystems- Detritus based Treatment for solid wastes – marine systems- Case studies.

Reference Books

1. Kangas, P.C. and Kangas, P., Ecological Engineering: Principles and Practice,Lewis Publishers.
2. Concepts of Ecology by Kormondy, PHI Publications.
3. Etnier, C. and Guterstam, B., Ecological Engineering for Wastewater Treatment, Lewis Publishers.

Year 2: Semester 3

Course17 - Fundamentals of Management

Objectives:

- The course will cover the management theories, evolution of management over the yearsand few basic concepts without going into the details.
- To expose the students to know the functions of management, the organizational design,leadership and ethics in management.

UNIT-I - MANAGEMENT THEORIES

Concept and Foundations of Management, Evolution of Management Thoughts [Pre-Scientific Management Era (before 1880), Classical management Era (1880-1930), Neo-classical Management Era (1930-1950), Modern Management era (1950-onward).

Contribution of Management Thinkers: Taylor, Fayol, Elton Mayo etc

UNIT-II - FUNCTIONS OF MANAGEMENT & LEADERSHIP

Planning, Organizing, Staffing, Directing, Controlling, Leadership - Concept, Nature, Importance, Attributes of a leader, developing leaders across the organization, Leadership Grid.

UNIT-III - ORGANIZATIONAL DESIGN

Classical, Neoclassical and Contingency approaches to organizational design; Organizational theory and design, Organizational structure (Simple Structure, Functional Structure, Divisional Structure, Matrix Structure).

UNIT-IV - ORGANIZATION BEHAVIOR

Introduction, Personality, Perception, Learning and Reinforcement, Motivation, Group Dynamics, Power & Influence, Work Stress and Stress Management, Decision Making, Problems in Decision Making, Decision Making, Organizational Culture, Managing Cultural Diversity.

UNIT-V MANAGERIAL ETHICS

Ethics and Business, Ethics of Marketing & advertising, Ethics of Finance & Accounting, Decision – making frameworks, Business and Social Responsibility, International Standards, Corporate Governance, Corporate Citizenship, CorporateSocial Responsibility.

Reference Books

1. Stephen P. Robbins, Timothy A. Judge, Neharika Vohra, OrganizationalBehavior, Eighteenth Edition, Pearson India,2019.
2. Richard L. Daft, Understanding the Theory and Design of Organization,Eleventh Edition, Cengage Learning India Private Limited, 2020.

Year 2: Semester 3

Course18 - Environmental Instrumentation

AnalysisCourse Objectives

- Demonstrate knowledge of the regulations and standards for the analysis of environmental samples.
- Demonstrate competence in analytical procedures and instrument analysis.
- Demonstrate submit evaluated sample results and record keeping.

Course Outcomes

After completion of the course, the student will be able to

- Describe the functions, strengths, and limitations of various analytical instruments
- Differentiate the various types of errors in the management of data in quantitativeanalysis
- Use various instruments such as Colorimetry, Spectrophotometer, Fluorometry,Nephelometry for the estimation of parameters
- Understand the Chromatography Method and its application in the environmentalquality monitoring
- Comprehend the Electro Analytical Methods and Continuous Monitoring Methods
- Explain the function and importance of analyzer sample

  systems

Unit I Fundamentals:

Functional Elements of Generalized Measuring Systems - Management of Data in quantitative analysis: Accuracy, precision, types of errors, Minimization of error, statistical analysis and curve fittings - Classification of Measuring Instruments, Introduction of Microprocessors based instrumentation. Standards of Measurement and classification - Calibration of instruments and its importance - Transducers, measurement of non-electrical quantities like pressure, temperature, flow and level etc.

Unit II Instrumental Methods:

pH meter – Colorimetry, Spectrophotometer: Flame Emission Spectrometry- Absorption spectrometry - Nephelometry - Atomic Absorption Spectrometry -Total Organic carbon analyzer – Mercury Analyzer polar graph for metal estimation and organic compounds - Ion selective Electrode - Instrument components and its workingprinciple

Unit III Chromatography Method:

Classification, Principal and application of Chromatography – Gas chromatography,GC-MS, HPLC, Ion Chromatography, Paper chromatography and thin layer Chromatography

Unit IV Electro Analytical Method:

Conductometry Potentiometry, Coulometry and Polarography. Continuous environmental quality Monitoring instruments and their principals: NDIR for CO, Chemiluminescence analysis for NOX and fluorescence analysis for SO2

Unit V Air Pollution Control Equipment's:

Working principles of electrostatic precipitator – cyclone separators – settling chamber – operation and Maintenance. Machinery for solid waste collection and disposal incineration – compactors – magnetic separators- incinerators - Monitors Intended fora Broad Range of Compounds.

Text Books

- Instrumentation and Mechanical Measurement by Prof. A. K. Tayal
- Hand Book of Analytical Instrumentation by R. S. Khandpur
- Instrumentation Measurement and Analyst by B. C. Nakra and K K Chaudhry

Reference Books

- Standards Methods for the Examination of Water and Waste Water, 20th Edition,WPCF, APHA and AWWA, USA
- Trivedy R. K. & Goel P.K., Chemical and Biological methods for water pollutionstudies, Environmental publication, Karat.
- Cox C.R., Operation and Control of Water Treatment Processes, World HealthOrganisation, Geneva.

Year 2: Semester 3

Course19 - Engineering Thermodynamics

COURSE OBJECTIVES:

- Impart knowledge on the basics and application of zeroth and first law ofthermodynamics.
- Impart knowledge on the second law of thermodynamics in analysing the performanceof thermal devices.
- Impart knowledge on availability and applications of second law of thermodynamics
- Teach the various properties of steam through steam tables and Mollier chart.
- Impart knowledge on the macroscopic properties of ideal and real gases.

UNIT I BASICS, ZEROTH AND FIRST LAW

Review of Basics – Thermodynamic systems, Properties and processes Thermodynamic Equilibrium - Displacement work - P-V diagram. Thermal equilibrium - Zeroth law – Concept of temperature and Temperature Scales. First law – application to closed and open systems – steady and unsteady flow processes.

UNIT II SECOND LAW AND ENTROPY

Heat Engine – Refrigerator - Heat pump. Statements of second law and their equivalence & corollaries. Carnot cycle - Reversed Carnot cycle - Performance - Clausius inequality. Concept of entropy - T-s diagram - Tds Equations - Entropychange for a pure substance.

UNIT III AVAILABILITY AND APPLICATIONS OF II LAW

Ideal gases undergoing different processes - principle of increase in entropy.Applications of II Law. High- and low-grade energy. Availability and Irreversibility for open and closed system processes - I and II law Efficiency

UNIT IV PROPERTIES OF PURE SUBSTANCES

Steam - formation and its thermodynamic properties - p-v, p-T, T-v, T-s, h-s diagrams. PVT surface. Determination of dryness fraction. Calculation of work done and heat transfer in non-flow and flow processes using Steam Table and Mollier Chart.

UNIT V GAS MIXTURES AND THERMODYNAMIC RELATIONS

Properties of Ideal gas, real gas - comparison. Equations of state for ideal and real gases. vander Waal's relation - Reduced properties - Compressibility factor - Principle of Corresponding states - Generalized Compressibility Chart. Maxwell relations - TdS Equations - heat capacities relations - Energy equation, Joule- Thomson experiment - Clausius-Clapeyron equation.

Course Outcomes:

At the end of the course the students would be able to

- Apply the zeroth and first law of thermodynamics by formulating temperature scalesand calculating the property changes in closed and open engineering systems.
- Apply the second law of thermodynamics in analysing the performance of thermaldevices through energy and entropy calculations.
- Apply the second law of thermodynamics in evaluating the various properties ofsteam through steam tables and Mollier chart.
- Apply the properties of pure substance in computing the macroscopic properties of
- ideal and real gases using gas laws and appropriate thermodynamic relations.
- Apply the properties of gas mixtures in calculating the properties of gas mixtures andapplying various thermodynamic relations to calculate property changes.

TEXT BOOKS:

- Nag.P.K., “Engineering Thermodynamics”, 6th Edition, Tata McGraw Hill (2017),New Delhi.
- Natarajan, E., “Engineering Thermodynamics: Fundamentals and Applications”, 2ndEdition (2014), Anuragam Publications, Chennai.

REFERENCES:

- Cengel, Y and M. Boles, Thermodynamics - An Engineering Approach, TataMcGraw Hill,9th Edition, 2019.
- Chattopadhyay, P, "Engineering Thermodynamics", 2nd Edition Oxford UniversityPress, 2016.
- Rathakrishnan, E., "Fundamentals of Engineering Thermodynamics", 2nd Edition,Prentice Hall of India Pvt. Ltd, 2006.
- Claus Borgnakke and Richard E. Sonntag, "Fundamentals of Thermodynamics",10th Edition, Wiley Eastern, 2019.
- Venkatesh. A, "Basic Engineering Thermodynamics", Universities Press (India)Limited, 2007

Year 2: Semester 3

Course20 - Thermodynamics Lab

Objectives:

- To gain insight into basic concepts taught in Chemical Engineering Thermodynamics theory course by performing hands on experiments.
- Course Outcomes: At the end of the lab the student shall be able toIllustrate first law of thermodynamics and Hess's law
- Interpret thermodynamic cycles and equation of stateEstimate property changes of mixing.
- Analyze phase equilibria and related laws.Evaluate equilibrium constant.

Experiments:

Introduction

Introduction about the lab, experiments and the equipment

Layout of Steam Power Plant

To draw the layout of the steam power plant and study the main characteristics of the system.

Steam Boiler

To study the starting procedure of steam boiler.

Relationship of Steam Temperature and Pressure

To investigate the relationship between pressure and temperature of saturated steam.

Dryness Fraction

To find out the dryness fraction of steam by using separating and throttling calorimeter.

Fault finding on Boiler Demonstration Unit

To carry out fault finding on Boiler control demonstration unit.

Flow through a Convergent Nozzle

To investigate the flow of steam through a convergent Nozzle.

Flow through a Convergent/Divergent Nozzle

To investigate the flow of steam through convergent/divergent nozzle and to plot the pressure variation along its length.

Single Cylinder Steam Engine

To determine the brake power of a single cylinder steam engine with varying load.

PV Diagram of a Steam Engine

To trace the PV diagram of a piston side and piston rod side with the help of indicator unit.

Study of the Steam Turbine

Study of operational procedure and determination of steam flow rate of a steam turbin

Study of the Air-Water-Steam Heat Exchanger

To study the heat exchanger and to plot the temperature difference curves for a varietyof flow conditions.

Air-Water-Steam Heat Exchanger

To determine the mean temperature difference between two mediums in both contra and parallel flow.

References:

1. Koretsky M.D.Engineering and Chemical Thermodynamics, 2nd Edition, John Wiley& Sons, Inc., 2012.

2. Narayanan K. V., Chemical Engineering Thermodynamics, PHI, 2000.

3. Rao Y.V. C., Chemical Engineering Thermodynamics, University Press Ltd., 2001

4. Kyle B.G., Chemical and Process Thermodynamics, 3rd Edition, Pearson, Prentice Hall, 1999.

Note:

1. At least ten experiments are to be performed in the semester.

2. At least seven experiments should be performed from the above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institute as per the scope of the syllabus.

Year 2: Semester 4

Course 21 - Energy, Environment and Climate Change

Course Objectives

- To learn about the earth's energy condition, environment, and climate change.
- To understand the relationship of the terrestrial energy-environment-climate system.
- To understand the perturbing effects of anthropogenic activities on the system.
- To study the climate change quantification and mitigating adverse climate changeimpacts.

Unit-1. Introduction:

Beginning of earth and living things; structure of atmosphere; World energy use and current energy scenario; energy and carbon emissions; environmental pollution; climatic conditions.

Unit-2. Energy balance and management:

Solar and terrestrial radiation; absorption of radiation by gases; earth's energy balance; stern's report; carbon credits; energy usage patterns (oil, coal, gas etc.).Alternative energy sources: solar, wind, hydropower, and nuclear energy, clean technology.

Unit-3. Environmental Variability:

Pollution of the environment; natural (volcanoes, forest fires) and anthropogenic (antarctic ozone hole, global warming). Effects of urbanization, landscape changes, the influence of irrigation, desertification, and deforestation; environmental life cycle assessment (LCA).

Unit-4. Atmospheric Issues:

The global temperature record; global warming and its possible effects; atmospheric chemistry on climate change. Atmospheric aerosol and cloud effects on climate.

Composition of the present-day atmosphere. Greenhouse gas theory; greenhouse gases; ozone depletion problem. Post-industrial revolution scenario.

Unit-5. Climate change and safeguarding:

Photosynthetic mechanism and global climate change; various impacts of global warming; prediction of future climate changes; global climate models; The role of international bodies. Kyoto and Montreal protocols and Kigali agreement.

Intergovernmental panel on climate change (IPCC). Moral problems and responses.

Reference Books

1. Wilbanks, T., Bilello, D., Schmalzer, D., & Scott, M, Climate change and energy supply and use: Technical report for the U.S. department of energy in support of the national climate assessment. Washington, DC: Island Press. 2013.

2. Frank T. Princiotta, Global climate change - The technology challenge, Springer, 2011.

3. IPCC (Intergovernmental Panel on Climate Change) 1990. Climate Change: The IPCC Assessment. Cambridge University Press, Cambridge.

4. Sorokhtin, O.G.,Chilingar, G.V. and Khilyuk, L.F. Global warming and global cooling: Evolution of climate and earth, Elsevier, 2007.

5. Fouquet R., Handbook on energy and climate change, Edward Elgar Publishing, U.K., 2015.

6. Cherian A., Energy and global climate change: Bridging the sustainable development divide, Wiley Publisher, 2015.

Year 2: Semester 4

Course22 - : Sustainable Construction Materials

OBJECTIVE:

- To impart knowledge about sustainable construction and to understand the concepts of sustainable materials, energy calculations, green buildings and environmental effects.

UNIT-I INTRODUCTION

Introduction to Sustainability and its Need in construction, The concept of "sustainable development" and materials: environmental, social and economic aspects of materials usage and development.

UNIT-II INTRODUCTION & MATERIALS USED IN SUSTAINABLE

CONSTRUCTION Introduction and definition of Sustainability – Carbon cycle – role of construction material: concrete and steel, etc. – CO2 contribution from cement and other construction materials – Recycled and manufactured aggregate – Role of QC anddurability – Life cycle and sustainability.

UNIT III - ENERGY CALCULATIONS

Components of embodied energy - calculation of embodied energy for construction materials - Energy concept and primary energy - Embodied energy via-a-vis operational energy in conditioned building - Life Cycle energy use

UNIT IV GREEN BUILDINGS

Control of energy use in building - ECBC code, codes in neighboring tropical countries - OTTV concepts and calculations – Features of LEED and TERI – Griha ratings - Role of insulation and thermal properties of construction materials - influence of moisture content and modeling - Performance ratings of green buildings - Zero energy building

Unit V ENVIRONMENTAL EFFECTS

Non-renewable sources of energy and Environmental aspects – energy norm, coal, oil, natural gas - Nuclear energy - Global temperature, Green house effects, global warming - Acid rain: Causes, effects and control methods - Regional impacts of temperature change.

REFERENCES:

1. Charles J Kibert, Sustainable Construction : Green Building Design & Delivery, 4th Edition , Wiley Publishers 2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.
3. Craig A. Langston & Grace K.C. Ding, Sustainable Practices in the Built Environment, Butterworth Heinemann Publishers, 2011.
4. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt. Ltd, 2012.
5. New Building Materials and Construction World magazine

Year 2: Semester 4

Course 23 Sustainable Audit Management

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Sustainable Audit Management	**CC**	**3**	**0**	**0**	**3**

Course objectives:

- Define sustainable strategic audit and explain its importance
- Identify and assess sustainability risks and opportunities

Unit 1: Introduction to Sustainable Strategic Audit

Sustainable strategic audit, Importance of sustainable strategic audit, Benefits of sustainable strategic audit, Different types of sustainable strategic audit, Sustainable strategic audit framework, Case studies of sustainable strategic audit

Unit 2: Assessing Sustainability Risks and Opportunities

Identifying sustainability risks and opportunities, Assessing the impact of sustainability risks and opportunities, Developing mitigation and adaptation strategies,Case studies of sustainability risk and opportunity assessments

Unit 3: Evaluating Sustainability Performance

Developing sustainability performance indicators, Collecting and analyzing sustainability data Reporting on sustainability performance, Case studies of sustainability performance evaluation

Unit 4: Integrating Sustainability into Strategic Planning

Developing a sustainability strategy, Aligning the sustainability strategy with the overall business strategy, Implementing the sustainability strategy, Monitoring and evaluating the sustainability strategy, Case studies of sustainability integration into strategic planning

Unit 5: Sustainable Strategic Audit Reporting

Developing a sustainable strategic audit report, Communicating the findings of the sustainable strategic audit report to stakeholders, Using the sustainable strategic audit report to improve sustainability performance, Case studies of sustainable strategic audit reporting

Course outcomes:

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

- Conduct a sustainable strategic audit of an organization
- Identify and recommend strategies to mitigate sustainability risks and improve sustainability performance
- Develop a sustainability strategy that is aligned with the organization's overall business strategy
- Communicate the findings of a sustainable strategic audit to stakeholders

Text Book(s):

- Sustainable Audit Management: Concepts, Tools and Practices by Shelley W. W. Zhou and Thomas H. W. Lau (Springer, 2023, 2nd Edition)
- Sustainability Accounting and Reporting: A Comprehensive Guide by Robert G. Eccles, Robert H. Herz, and Stefan Schmidheiny (Wiley, 2023, 7th Edition)
- Accounting: The Basis for Business Decisions by Robert F. Meigs, James M. Reeve, James C. Vancil (McGraw-Hill Education, 15th edition)

Reference Books(s)

- Environmental Auditing: Theory and Practice by Gerald W. Johnson and Michael A. Percy (Routledge, 2022, 5th Edition)
- Sustainability Auditing for Managers: A Practical Guide by Adam Lindgreen and Michael Porter (Routledge, 2021, 3rd Edition)

Year 2: Semester 4

Course24 - Environmental Economics

Unit1: Economy and Environment

Environment economy relationship-Laws of Thermodynamics and Material Balance Model, Environmental Kuznets Curve (EKC): Concepts and Genesis. Explanations of inverted-U shaped EKC-empirical evidence- N shaped EKC

Unit 2: Environmental Pollution as Economic Problem

Environmental Pollution as a Negative Externality (Pigou), the issue of Property Rights (Coase), Optimal Pollution

Unit 3: Pollution Control:

Command and Control and Alternative Market Based Instruments- Command and Control measures; Pigouvian taxes and subsides, marketable pollution permits and mixed instruments (the charges and fees), Tradable pollution permits and international carbon tax, Coase' s bargaining solution and collective action; Hybrid Instruments- two-part tariff, double dividend hypothesis, illicit dumping.

Unit 4: Environmental Valuation

Basic issues of environmental valuation, Revealed Preference Approach- household production function, travel cost, Hedonic price; Stated Preference Approach-contingent valuation method.

Unit 5: Sustainable Development and Environmental Accounting

Concept of sustainable development- sustainable development rules and indicators measures of sustainable development, Sustainable accounting-economics of green accounting and sustainable resource management. Environment law: Carbon tax (vscap and trade), its purpose and how it works, Control and Command (environmental economics), The Environment Protection Act (1986), Forest Conservation Act (1980), Indian Forest Act (1947), National Action Plan on Climate Change: its 8 missions.

Reference Books

1. Pearce,D.W. and Turner,R.K. (1991) : Economics of Natural Resources and the Environment, Hemel Hempstead, Harvester-Wheatsheaf.

2. Baumol, W.J. and Oates W.E. (1988) : Theory of Environmental Policy, 2nd Edition, Cambridge University Press.

3. Bhattacharyya, R.N. (2001): Environmental Economics: Indian Perspective, Oxford University Press.

Year 2: Semester 4

Course25 - Total Quality Management

UNIT-I INTRODUCTION

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

UNIT-II TQM PRINCIPLES

Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen, 8D methodology - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT-III TQM TOOLS AND TECHNIQUES I

The seven traditional tools of quality - New management tools - Six sigma, Lean Six Sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages,Types.

UNIT-IV TQM TOOLS AND TECHNIQUES II

Quality Circles – Cost of Quality – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures,POKA-YOKE, JIT Concepts.

UNIT-V QUALITY MANAGEMENT SYSTEM

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000– ISO 9001 Requirements— Implementation—Documentation—Internal Audits—Registration ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series

Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.

Reference Books

1. Dale H.Besterfield, Carol Besterfield- Michna, Glen H. Besterfield, Mary Besterfield - Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe —Total Quality Management, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.

Year 2: Semester 4

Course26 - Computer Applications in Environmental Engineering

Population Forecast Programs: Arithmetic Increase Method, Geometric Increase Method And Incremental Increase Method.

Water Supply And Treatment Programs: Rising main design, pumping unit, Water treatment units design –– Cascade aerator, plain sedimentation tank, clariflocculator tank, filters (rapid and slow) and disinfection

Wastewater Collection And Treatment Units Programs: wastewater treatment units – Screen and Grit chamber, Primary settling tank, Aeration tank and Secondary settling tank of ASP, Trickling filter unit, Sludge drying beds and Septic tank.

Aquatic Systems Programs: Water quality models for discharge of conservative and nonconservative waste in rivers, DO models for rivers (Streeter- Phelps equation).

Air Quality Programs: Effective Stack height calculation, Gaussian Plume Model for gaseous and particulate dispersion from point sources. Design of particulate control devices – Settling chamber and cyclone separators.

(Writing Flow Sheets, 'C' programme along with Design Steps & Equations is compulsory). CAD: Introduction to CAD and its application to Environmental Engineering; Introduction to Computer Graphics – Applications.

Introduction to Application Software's - RMAIN, WATPLANT, DOWATTS, LOOP, QUALOOP, EPANET, SEWER, STREAM, ISCST/LT, CALINE, MIXING ZONE

MODELS, SWMM (storm water management model), MATLAB

Reference Books

1. Thomann, R. V., and Mueller, J.A., (1987), "Principles of Surface Water Quality Modeling and Control" –,Harper Int. Edition.
2. Krishna Murthy, C.S., and Rajeev, S., (1998), "Computer Aided Design software and Analytical Tools"– Norosa Publishing House.
3. Wark K. Warner, G.F., and Davis, W.T., (1998), "Air Pollution its Origin and Control" – Addison- Wesley.
4. Sincero, A.P., and Sincero, G.A., (1999), "Environmental Engineering – A Design Approach" - Prentice Hall of India.
5. Water Supply and Treatment – CPHEEO Manual (Latest version), New Delhi.
6. Wastewater Collection, Treatment & Disposal – CPHEEO Manual (Latest version), New Delhi

Year 2: Semester 4

Course27 - Environmental Engineering Lab

Course Objectives

The course will address the following:

- Estimation some important characteristics of water and wastewater in the laboratory
- It also gives the significance of the characteristics of the water and wastewater

List of Experiments

1. Determination of pH and Electrical Conductivity (Salinity) of Water and Soil.
2. Determination and estimation of Total Hardness–Calcium & Magnesium.
3. Determination of Alkalinity/Acidity
4. Determination of Chlorides in water and soil
5. Determination and Estimation of total solids, organic solids and inorganic solids andsettleable solids by Imhoff Cone.
6. Determination of Iron.
7. Determination of Dissolved Oxygen with D.O. Meter & Winkler's Method andB.O.D.
8. Determination of N, P, K values in solid waste
9. Physical parameters – Temperature, Color, Odour, Turbidity, Taste.
10. Determination of C.O.D.
11. Determination of Optimum coagulant dose.
12. Determination of Chlorine demand.
13. Presumptive Coliform test.

NOTE: At least 10 of the above experiments are to be conducted.

Reference Books

1. Standard Methods for Analysis of Water and Waste Water – APHA
2. Chemical Analysis of Water and Soil by KVSG Murali Krishna, Reem Publications, New Delhi

Year 2: Semester 4

Course28 - Regulatory Framework & Legal Aspects in Sustainability (Report Preparation)

- Factories Act, 1948
- Environment Protection Act, 1986,
- Air (Prevention and Control of Pollution) Act, 1981,
- Water (Prevention and Control of Pollution) Act, 1974,
- Hazardous Waste (Management, Handling and Transboundary Movement) Rules,2016,
- Companies Act, 2013
- Prevention of Money Laundering Act, 2002, Prevention of Corruption Act, 1988, and
- Laws with respect to the payment of minimum wage, bonus, gratuity, welfare activities,health and safety, etc

Year 2: Semester 4

Course29 - Energy Resources LabCourse

Objectives

- Provide knowledge about various renewable energy technologies
- Impart knowledge about various possible hybrid energy systems
- Gain knowledge about application of various renewable energy technologies
- Provide hands on experience in the alternate energy systems functioning

List of Experiments

I. Biogas Generation

1. Bio gas Generation
2. Study of various rural Biogas generation plant

II. Solar Energy

1. Solar Radiation Measurement
2. Solar Distillation
3. Solar Pumping
4. Solar Heater (Thermosiphon and Forced Circulation)
5. Solar Lanterns and Street light

III. Wind Energy

1. Study of Wind Mill
2. Experiment using Wind Energy Generator
3. Experiment on Performance assessment of micro Wind Energy Generator.
4. Simulation study on Hybrid (Solar-Wind) Power System.

IV. Small Hydel plants
1. Study on Hydel Power systems

V. MFCs and CFCs
1. Experimental study on MFCs and CFCs

VI. Tidal Energy
1. Experimental study on MFCs and CFCs

VII. Electro Chemical systems
1. Experimental study on Electro-chemical systems

Reference Books

- Joshua Earnest, Tore Wizeliu, 'Wind Power Plants and Project Development', PHILearning Pvt.Ltd, New Delhi, 2011.
- D.P.Kothari, K.C Singal, Rakesh Ranjan "Renewable Energy Sources and EmergingTechnologies", PHI Learning Pvt.Ltd, New Delhi, 2013.
- Scott Grinnell, "Renewable Energy & Sustainable Design", CENGAGE Learning,USA, 2016.
- P.M.V. Subba Rao Course material of "Energy systems and Technologies" Department of Mechanical Engineering Indian Institute of Technology New Delhi

SEMESTER V

Course No : 30	Course Title (Theory course)	Category	L	T	P	C
	Energy audit and management	**CC**	**3**	**0**	**0**	**3**

Objectives:
• To provide students with a comprehensive understanding of energy management and auditing principles and practices. • To develop Students' Skills In Conducting Energy Audits And Preparing Energy Management Reports.

UNIT-I	**Energy Scenario:**	**09**
Primary and Secondary Energy, Conventional and non-conventional energy, Energy Security, Energy Conservation and its importance, Energy conservation Act., Thermal Energy basics, Energy Audit its definition & methodology, Energy Audit Instruments, Benchmarking for energy performance, Energy Action Planning, Duties and responsibilities of Energy Manager; Energy financial management, Project Management, Energy monitoring and targeting, pinch technology, Fuels and Combustions, combustion calculations, 3T's of combustion, Burners, Turndown ratio, draft.		
UNIT-II	**Boilers:**	**09**
Introduction, different types and their classification, performance evaluation of boilers, Thermal efficiency and its determination by direct and indirect method, Blow-down, boiler water treatment, external water treatment, feed water preheating, combustion air preheating, excess air control, energy saving opportunities in boilers. Fluidized bed boilers: principles of fluidization, circulating fluidized bed, bubbling bed boilers, pressurized fluid bed combustion, advantages of fluidized bed combustion boilers.		
UNIT-III	**Industrial furnaces:**	**09**
Types & classifications of furnaces, shanky diagram, Performance and its evaluation of a typical furnace, Heat losses in a furnace, furnace efficiency, Determination using direct and indirect methods, fuel economy measures in furnaces, Heat distribution in a reheating furnace, furnace draught, optimum capacity utilization, waste heat recovery from flue gases		
UNIT-IV	**Fans and Blowers:**	**09**
Difference between fans, blowers and compressors, Fan types, a centrifugal fans, arial flow fans, fan laws, fan design and selection criteria's, flow control strategies, fan performance, assessment, energy saving opportunities in fans. Pumps & Pumping System: Types of pumps, pump curves, factors affecting pump performance, flow control strategies, Energy conservation opportunities in pumping system		
UNIT-V	**Refrigeration System:**	**09**
Introduction, types of refrigeration system, Performance assessment of a refrigeration system, COP, factor affecting performance, energy savings opportunities in refrigeration systems. Compressed Air System: Compressor Type, free air delivery, efficiency of compression, leak test, energy efficiency opportunities in compressed air systems, Cooling Towers, flow control strategies, Energy saving options in cooling towers.		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
• Explain the concepts of energy audit and management, and discuss their importance for businesses and organizations.
• Apply energy audit methodologies to assess the energy performance of a building orindustrial facility.
• Identify and evaluate energy conservation opportunities.
• Develop and implement energy management plans.
• Communicate the results of energy audits and management plans to stakeholders.

Text Book(s):
• Energy Audit and Management by Rajeev Sawhney -2nd edition, PHI Learning, 2022
• Handbook of Energy Audit and Management by Y.P. Abbi and Shashank Jain -3rd edition,The Energy and Resources Institute, 2019
• Energy Audit and Management: Concepts, Methodologies, Procedures, and Case Studies by Ganesan Kumar -1st edition, Routledge, 2023

Reference Books(s)
• Energy Audit and Management for Mumbai University B.E. Mechanical Engineering Sem 7 by Dr. Subhash Gadhave, Anup Goel, Siddu Patil, and Laxmikant D. Jathar -2nd edition,Technical Publications, 2020
• Energy Management, Audit and Conservation by Barun Kumar De -2nd edition, VrindaPublications P Ltd., 2014

Course No : 31	Course Title (Theory course)	Category	L	T	P	C
	Sustainable Design and Innovation	**CC**	**3**	**0**	**0**	**3**

Objectives:
The objective of the introduction, beyond providing a basic introduction to sustainable development concepts, is to recognize the challenges of sustainable development; the opportunities and limits of the private sector in meeting these challenges; and prepare students for the application of these concepts in functional business topics.

UNIT-I	**Introduction**	**09**
Built Environment and Climate Change: Status, Challenges and Opportunities- salient features of energy use and greenhouse gas emissions (GHGs) from building use and construction.		
UNIT-II	**Concept of Sustainable Design:**	**09**
The Concept of Sustainable Design: Philosophy and Principles- negative impacts to the natural environment- holistic approach, in respect to the triple bottom line (TBL)		
UNIT-III	**Sustainable Architecture**	**09**
Sustainable Architecture: Definitions, Conceptual framework, and Objectives- e role it plays in the context of climate change, energy scarcity, materials, and carbon- creation and responsible management of a healthy built environment based on resource efficient and ecological principles- non-renewable resource consumption, enhancing the natural environment, and eliminating or minimizing the use of toxins- f theories, principles and framework for implementing sustainability in building construction		
UNIT-IV	**Sustainable Development: Concepts and Stakeholders**	**09**
Basic concepts- landmark events that have contributed to today's notion of sustainability- factors affecting Sustainable Development - s transparency change institutions' behavior- public private partnerships that advance SD goals		
UNIT-V	**Sustainable Development and a Business Strategy Perspective**	**09**
Firms, governments and NGOs adopt sustainable strategies- tools used to implement their SD strategies- stakeholders evaluate a firm's commitment to sustainable strategies		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
1. Apply sustainable design principles and methodologies to the design and development of new products, services, and systems.
2. Evaluate the environmental and social impacts of design decisions.
3. Identify and apply sustainable materials and manufacturing processes.
4. Communicate sustainable design concepts and solutions to stakeholders.

Text Book(s):
"Sustainable Development: A Business Strategy Perspective." Forest L. Reinhardt, Harvard Business School, 2004.
"Managing a Broader Portfolio of Assets." World Development Report 2003, World Bank, Washington, D.C., 2003.
"The Policy Implications of Social Capital." The National Economic and Social Forum,Dublin, Ireland, May 2003

Reference Books(s)
Porter, Michael. 2002. Preface. In Tomorrow's Markets, Global Trends and their Implications for Business
MacLean, Dick. "Making the Move from Spin to Strategy." AHC Group.

Course No: 32	Course Title (Theory course)	Category	L	T	P	C
	Innovative Entrepreneurship	**CC**	**3**	**0**	**0**	**3**

Objectives:
To sensitize students on the prospects, opportunities, and challenges in entrepreneurship and the potential for value creation from prospective ideas.

UNIT-I	**Product Innovation and Design Thinking**	**09**
Entrepreneurial motivation -Entrepreneurial mind-set, Intrapreneurship- Design Thinking and Affordable Innovation- Product Innovation		
UNIT-II	**Digital Technology Entrepreneurship**	**09**
Industry 4.0 landscape and innovations using digital technologies like AI, IOT, AR/VR, Cloud, SAAS, User Applications. The basic technology framework and development platforms- Analytics- based opportunities		
UNIT-III	**Business strategies**	**09**
B Plan: An overview of Business Plan Development, Preparing Business Concept Document- Going to market Strategy: Understanding and delivering Value, Product-Market Matrix, Delivery Strategy with a Difference		
UNIT-IV	**Startup Economics**	**09**
Introduction: Economic consideration for starting a venture, Understanding Feasibility analysis- Market considerations for start-ups: Understanding market, targeting customer and positioning product		
UNIT-V	**Entrepreneurship concepts**	**09**
Factors influencing success of a business: Business model innovation, Business process management , competitive advantages, Business model canvas - Funding options of your business: Bootstrapping, angel investors, incubation and acceleration, concept of break-even point		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
Define and explain the concept of innovative entrepreneurship, and discuss its importance for the economy and society.
• Identify and evaluate opportunities for innovative entrepreneurship.
• Develop and implement innovative business plans.
• Secure funding and resources for innovative ventures.
• Build and lead high-performing teams in innovative ventures.

Text Book(s):
• Entrepreneurship- Theory, Process & Practice –by Kuratko & Hodgetts, Thompson South-Western Publication
• Technology Entrepreneurship Taking Innovation to the Marketplace – by Thomas N.Duening, Robert D. Hisrich and Michael A. Lechter, Elsevier
• Entrepreneurship Simplified – by Ashok Soota & S. R. Gopalan, Penguin
• Innovation and Entrepreneurship – by Peter Drucker, Harper Collins

Reference Books(s)
• The Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems Paperback – Illustrated, 29 June 2018; by MichaelLewrick , Patrick Link, Larry Leifer
• Bloomsbury Design Thinking Understanding How Designers Think and Work 2019 Edition by Prof. Nigel Cross

Course No: 33	Course Title (Theory course)	Category	L	T	P	C
	Life Cycle Assessment	**CC**	**3**	**0**	**0**	**3**

Objectives:
To understand the concept and methodology of Life Cycle Assessment as per international standards , its potential applications to develop sustainable products and promote sustainable consumption

UNIT-I	Goal and Scope Definition	09
Introduction to Life Cycle Thinking - - analytical tools for product and service systems – History anddefinition of LCA - International organizations and networks - The ISO 14040 framework - Life cycleof Products and services –Industrial ecology - Impacts & value creation along the life cycle –Life cycle management (LCM) and Stakeholder Expectations – LCM drivers and issues materials flow analysis –technical characteristics – applications - limitations and how to solve them- - Life cycle goal and scope definition - function, functional unit and reference flow		

UNIT-II	Inventory and Impact Analysis	09
System boundaries, data categories, inputs and outputs, data quality, critical review and other procedural aspects - Dealing with Allocation Issues - Solutions to the multifunctionality problem - Flow diagram - Format and data categories - Attributional versus consequential LCI - LCA softwares and database - Data quality - Data collection and relating data to unit processes -Data validation - Cut-off and data estimation - Characterization factors and principle of characterization - Selection of impact categories, category indicators and characterization models – Classification - Characterization - Optional elements - normalization , grouping, weighting ,data quality analysis - Characterization models.		
Impact assessment Case studies		
UNIT-III	**Interpretation of LCA Results**	**09**
Simplified/streamlined Life Cycle Assessments - procedural approaches, numerical approaches - Examples of numerical approaches - contribution analysis, perturbation analysis, uncertainty analysis, comparative analysis, key issue analysis - Treatment of uncertainties - Elements in uncertainty handling - Sensitivity of LCA results – Sustainability analysis - Extending LCA - economic dimension, social dimension - Life cycle costing - Eco-efficiency - Combining LCA and LCC – Case studies		
UNIT-IV	**Ecodesign of Products and Ecolabelling**	**09**
Sustainable consumption – Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility – ecodesign strategies – design for Environment – Design for Disassembly - Dematerialization, rematerialization, transmaterialization – Green procurement and green distribution - Analysis framework for reuse and recycling - Typical constraints on reuse and recycling - Communication of Life Cycle Information - - Indian ecomark scheme - Environmental product declarations – Environmental marketing		
UNIT-V	**LCA case studies**	**09**
LCA case studies from International Journal of Life Cycle Assessment, Journal Cleaner Production and Journal of Industrial Ecology etc. on Product Design, Product Improvement, Product Comparison and Policy development.		
		Total Contact Hours: 45

Course Outcomes:
After completing the course, the Learners will be able to : • Appreciate the elements of Life Cycle Assessment of Products and services complying to international environmental management system standards • Lead Life Cycle assessment team and implement design for environment over product cycle • Develop, Implement, maintain and Ecolabelling Schemes for Products

Text Book(s):
• Marry Ann Curan, Environmental Life Cycle Assessment, Mc Graw Hill New York 1996
• International Organization for Standardization: ISO 14040 series of Standards for LifeCycle Analysis , 1997
• Wimmer W, Zust R, Lee K . Ecodesign Implementation: A systematic guidance tointegratingenvironmental considerations into product development. Springer, 2004
• International Organization for Standardization: ISO TR 14062 Environmental • management -Integrating environmental aspects into product design and development, 2002.

Reference Books(s)
David F Ciambrone , Environmental Life Cycle Analysis, CRC Press LLC, 1997
UNEP/SETAC LifeCycle Initiative http://www.uneptie.org/sustain/lcinitiative , 2004.

Course No: 34	Course Title (Theory course)	Category	L	T	P	C
	International Energy Markets	**CC**	**3**	**0**	**0**	**3**

Objectives:
The course will develop the capability to read present energy market data and extrapolatetrends from it. This will be applied in the final project and practiced throughout the course

UNIT-I	**Introduction to Global Markets:**	**09**
Broad Economic Trend - Global markets and current trends - e international trends in energy markets, noting the pace of the rise of renewable energy- focus on the sources of data- Course logistics and grading		
UNIT-II	**Policy of Energy Consumption:**	**09**
International and National Frameworks- National policy- market regulations such as tariffs, tradable emission caps- renewables and non-renewables- y issues of policy and regulation		
UNIT-III	**China: Growing Energy Demands**	**09**
Environmental impacts- internal and external- supply-side of the global energy market - international accords and climate agreements - ethical issues associated with pushing developing countries		
UNIT-IV	**Germany and Western Europe: Renewable Energy and Regulation**	**09**
Germany's massive renewable energy transition from a regulatory and economic standpoint- scale to implement such a rapid transition- employment and the conventional energy market- German case Study		
UNIT-V	**Next in international energy markets**	**09**
Global forward outlook- Review of countries that might most greatly impact world energy markets- Case studies		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
• Understand the structure and dynamics of global energy markets.
• Analyze the global energy supply and demand outlook.
• Assess the impact of international energy policies on global energy markets.
• Evaluate the role of renewable energy in the global energy transition.

Text Book(s):
• International Energy Markets, Paul Stevens, Routledge publication, 9th Edition (2023)
• The Global Energy Market: A Primer, Daniel Yergin, Oxford University Press publication,8th Edition (2022)
• International Energy Economics and Policy, Paul R. Joskow, MIT Press publication, 3rdEdition (2018)

Reference Books(s)
World Energy Markets: A Reference Handbook, David Elliott, publication: Routledge, 9th Edition (2023)
International Energy Law and Policy, Fereidun Fesharaki, publication-Cambridge University Press, 3rd Edition (2019)

Course No: 35	Course Title (Theory course)	Category	L	T	P	C
	Sustainable Project Management	**CC**	**3**	**0**	**0**	**3**

Objectives:
To outline the need for Project Management To highlight different techniques of activity planning Project Planning & Management

UNIT-I	Introduction to Project Management and Project Selection	09
Objectives of Project Management- Importance of Project Management- Types of Projects Project Management Life Cycle- Project Selection – Feasibility study: Types of feasibility Steps in feasibility study.		
UNIT-II	**Project Planning and Implementation**	**09**
Project Scope- Estimation of Project cost – Cost of Capital – Project Representation and Preliminary Manipulations - Basic Scheduling Concepts - Resource Levelling – Resource Allocation.		
UNIT-III	**Project Monitoring and Control**	**09**
Setting a base line- Project management Information System – Indices to monitor progress. Importance of Contracts in projects- Teamwork in Project Management - Attributes of a good project team – Formation of effective teams – stages of team formation.		
UNIT-IV	**Project Closure**	**09**
Project evaluation- Project Auditing – Phases of project Audit- Project closure reports Guidelines for closeout reports.		
UNIT-V	**Special Topics in Project Management**	**09**
Computers, e-markets and their role in Project management- Risk management- Environmental Impact Assessment. Case studies in Project management.		
Total Contact Hours: 45		

Course Outcomes: After completing the course, the Learners will be able to :
Evaluate and select the most desirable projects.
Apply appropriate approaches to plan a new project and develop projectschedule.
Identify the important risks facing in a new project.

Text Book(s):
Berkun, Scott (2005), The Art of Project Management, O'Reilly Media: Cambridge, MA.
Campbell, Clark A. (2006), The One-Page Project Manager: Communicate and ManageAny Project With a Single Sheet of Paper, Wiley: New York.
Crowe, Andy (2006), Alpha Project Managers: What the Top 2% Know that Everyone Else Does Not, Velociteach: Kennesaw, GA.

Reference Books(s)
Berkun, Scott (2008), Making Things Happen: Mastering Project Management, O'Reilly Media: Cambridge, MA.
Cook, Curtis R. (2004), Just Enough Project Management, McGraw-Hill: Boston, MA

Course No:36	**Course Title (Practical course)**	**Category**	**L**	**T**	**P**	**C**
	Supply chain sustainability Lab	**CC**	**2**	**0**	**0**	**2**

Objectives:
This course is mostly qualitative and uses real-world examples to discuss issues and illustrate approaches. Active participation in class is important throughout the course. This means that you should read the assigned material before the session, think about the discussion questions, and if possible, find additional relevant material to share with the class. To ensure that everyone has a chance to participate, I may at times call on students randomly.

UNIT-I	**Research Projects**	**06**
The research findings will be of interest to policymakers, stakeholders, and industry leaders in India and beyond, who are looking to implement measures to reduce emissions and promote sustainable practices in international shipping.		
UNIT-II	**Case Study Project**	**06**
The lab research on case studies will contribute towards advancing sustainable supply chain management practices in India and beyond.		
UNIT-III	**White Papers**	**06**
The lab's white paper will provide valuable insights and guidance to policymakers, industry leaders, and stakeholders in their efforts to decarbonize the transportation sector and reduce the impact of climate change.		
UNIT-IV	**Supplier Sustainability Program**	**06**
The lab has also been providing guidance and recommendations on adopting greener technologies and processes, as well as measuring and monitoring the suppliers' sustainability performance.		
UNIT-V	**Consultancy Project**	**06**
The lab's goal is to help the company develop a sustainable supply chain and reduce its environmental impact.		
		Total Contact Hours: 30

Course Outcomes: After completing the course, the Learners will be able to :
To be first and India's premier centre of excellence in Sustainable Supply Chain practice, dissemination, and advocacy.
Creating sustainable solutions for organizations and supply chains that lead to large-scale adoption and subsequent benefits.
Advancing and disseminating sustainable supply chain management knowledge.
To conduct research to identify and replicate good practices for sustainable supply chains.
Cooperate and coordinate with other organizations with similar aims and objectives within and outside the country.

Text Book(s):
Simchi-Levi, David, Philips Kaminsky, and Edith Simchi-Levi. Designing and Managing the Supply Chain. 3rd ed. McGraw Hill, 2008.
Hopp, Wallace, and Mark Spearman. Factory Physics. 2nd ed. McGraw-Hill / Irwin, 2000. ISBN: 9780256247954.
Shapiro, Jeremy F. Modeling the Supply Chain. South-Western College, 2006. ISBN: 9780495126096. [Preview with Google Books]
Silver, Edward A., David F. Pyke, and Rein Peterson. Inventory Management and Production Planning and Scheduling. 3rd ed. Wiley, 1998. ISBN: 9780471119470.

Reference Books(s)
Nahmias, Steven. Production and Operations Analysis. 4th ed. Burr Ridge, 2000. ISBN: 9780072312652.
Chopra, Sunil, and Peter Meindl. Supply Chain Management. 3rd ed. Prentice Hall, 2006. ISBN: 9780131730427.

Course No:37	Course Title (Practical course)	Category	L	T	P	C
	Research Project – Climate Change	**CC**	**0**	**0**	**2**	**2**

Objectives:
To develop students' critical thinking skills, including the ability to analyze and evaluate different perspectives on climate change and develop their own informed opinions. To provide students with an opportunity to contribute to the public understanding of climate change by sharing their research findings with others.

Guidelines:
The students are instructed to choose a topic that you are interested in and that is relevant to the course. The topic should be narrow enough to be covered in a research paper, but broad enough to allow for original research and analysis. Once you have selected a topic, you will need to conduct research to gather information. This may involve reading books, articles, and other scholarly sources, as well as conducting interviews with experts. The project statement is the main argument of your research paper. It should be a clear and concise statement that summarizes your findings and conclusions.

Course Outcomes: After completing the course, the Learners will be able to :
Understand the structure of a research seminar in order to summarize the speaker's conclusions, and be able to ask insightful questions
Appreciate and describe the multidisciplinary aspects of climate change
Draw connections between various lines of climate change research.
Recognize the challenges in interpreting science for mitigation strategy implementation.
Identify ways in which the scientific process does or does not inform climate policy

SEMESTER VI

Course No:38	Course Title (Theory course)	Category	L	T	P	C
	Business Ethics and Corporate Social Responsibility	**CC**	**3**	**0**	**0**	**3**

Objectives:
To familiarize the learners with the concept and relevance of Business Ethics in the modern era To enable learners to understand the scope and complexity of Corporate Social responsibility in the global and Indian context

UNIT-I	Introduction to Business Ethics	09
Business ethics: Meaning of ethics, why ethical problems occur in business. Theories ofethics: Utilitarianism: weighing social cost and benefits, Rights and duties, Justice andfairness, ethics of care, Integrating utility, rights, justice and caring, An alternative to moralprinciples: virtue ethics, teleological theories, egoism theory, relativism theory, Moral issuesin business: Worker's and employee's rights and responsibilities. Scope of Business Ethics,Ethics in Compliance, Ethics in Finance, Ethics in Human Resources, Ethics in Marketing,Ethics in Production, Advantages of Business Ethics.		

UNIT-II	Code of Ethics	09
Ethical Principles In Business: introduction, Organization Structure And Ethics, Role ofBoard of Directors, Ethics Programme, Best Practices in Ethics Programme Features of GoodEthics Programme Code of Ethics, Code of Conduct, Model Code of Business Conduct &Ethics Credo, Ethics Training and Communication, Ethics Committee, Functions of EthicsCommittee, Integrity Pact, Whistle Blower Policy and Whistle Mechanism Social and EthicalAccounting, Principles of social and ethical accounting Ethics Audit, Ethical Dilemma.		
UNIT-III	**CSR**	**09**
Meaning and definitions of CSR, CSR is not philanthropy, CSR is a contract with society,why CSR is required, Factors influencing CSR, Triple bottom line approach of CSR, CSR inIndia, Corporate Social Responsibility Voluntary Guidelines, 2009, NationalVoluntaryGuidelines on Social, Environmental and Economic, Responsibilities of Business, CSR underthe Companies Act, 2013, Corporate Citizenship – Beyond the Mandate of Law, GlobalPrinciples and Guidelines, CSR Audit, Profit maximization vs. social responsibility.		
UNIT-IV	**Sustainable Development**	**09**
Sustainable Development, Role of Business in Sustainable Development, SustainabilityTerminologies, Corporate Sustainability, Corporate Sustainability and Corporate SocialResponsibility, Sustainability is Imperative, Government Role in improving SustainabilityReporting KYOSEI, Triple Bottom Line (TBL), Sustainability Reporting, Benefits of Sustainability Reporting, Global Reporting Initiative (GRI) – Sustainability Reporting		
UNIT-V	**Measuring framework**	**09**
Framework Global Reporting Initiative (GRI) - Sustainability Reporting Guidelines UNGlobal Compact – Ten Principles, 2000, Sustainability Indices, Sustainability ReportingFramework in India, Challenges in Mainstreaming Sustainability Reporting, ContemporaryDevelopments- Integrated Reporting, Integrated Reporting by Listed Entities in India,Relation between Integrated Reporting and Sustainability Reporting		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
Understand the importance of ethics and CSR in the day-to-day working of organizations
Learn the issues involved in maintaining ethics and how to deal with such situations
Learn scope of business ethics in Compliance, finance, Human resources, marketing, and production.

Text Book(s):
1. Velasquez Manuel G: Business ethics- concepts and cases. (Chapter 1, 2, 6, 7)
2. Fernando A.C.: Business Ethics – An Indian Perspective. (Chapter 1, 2, 3, 4, 14, 15)
3. Ghosh B N: Business Ethics & Corporate Governance, Mc Graw Hill (Chapter 10, 12, 13, 15)
4. DeGeorge Richard T.: Business Ethics, Pearson. (Chapter 14)

Reference Books(s)
• Crane Andrew & Matten Dirk: Business Ethics, Oxford. (Chapter 1, 2, 7)
• Luthans Fred, Richard, M. Hodgetts and Kenneth, R. Thompson, Social issues in business, Macmillan, USA

Course No:39	Course Title (Theory course)	Category	L	T	P	C
	Sustainable Transportation and Infrastructure	**CC**	**3**	**0**	**0**	**3**

Objectives:
To provide understanding of sustainable transport and relevant policies and programs To introduce to the concepts and aspects of transport planning and differentiate betweenshort-term and long-term strategies and impacts

UNIT-I	**Introducing the concepts of Transportation, accessibility and mobility planning**	**09**
Conceptualizing key terminologies - transport, transport systems, travel behaviour,infrastructure and users/commuters - Sustainable transport concepts – society, environment and economy, indicators - based approach - Policy initiatives and programs on sustainable transport - global perspectives (SUMP, KYOTO Protocol), national policies (NUTP, CMP and NAPCC) and local InitiativesTransport system effectiveness and efficiency – service level benchmarks		
UNIT-II	**Transport economics, externalities and pricing**	**09**
Demand – supply elasticity, factors that influence demand andExternalities of transport, quantification and value association **1.** Energy consumption, emissions and air quality (Lifecycle assessment) **2.** Safety and security **3.** Land consumption and waste production **4.** Equity and inclusiveness **5.** Mobility and accessibility Transport pricing and user costs - internalizing externalities		
UNIT-III	**Behaviour analysis and travel demand models**	**09**
GIS-T - Four-step travel demand model - Data collection and travel surveys - User and their choices – variables that influence travel behavior		
UNIT-IV	**Strategies and regulations for sustainable transport**	**09**
Integrated land use and transport planning and neighbourhood designs - Planning and designing for pedestrians and bicycles - Planning and design of a public transport systems - Integrated multi-modal transport networks - Regulations and Enforcements (Parking policy, Congestion pricing.		
UNIT-V	**Transport infrastructures**	**09**
Decision support systems for EIA of transport infrastructures - Abatement measures - Sustainable transportation systems - Case studies of highway, railway and airport projects.		
Total Contact Hours: 45		

Course Outcomes: After completing the course, the Learners will be able to :
Understand the impact of alternate transport infrastructure improvement strategies on society and environment
Identify key variables that influence travel choices and behaviour
Assess infrastructure quality and define strategies to achieve sustainable transport/mobility

Text Book(s):
Hensher, David A, Kenneth Button, Handbook of Transport Modelling, Pergamon Press, 2000.
Button, K., 2010. Transport economics. Edward Elgar Publishing. (chapter 5, 6, 7 and 11)
Ortuzar, J.D. and Willhumsen, L.G. Modelling Transport, 4th edition John Wiley, 2011.
TERI (2013); Pro-poor mobility - Policy guidelines and case studies Available at:
http://www.teriin.org/div/pro-poormobility_policy-guidelines-case-studies.pdf

Reference Books(s)
• Fundamentals of Transportation System Analysis, Volume -1: Basic Concepts by Manheim Marvin
• National Urban Transport Policy (2012)
• Ahmad, S. & Puppim de Oliveira, J.A. 2016. Determinants of urban mobility in India:
• Lessons for promoting sustainable and inclusive urban transportation in developing countries. Transport Policy, 50, 106-114
• Appleton, B., Davies, M., Tansey, J., Atwal, P., Dore, G. P., & Muzyka, D. 2008,
• GreenApple Canada 2008: SMART Transportation Ranking Report, Appleton Charitable Foundation.

Course No:40	Course Title (Theory course)	Category	L	T	P	C
	Renewable Energy Technologies	**CC**	**3**	**0**	**0**	**3**

Objectives:
To introduce to the concepts and aspects of Renewable Energy Technologies

UNIT-I	**ENERGY SCENARIO**	**09**
Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans		
UNIT-II	**SOLAR ENERGY**	**09**
Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.		
UNIT-III	**WIND ENERGY**	**09**
Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.		
UNIT-IV	**BIO-ENERGY**	**09**
Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters – Biodiesel production – Ethanol production - Applications.		
UNIT-V	**OCEAN AND GEOTHERMAL ENERGY**	**09**
Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
• Discuss the Indian and global energy scenario.
• Describe the various solar energy technologies and its applications.
• Explain the various wind energy technologies.
• Explore the various bio-energy technologies.
• Discuss the ocean and geothermal technologies.

Text Book(s):
Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu,
Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

Reference Books(s)
1. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.
2. Rai.G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.
3. Sukhatme.S.P., "Solar Energy: Principles of Thermal Collection and Storage", TataMcGraw Hill Publishing Company Ltd., New Delhi, 2009.
4. Tiwari G.N., "Solar Energy – Fundamentals Design, Modelling and applications", Alpha Science Intl Ltd, 2015.
5. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFNSpon Ltd., UK, 2015.

Course No:41	**Course Title (Theory course)**	**Category**	**L**	**T**	**P**	**C**
	Marketing Management	**CC**	**3**	**0**	**0**	**3**

Objectives:
To enable students to deal with newer concepts of marketing concepts like strategic marketing segmentation, pricing, advertisement and strategic formulation. The course will enable a student to take up marketing as a professional career.

UNIT-I	**Marketing Process:**	**09**
Definition, Marketing process, dynamics, needs, wants and demands, value and satisfaction, marketing concepts, environment, mix. Philosophies, selling versus marketing, organizations, industrial versus consumer marketing, consumer goods, industrial goods, product hierarchy.		
UNIT-II	**Buying Behaviour and Market Segmentation:**	**09**
Major factors influencing buying behaviour, buying decision process, business buying behaviour. Segmenting consumer and business markets, market targeting.		
UNIT-III	**Product Pricing and Marketing Research:**	**09**
Objectives, pricing, decisions and pricing methods, pricing management. Introduction, uses, process of marketing research.		
UNIT-IV	**Marketing Planning and Strategy Formulation:**	**09**
Components of marketing plan-strategy formulations and the marketing process, implementations, portfolio analysis, BCG, GEC grids.		

UNIT-V	Advertising Sales Promotion and Distribution:	09
Characteristics, impact, goals, types, and sales promotions – point of purchase – unique selling proposition. Characteristics, wholesaling, retailing, channel design, logistics, and modern trends in retailing.		
Total Contact Hours: 45		

Course Outcomes: After completing the course, the Learners will be able to :
The learning skills of Marketing will enhance the knowledge about Marketer‟s Practices and create insights on Advertising, Branding, Retailing and Marketing Research.

Text Book(s):
Kolter P. – 'Marketing Management' – Pearson Education – 2014
Ramasamy and Namakumari, – 'Marketing Environment: Planning, Implementation and Control to the Indian Context' – 1990

Reference Books(s)
• Paul G. E. and Tull D. – 'Research for Marketing Decisions' – Prentice Hall of India – 1975
• Tull D. S. and Hawkins – 'Marketing Research' – Prentice Hall of India – 1997
• Kotler P. and Armstrong G. – 'Principles of Marketing' – Prentice Hall of India – 2000
• Skinner S. J. – 'Marketing' – All India Publishers and Distributes Ltd. – 1998
• Govindarajan, M. – 'Industrial Marketing Management' – Vikas Publishing Pvt. Ltd. – 2003
• Paul G. E. and Tull D. – 'Research for Marketing Decisions' – Prentice Hall of India – 1975

Course No:42	Course Title (Theory course)	Category	L	T	P	C
	Engineering Economics and Sustainability	**CC**	**3**	**0**	**0**	**3**

Objectives:
This subject is aimed to • To understand and apply engineering economic principles to decision-making in a sustainable context. • To develop the skills and knowledge necessary to design and implement sustainable engineering solutions.

UNIT-I	**Introduction**	**09**
Engineering and economics, Problem solving and decision making, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity.		
UNIT-II	**Basic Concepts**	**09**
Law of Returns, Interest and interest factors, simple and compound interest, Cash flowdiagrams, personal loans and EMI payment calculation with flexible interest rates, Discussionand problems		
UNIT-III	**Returns**	**09**
Present, future and annual worth and rate of returns: Basic present worth comparisons,Present worth-equivalence, Assets with unequal lives and infinites lives, future worthcomparisons, payback comparisons, Equivalent annual worth comparisons, situations for annual worth comparisons.		
UNIT-IV	**Costing**	**09**
Costing and depreciation: Components of costs, estimation of selling price, marginal cost, firstcost, all kinds of overheads, indirect cost estimation with depreciation, mensuration andestimation of material cost, cost estimation of mechanical process, idling time.		
UNIT-V	**Depreciation**	**09**
Product costing (approaches to product costing), causes of depreciation, methods of computingdepreciation charges, straight line method, declining balance method, sum of years method,sinking fund method, service output methods, taxation concepts, personal income taxes andcorporate taxes, Discussions and problems.		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
• Discuss Decision making, Organizing, Staffing, Directing and Controlling
• Select the best economic model from various available alternatives
• Understand various interest rate methods and implement the suitable one.
• Estimate various depreciation values of commodities
• Prepare the project reports effectively

Text Book(s):
Mechanical estimation and costing, T.R. Banga & S.C. Sharma, 17th edition 2015
Engineering Economy, Riggs J.L. McGraw Hill, 2002
Engineering Economy, Thuesen H.G. PHI , 2002

Reference Books(s)
• Basics of Engineering Economy, Leland Blank & Anthony Tarquin, McGraw Hill Publication (India) Private Limited
• Engineering Economics, R.Paneerselvam, PHI publication
• Fundamentals of Management: Essential Concepts and Applications, Pearson Education, Robbins S.P. and Decenzo David A.
• Economics: Principles of Economics, N Gregory Mankiw, Cengage Learning

• Modern Economic Theory, By Dr. K. K. Dewett & M. H. Navalur, S. ChandPublications
• Basics of Engineering Economy, Leland Blank & Anthony Tarquin, McGraw Hill Publication (India) Private Limited

Course no:43	Course Title (Theory course)	Category	L	T	P	C
	Advanced Eco design	**CC**	**3**	**0**	**0**	**3**

Objectives:
This subject is aimed to 1.Provide students with the recent global trends and significance eco-design and manufacture in industry;
2.Ensure that students are aware of the regulatory requirements of European Union (EU), China, USA, Japan, and other regions on eco-design and manufacture;

UNIT-I	**Introduction to Eco-design and Manufacture**	**09**
Sustainable product development, global environmental concerns, impact on merchandise trade, eco-product market trends, business benefits and opportunities; driving forces of eco-design and manufacture, role of designers and engineers.		
UNIT-II	**Environmental Considerations in Product eco-design**	**09**
Stages of product development process in eco-design; Materials, manufacturing and packaging, use, end-of-life and disposal issues; design for disassembly and recycling; Recycling Potential Indicator (RPI); the six RE-philosophy.		
UNIT- III	**Global and regional regulatory requirements on Eco-design andManufacture**	**09**
Eco-product Laws in Japan; Eco- product Legislations in the US; EU Directives: Waste of Electrical and Electronic Equipment (WEEE) and Restriction of Hazardous Substances(RoHS) and EcoDesign framework for Energy Using Product (EuP) and Energy-related Product (ErP); China Environmental Laws.		
UNIT-IV	**Environmental Assessment of Products and related tools and techniques**	**09**
Life Cycle Assessment (LCA) and streamlined methods, e.g. MET, Philip's Fast-Five;Software tools in LCA, e.g. SimaPro and Gabi; Integrated Product Policy (IPP); "Green Mark", "Eco-labels" and eco- labeling schemes and programmes.		
UNIT-V	**Environmental Management Systems**	**09**
International Standards (ISO14000), management of waste materials and chemical substances; Registration of Chemicals in European Union; Green supply chain management.		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
• Address issues relating to recent global trends and significance of eco-design andmanufacture in industry;
• Aware of the regulatory requirements of European Union (EU) on eco-design and • manufacture;
• Take a holistic approach to eco-design and manufacture, addressing and relating elementslike: environmental impacts; product eco-design, use and life; technology capabilities; andbusiness benefits;

Text Book(s):
• Davis M.L. and Masten S.J., *Principles of Environmental Engineering and Science*, McGraw-Hill
• Ulrich K.T. and Eppinger S.D., *Product Design and Development*, McGraw-Hill, latest edn
• J. Rodrigo, *Electrical and Electronic: Practical Design Guide*, F. Castells University Rovira I Virgili, Tarragona, Spain, latest edn.
• H. Lewis and J. Gertsakis, *Design + Environment: A Global Guide to Design Greener Goods*, Greenleaf Publishing Ltd., latest edn
• European Union Directives on WEEE, RoHS and EuP, latest edn

Course No:44	Course Title (Practical course)	Category	L	T	P	C
	Research Project – Social themes	**CC**	**0**	**0**	**2**	**2**

Objectives:
To develop problem and address the problem through models, prototype etc. for the problem

	Guidelines	
Students under the guidance of Faculty in-charge(s) of the given project work, carry out the background work, identify a tentative Title for the Project work, Review20-25 Research papers, prepare a Review Paper, surveying and preparing report		

Course Outcomes: After completing the course, the Learners will be able to :
● To acquire required knowledge and demonstrate skills learned in the semester

Course No:45	Course Title (Practical course)	Category	L	T	P	C
	Sustainable Business Lab (S-Lab)	**CC**	**2**	**0**	**0**	**2**

Objectives:
The course aims to provide participants with access and in-depth exposure to firms that are actively grappling with the sustainability-related issues through cases, readings and guest speakers.

UNIT-I	**Framework**	**06**
Redefining traditional business models - Walking the talk: sustainability and new product development - Sustainable retail.		
UNIT-II	**Restructure the supply chain**	**06**
Ensuring sustainability along the supply chain - Ensuring the sustainability of shared resources - Social sustainability and labor standards		
UNIT-III	**Feasibility study**	**06**
What is legal? What is politically feasible? - Pause for reflection		
UNIT-IV	**Build a new industry (or rebuild an old one)**	**06**
Alternative transportation networks - Case example of alternative transportation opportunities (- Energy efficiency as a new market		
UNIT-V	**Infrastructure**	**06**
Green buildings: new markets and services - Sustainable infrastructure and international markets - Growth with vision		
		Total Contact Hours: 30

Course Outcomes: After completing the course, the Learners will be able to :
In-depth knowledge of the various sustainability issues we face today;
Learn a set of analytical tools and frameworks that will help you understand/analyze as wellas impact these issues; and
Experience working with a firm or organization currently developing new business models(or reforming existing ones) in line with sustainable development.

Text Book(s):
Little, Richard G. "Tending the Infrastructure Commons: Ensuring the Sustainability of Our Vital Public Systems." Paper presented at the International Workshop on Integrated Life-cycle Management of Infrastructures, Hong Kong, December 9-11, 2004.
Bell, Ann Maria. "Taking Externalities Seriously: An Economic Perspective on the Precautionary Principle." Redefining Progress, 2002. (PDF)

Reference Books(s)
Commission on Sustainable Development. "Sanitation: Policy Options and Possible Actions to Expedite Implementation." United Nations report, December 2004. This report can be accessed from here, file E/CN.17/2005/3.
Kareiva, Peter, Sean Watts, Robert McDonald, and Tim Boucher. "Domesticated Nature: Shaping Landscapes and Ecosystems for Human Welfare." Science 316, no. 5833 (2007): 1866-1869.
Gleick, Peter. "Global Freshwater Resources: Soft-Path Solutions for the 21st Century." Science 302, no. 5650 (2003): 1524-1528.
Margonelli, Lisa. "Waste Not." Atlantic, May 2008.
Murcott, Susan. "Implementation, Critical Factors and Challenges to Scale-Up of Household Drinking Water Treatment and Safe Storage Systems." Draft Article, May 2006. (PDF)
Brown, Paige, editor. "Sustainable Agriculture and Common Assets: Stewardship Success Stories." Redefining Progress, 2002. (PDF)

SEMESTER VII

Course no:46	Course Title (Theory course)	Category	L	T	P	C
	Financial Management	**CC**	**3**	**0**	**0**	**3**

Objectives:
1. To understand the functional distinctions of a Finance Manager. **2.** To understand the techniques involved in deciding upon purchase or sale of securities.

UNIT-I	INTRODUCTION :	09
Introduction to Financial Management- Goals of the firm- in financial Environments. Time Value of Money : Simple and Compound Interest Rates, Amortization, Computing more than once a year, Annuity Factor.		

UNIT-II	**VALUATIONOFSECURITIES**	**09**
Bond Valuation, Preferred Stock Valuation, Common Stock Valuation, Concept of Yield and YTM. Risk & Return:Defining Risk and Return, Using Probability Distributions to MeasureRisk, Attitudes Toward Risk, Risk and Return in a Portfolio Context, Diversification, The Capital Asset Pricing Model (CAPM).		
UNIT-III	**CAPITALBUDGETING**	**09**
The Capital Budgeting Concept & Process - An Overview, Generating Investment Project Proposals, Estimating Project, After-Tax Incremental Operating Cash Flows, Capital Budgeting Techniques, Project Evaluation and Selection –Alternative Methods.		
UNIT-IV	**COSTOFCAPITAL,OPERATING&FINANCIAL LEVERAGE**	**09**
Cost of Capital : Concept , Computation of Specific Cost of Capital for Equity - Preference –Debt, Weighted Average Cost of Capital–Factors affecting Cost of Capital 4L. Operating & Financial Leverage: Operating Leverage, Financial Leverage, Total Leverage and Indifference Analysis in leverage study.		
UNIT-V	**WORKINGCAPITALMANAGEMENT**	**09**
Working Capital Management: Overview, Working Capital Issues, Financing Current Assets (Short Term and LongTerm- Mix), Combining Liability Structures and Current Asset Decisions, Estimation of Working Capital. Accounts Receivable Management: Credit & Collection Policies, Analyzing the Credit Applicant, Credit References, Selecting optimum Credit period.4L. Cash Management: Motives for Holding cash, Speeding Up Cash Receipts, Slowing Down Cash Payouts, Electronic Commerce, Outsourcing, Cash Balances to maintain, Factoring.		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
• Identifythebasicconceptsoffinancialmanagementandtimevalueofmoney.
• Understandthevariousprocessesinvolvedinsecuritiesmarket.
• Evaluateandchoosethebestproject fromalternativesbasedoncost-benefit analysis.
• Computethefundamentalconcepts offinancialmanagement.
• Influencetheconceptfor decidingfinancialangleof ITprojects.

Text Book(s):
1. ChandraPrasanna,"Financial Management-Theory& Practice",TataMcGrawHill,10th Edition,2019.
2. M.Y.KhanandandP.K.Jain,"Financial management,Text,ProblemsandCases",TataMcGrawHill,5th Edition,2000.
3. I.M.Pandey, "Financial Management",VikasPublishingHousePvt.Ltd.,8th Edition,2007.
4. AswatDamodaran, "CorporateFinanceTheoryandPractice",JohnWiley&Sons,2nd Edition,2008.
5. JamesC.Vanhorne,"FundamentalsofFinancialManagement",PHILearning,11th Edition ,2008.

Reference Books(s)
1. VanHorneandWachowicz,"FundamentalsofFinancialManagement",PrenticeHall,13th Edition,2009.
2. BrighamandEhrhardt,"FinancialManagementTheoryandPractice", 11thedition, CengageLearning,2011.

Course no:47	Course Title (Theory course)	Category	L	T	P	C
	Integrated Product service engineering	**CC**	**3**	**0**	**0**	**3**

Objectives:
To provide students with a comprehensive understanding of IPSE, including its principles, benefits, challenges, and applications.

UNIT-I	**Introduction to Integrated Product Service Engineering**	**09**
What is IPSE? - The principles of IPSE - The benefits of IPSE - The challenges of IPSE -Case studies of IPSE in practice		
UNIT-II	**Product-Service Systems**	**09**
What are product-service systems (PSS)? - The different types of PSS - The benefits of PSS - The challenges of PSS - Case studies of successful PSS –		
UNIT-III	**IPSE Design**	**09**
IPSE design principles and tools - How to design PSS - How to integrate products and services - Case studies of IPSE design in practice		
UNIT-IV	**IPSE Implementation**	**09**
How to implement IPSE in organizations - Challenges of implementing IPSE - Case studiesof IPSE implementation		
UNIT-V	**The Future of IPSE**	**09**
Trends and developments in IPSE - The challenges and opportunities of IPSE in the future - Case studies of visionary IPSE businesses and initiatives		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
Define and explain the principles of IPSE.
Identify and discuss the benefits and challenges of IPSE.
Apply IPSE principles and tools to real-world product and service design challenges.
Develop and implement IPSE solutions in organizations of all sizes.
Evaluate the effectiveness of IPSE solutions.
Discuss the future of IPSE and the role of businesses in supporting the transition to a more integrated product-service economy.

Text Book(s):
1. Karl T.Ulrich, Steven D.Eppinger, Anita Goyal, "Product Design and Development", McGraw –Hill Education (India) Pvt. Ltd, 4th Edition, 2012.
2. Kenneth Crow, "Concurrent Engineering/Integrated Product Development". DRM Associates, 6/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book
3. Kevin N Otto, Kristin L Wood, "Product Design – Techniques in Reverse Engineering and New Product Development", Pearson Education, Inc, 2016
4. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin Homewood, 1992 5. Stuart Pugh, "Total Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, Neyourk, NY, 1991.

Course no:48	Course Title (Theory course)	Category	L	T	P	C
	Management Systems and Sustainability	**CC**	**3**	**0**	**0**	**3**
Objectives:						
To provide students with a comprehensive understanding of management systems and their role in sustainability.						

UNIT-I	**Introduction to Management Systems and Sustainability**	**09**
The different types of management systems - The benefits of implementing a management system - The relationship between management systems and sustainability - Case studies of organizations that have successfully implemented management systems for sustainability		
UNIT-II	**ISO 14001 Environmental Management Systems**	**09**
The requirements of ISO 14001 - The benefits of implementing an ISO 14001 system - How to implement an ISO 14001 system - Case studies of organizations that have successfully implemented ISO 14001		
UNIT-III	**Other Management Systems for Sustainability**	**09**
Other popular management systems for sustainability, such as the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) - The benefits of implementing these management systems - How to implement these management systems - Case studies of organizations that have successfully implemented these management systems		
UNIT-IV	**Management Systems and Sustainable Development**	**09**
The role of management systems in supporting sustainable development - How to integrate management systems for sustainability into an organization's overall strategy - Case studies of organizations that are successfully integrating management systems for sustainability into their overall strategy		

UNIT-V	The Future of Management Systems and Sustainability	09
Trends and developments in management systems and sustainability - The challenges and opportunities of implementing management systems for sustainability in the future - Case studies of organizations that are leading the way in the future of management systems andsustainability		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
Define and explain the different types of management systems and their role in sustainability.
Identify and discuss the benefits of implementing management systems for sustainability.
Apply management systems principles and tools to real-world sustainability challenges.
Develop and implement management systems for sustainability in organizations of all sizes.
Evaluate the effectiveness of management systems for sustainability

Text Book(s):
1. Management Systems for Sustainability: How to Connect Strategy and Act by PhilCumming (2nd edition
2. Environmental Management Systems: A Step-by-Step Guide to Implementation and Maintenance by Christopher Sheldon and Mark Yoxon (7th edition
3. Environmental Management Systems and Sustainability: Integrating Sustainability in Environmental Management Systems by Polin Kumar Saha (2nd edition
4. Sustainability Management Systems: A Comprehensive Guide to Implementation and Improvement by David A. Garvin

Reference Books(s)
1.The Business of Sustainability: Building a Sustainable Future for Our Organizations, Our Communities, and Our World by David Grayson, Mark Allenby, and Bob Zimmerman (2nd edition, Island Press, 2019)
2.The Natural Step: Framework for Leading the Sustainability Revolution by Karl-Henrik Robèrt
3.Cradle to Cradle: Remaking the Way We Make Things by William McDonough and Michael Braungart (North Point Press
4.The Doughnut Economy: Seven Ways to Think Like a 21st-Century Economist by Kate Raworth (Random House Business Books
5.The Natural Step: Framework for Leading the Sustainability Revolution by Karl-Henrik Robèrt

Course no:49	Course Title (Theory course)	Category	L	T	P	C
	Human Resource Management & Sustainability	**CC**	**3**	**0**	**0**	**3**

Objectives:
Facilitate student to imbibe knowledge about understanding the basic concepts and importance of HumanResources Management, Recruitment, Training, Communications, Employee Empowerment, Employee Interaction, Various Human Resources Applications and Practices, Managerial functions etc.

UNIT-I	**HUMAN RESOURCES MANAGEMENT**	**09**
Concept and Challenges, HR Philosophy, Policies, Procedures and Practices.		
UNIT-II	**HUMAN RESOURCE SYSTEM DESIGN**	**09**
HR Profession and HR Department, Line Management Responsibility in HRM, Measuring HR, Human ResourcesAccounting and Audit, Human Resource Information system		
UNIT-III	**FUNCTIONAL AREAS OF HRM**	**09**
Recruitment and Staffing, benefits, compensation, Employee Relations, HR Compliance, Organizational Design, Training and Development, Human Resources Information systems (HRIS) and Payroll.		
UNIT-IV	**HUMAN RESOURCES PLANNING**	**09**
Demand Forecasting, Action Plans – Retention, Training, Redeployment and staffing, succession Planning.		
UNIT-V	**STRATEGIC MANAGEMENT OF HUMAN RESOURCES**	**09**
SHRM, relationship between HR strategy and overall Corporate Strategy, HR as a Factor of Competitive Advantage,Managing Diversity in the Workplace.		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
Be aware of the basic principles of Human Resource Management.
Be familiarize with the system design of Human Resource Management.
Know the concepts, roles, functional areas and activities of HR.
Understand organization's employee, their interest, motivation, satisfaction belief of fair treatment.
Get awareness on actual impact on the firm's current performance and sustainability in the long run.

Text Book(s):
Prof. Gary Dessler , Human Resources Management, Pearson, 16th Edition, 2020.
Prof.John M.Ivancevich, "Human Resource Management", Tata McGraw Hill Publication, 12th Edition, 2003.
Prof.Aswathappa, "Human Resource Management and Personnel Management", 3rd Edition, Tata McGraw Hill,2002.

Reference Books(s)
Dr.C.B.Gupta, "Human Resource Management ", Sultan Chand & Sons, New Delhi, 1stEdition, 2018.
Prof.S.S.Khanka, "Human Resource Management", Chand & Company, New Delhi, 2019.
Dr.S.Seetharaman et al., "Human Resource Management", SciTech Publications Pvt Ltd. Chennai,2012.

Course no:50	Course Title (Theory course)	Category	L	T	P	C
	Emission Trading and Management	**CC**	**3**	**0**	**0**	**3**

Objectives:
To provide students with a comprehensive understanding of emission trading and its role in environmental management.

UNIT-I	**Introduction**	**09**
Emissions Trading - Kyoto Protocol (KP) - Four Phases in History - Trading – Provisions - Emission Cap and Trade System - Role of Emission Trading in Reducing Climate Change - Emissions Trading Scheme (ETS) in India - Significance and Benefits		
UNIT-II	**Emission Trading Markets**	**09**
Emission trading markets workings - The factors that influence the prices of emission permits - Different strategies that firms can use to participate in emission trading markets - Case studies of emission trading markets		
UNIT-III	**Emission Trading and Climate Change**	**09**
Emission trading mitigating climate change - The challenges and opportunities of using emission trading to address climate change - The effectiveness of different emission trading programs in reducing greenhouse gas emissions		

UNIT-IV	**Emission Trading and Other Environmental Policies**	**09**
Other environmental policies, such as carbon taxes and command-and-control regulations - The trade-offs between different types of environmental policies - Designing and evaluatingeffective environmental policy mixes		
UNIT-V	**Case Studies in Emission Trading**	**09**
Real-world examples of emission trading programs - The strengths and weaknesses of different emission trading programs - Lessons learned from different emission trading programs		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
To provide students with a comprehensive understanding of emission trading and its role in environmental management.
To develop students' analytical and critical thinking skills in the context of emission trading.
To prepare students for careers in emission trading, environmental policy, and other related fields.

Text Book(s):
Kolstad, C. Environmental Economics. Chapter 13, p. 272-280, Ch. 14, pp. 289-293
Baumol, W. and W. Oates. The Theory of Environmental Policy. 2nd ed. Chapter 12.
Ellerman, A.D., Marcantonini, C. and A. Zaklan (2016). The European Union Emissions Trading System: Ten Years and Counting.
Review of Environmental Economics and Policy, 10 (1): 89-107. Martin, R., M. Muûls and U.J. Wagner (2016).
The Impact of the European Union Emissions Trading Scheme on Regulated Firms: What Isthe Evidence after Ten Years? Review of Environmental Economics and Policy, 10 (1): 129- 148.

Course no:51	Course Title (Theory course)	Category	L	T	P	C
	Circular Economy	**CC**	**3**	**0**	**0**	**3**

Objectives:
To provide students with a comprehensive understanding of the circular economy, including its principles, benefits, challenges, and the role of government and businesses in supporting the transition to a circular economy.

UNIT-I	**Introduction to Circular Economy**	**09**
Circular economy - The principles of a circular economy - The benefits of a circular economy - The challenges of transitioning to a circular economy - Case studies of circular economy businesses		
UNIT-II	**Circular Design**	**09**
Circular design - The principles of circular design - Circular design tools and techniques - Case studies of circularly designed products and services		
UNIT-III	**Circular Supply Chains**	**09**
Circular supply chains - The principles of circular supply chains - Circular supply chain management strategies - Case studies of circular supply chains		
UNIT-IV	**Circular Economy Policies and Regulations**	**09**
The role of government in supporting the transition to a circular economy - Circular economy policies and regulations around the world - Case studies of effective circular economy policies and regulations		
UNIT-V	**The Future of the Circular Economy**	**09**
Trends and developments in the circular economy - The challenges and opportunities of a fully circular economy - Case studies of visionary circular economy businesses and initiatives		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
Define and explain the principles of the circular economy.
Identify and discuss the benefits and challenges of transitioning to a circular economy.
Apply circular design principles to products and services.
Develop and manage circular supply chains.
Analyze and evaluate circular economy policies and regulations.

Text Book(s):
• Principles of Economics by N. Gregory Mankiw ,10th edition Cengage Learning, 2023
• Microeconomics by N. Gregory Mankiw ,10th edition Cengage Learning, 2023
• Macroeconomics by N. Gregory Mankiw, 10th edition Cengage Learning, 2023
• Economics by Paul Samuelson and William D. Nordhaus, 26th edition McGraw-Hill Education, 2023

Reference Books(s)
Modern Principles of Economics by Andrew B. Abel and Ben S. Bernanke (11th edition, Cengage Learning, 2023)
The Economy: People, Business, and Government by Roger A. Arnold (13th edition, Pearson Education, 2023)
Economics: Principles and Applications by Scott McConnell, Brue, and Flynn (14th edition, McGraw-Hill Education, 2023)
Economics: A Contemporary Introduction by William A. Baumol and Alan S. Blinder (13th edition, Cengage Learning, 2023)

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Teaching Methodology & Assessment Structure:

The curriculum is designed to provide students with a strong foundation in the key concepts and theories of B.Tech Sustainable Engineering and Management. The curriculum offers students opportunities to apply what they have learned to real-worldsituations.

The teaching methodologies used are:

- Problem Based Learning
- Learning Constructivist Approach
- Case Studies
- Peer Tutorials
- E-Learning
- Blended Learning
- Flipped Classrooms
- Experiential Learning
- Industrial Visits
- P

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Assessment

Evaluation:

The marks allotted for evaluation to all subjects would be 100. The weightage todifferent modes of assessments shall be as under.

	In-term Evaluation		End Sem Exam	Components of continuous mode
	Continuous Assessment	Mid Term Exam		
Theory	50	-	50	Quizzes, class tests (open or closed book), home assignments, group assignments, *viva-voce* assignments, discussions
Practical	50	-	50	Attendance, *viva -voce*, journal, assignments, project, experiments, tests

JUSTIFICATION FOR THE CURRICULUM AND SYLLABUS IN LINE WITH SDG'S

"Sustainable Engineering and Management represents a rapidly expanding discipline, offering solutions to one of today's most urgent issues: climate change. This program equips students with the skills needed to conceptualize and implement sustainable resolutions for real-world engineering dilemmas. Participants will gain insight into sustainability principles, renewable energy, energy efficiency, waste management, and pollution control. Additionally, they will cultivate the managerial proficiencies essential for guiding sustainable initiatives and organizations effectively.

Upon completion of this program, graduates will find themselves in high demand across diverse industries, spanning energy, construction, manufacturing, and transportation. They will also be well-prepared to launch their own sustainable enterprises.

The rationale behind this course stems from several factors:

SDG13 Addressing Urgent Global Challenges: The B.Tech Sustainable Engineering and Management program is designed to tackle pressing global issues like climate change, resource depletion, and environmental degradation, offering comprehensive knowledge and skills to address these challenges.

SDG 7 Environmental Stewardship: Courses such as Environmental Engineering and Renewable Energy Technologies empower students to become stewards of the environment, fostering sustainable practices.

SDG 9 Innovation and Entrepreneurship: With subjects like Sustainable Design and Innovation and Innovative Entrepreneurship, students are encouraged to think creatively, fostering innovation and entrepreneurship in sustainable ventures.

SDG 4 : Business Acumen: This program also equips students with essential business skills, including Marketing Management and Financial Management, to successfully manage sustainable enterprises.

SDG 16 : Ethical and Social Responsibility: Courses like Business Ethics and Corporate Social Responsibility instill values of ethics and social responsibility, crucial for responsible leadership in the field.

M.Tech. - Smart Cities and Sustainable Urban Planning

(PG – 2 Years)

CHOICE BASED CREDIT SYSTEM (CBCS)

CURRICULUM AND SYLLABUS

As urban areas are getting more crowded and falling increasingly short on future development potential, development of self-reliant and self -sustaining cities are emerging as an alternate solution to these problems. Technology is at the heart of these new self-sustaining cities enabling automation and real-time integrated city monitoring and management through a network of sensors, cameras, wireless devices and data centers. These new self-sustaining cities, the smart cities are a developed urban area that creates sustainable economic development and high quality of life by excelling in multiple key areas like economy, environment, energy efficiency, mobility, governance, people and living conditions.

Smart cities, on one hand present a substantial growth opportunity in the coming years while on the other offers various growth opportunities and challenges as well. Smart city projects are rather complex with urban spaces supported by an infrastructure backbone for its healthy living. A critical success factor is a need for a common technology platform to enable integration, coordination and synergistic functioning of different participants of the smart city ecosystem.

Semester 1

	Title	L	T	P	C
PC	Introduction to Smart Cities/ Fundamental of Smart City	3	0	0	3
PC	Data Science for Planning	3	0	0	3
PC	Fundamentals of Urban Planning	2	0	0	2
ES	IOT and Artificial Intelligence	3	0	0	3
EEC	Mapping and Diagramming Studio	2	0	2	3
EEC	Urban Planning Studio -1	0	0	12	6
				Credits	**20**

Semester 2

	Title	L	T	P	C
ES	GIS for Smart Cities	2	0	2	3
HS	Research Methodology	3	0	0	3
BS	Quantitative Techniques and Data Representation	3	0	0	3
PC	Big Data for Planning and Development	3	0	0	3
PE	Elective 1	2	0	0	2
EEC	Urban Planning Studio -2	0	0	12	6
				Credits	**20**

Semester 3

	Title	L	T	P	C
PC	Infrastructure for Smart Cities	3	0	0	3
PC	Intelligent transport systems	3	0	0	3
PC	Sustainable Urban development	3	0	0	3
PE	Elective 2	2	0	0	2
EEC	Urban Planning Studio -3	0	0	12	6
				Credits	**17**

Semester 4

	Title	L	T	P	C
PC	Infrastructure Management system & Policy for Smart city	3	0	0	3
PE	Elective 3	2	0	0	2
EEC	Project work	0	0	16	8
					13

SEMESTER 1

Introduction to Smart Cities/Fundamental of Smart City

The purpose of this course is to provide a deep understanding of the digital technologies, infrastructure, and social political forces shaping the future of our urban environments. We begin by defining Smart Cites through lectures and case studies and trickle down into the technologies shaping new and existing cities.

OBJECTIVES

- To understand the concept of smart city and associated challenges.
- To understand latest technologies used in city management.
- To understand process of planning and drafting a plan for smart city.
- To understand the importance of different smart system and how it could be integrated with the overall physical plan

Module 1 Understanding Smart Cities

Introduction to smart cities- Definition, dimensions, scope Smart Cities –Global Standards and Performance Benchmarks, Practice Code. India "100 Smart Cities" Policy and Mission. Planning for Urban Infrastructure Urban Infrastructure, Role of Planner in the provision of urban networks and services, feasibility studies for infrastructure projects, planning for major infrastructure projects, Various Infrastructure Programmes and policies by MOUD, PPP (DBOOT, BOOT, etc.) in infrastructure projects

Module 2 Physical Infrastructure

Water Supply Water– sources of water, treatment and storage, transportation and distribution, quality, networks, distribution losses, water harvesting, recycling and reuse, norms and standards of provision, institutional arrangements, planning provisions, and management issues. Network design, Economics, distribution networks, Computer applications – Appurtenances –sensor-based Leak detection. Principles of design of water supply in buildings – House service connection.

Module 3 Sanitation and Solid waste

Sanitation and Solid waste Sanitation – points of generation, collection, treatment, disposal, norms and standards, grey water disposal, DEWATS, institutional arrangements, planning provisions, and management issues. Storm water collection and disposal, norms and standards, institutional arrangements, planning provisions, and management issues. Municipal and other wastes –generation, typology, quantity, collection, storage, transportation, treatment, disposal, recycling and reuse, wealth from waste, norms, and standards, institutional arrangements, planning provisions, and management issues. Approach to the special category of Solid Waste i.e., E-Waste, Building & Debris Waste, Medical Waste, Food Waste, Garden Waste, etc, Scientific Landfill and reclamation of existing dump yard, Critical examinations of SWM endeavour with special emphasis on clean city rankings along with case study on solid waste management.

Module 4 Electricity and Renewable Energy

Electricity & Fire services and Renewable Energy Electricity – Sources of electricity, distribution networks, demand assessment, norms and standards, planning provisions, and management issues. Fire –fire hazards, vulnerable locations, methods of firefighting, norms, and standards, planning provisions, and management issues. Energy Management, energy requirement, non-conventional energy systems, management of solar energy, wind energy, tidal energy, biomass energy, energy from waste.

Module 5 Social Infrastructure

Social Infrastructure – Education, Health, Civic Social Infrastructure – Education, Health, Civic Types, hierarchical distribution of facilities, Access to facilities, provision and location criteria, Norms and standards, etc. provisions for e-education, Tele- Health

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Fundamentals of Urban Planning

The purpose of this course is to provide an insight to the principles of Urban Planning . Further it focusses on various theories on sustainable planning , infrastructure, and social political forces shaping the future of our urban environments. We begin by defining urban planning through lectures , case studies and best practices shaping new and existing cities.

OBJECTIVES

- To give awareness about the principles of urban planning
- To present a critical overview of relevant urban planning policies, techniques and methods, planning processes and their impact on urban growth, development & infrastructure.
- To give exposure to different aspects of data, data visualisation and data analysis ,planning standards, models and projections.

Module 1 Introduction

Introduction - Definition of basic terms – Concept of urban areas and regions – Trend of Urbanization at National and International level – Historical evolution of planning and its influence to modern planning

Module 2 Principles of sustainable Urban and Regional Planning

Principles of sustainable Urban and Regional Planning – Planning Standards - Institutional mechanism, Management and co-ordination for Urban and Regional Planning –Constraints for plan preparation and implementation - Legal, Financial, Human resource and Institutional.

Module 3 Planning Theories and Rational Planning

Planning Theories and Rational Planning - The relevance and review of Planning Theories - Garden City, Geddisian Triad, Conurbation and Constellation, Modernism Concept by Le-Corbusier, Radburn, Green belt, Neighborhood Concept, Theories of Ekistics, Land Use and Land Value, Theories by William Alan so, Concentric/ Sectorial/Mono/Poly Centric/Axial Theories and others –Globalization and its impact on Planning – Application of Theories to planning practice– Rational planning - Challenges to Comprehensive Planning

Module 4 Urban and Regional Planning Process

Urban and Regional Planning Process - Concept, Objectives and contents of Urban and Regional Plans – Regional Plan, Master Plan, New Town Development Plan, Smart City plan, Zonal Development Plan, Detailed development Plan and Local Area Plan - Planning Process in the formulation and implementation of Urban and Regional Plans – Application of systems approach, Choice theory and advocacy planning in the planning process- Current Planning Practice in India and the way forward – Planning in Western context and lessons therefrom for India.

Module 5 Plan Evaluation and Implementation

Plan Evaluation and Implementation - Need for evaluation - Inseparability of planning and evaluation - Planning theories and evaluation - Methods of evaluating development plans, Introduction to Project evaluation -Realization of policies and strategies and Implementation of Development Plans, Resources and constraints for plan implementation, Land, Finance and Legal.

Data Science for Planning

OBJECTIVES

- To understand the role of computers in Urban Planning
- To understand the role of data science in Urban planning
- To understand the role of big data in smart city and associated challenges.
- To understand the latest available smart data tools

Module 1 Introduction to Computers

Introduction to Computers Introduction to Computers, Data representation, Conversion of data. Memory organization, Different secondary storage devices and Magnetic media devices, Translators, Types of Programming languages, Data Representation, Data Science, and applications to Smart Cities.

Module 2 Operating Systems

Operating Systems & DBMS Information Technology and Operating System: Information Technology Infrastructure Hardware, software, and Data related issues, Systems Application software, Enterprise software, Operating System Concepts, Structures, Files, Directories, Process and Memory management. Relational database system, DBMS, Data Flow Diagrams, Logical Data model, Data Warehouses, Meta Data, and Global Databases, Spatial Databases available for natural resources and Terrain.

Module 3 Introduction to C- Programming

Introduction to C- Programming C programming: Basic structure of C programming, executing a C program. Constants, variables, and data types. Operators and expressions. Managing input and outputs, operations, conditional branching, and loops. Arrays (1D & 2D)- character arrays and strings. Basic algorithms: searching and sorting, linear search, binary search, bubble sort, selective sort Reaction and user-defined functions.

Module 4- Introduction to Python

Program Parts of python programming language, keywords, data types, reading input, printing output, conditions and loop statements, functions definition, and calling a function. Lists- creating lists, basic list operation- Tuples, dictionaries, data pre-processing and data visualization, PANDAS, NUMPY, MATPLOTLIB, SEABORN

Module 5 - PRACTICAL

C Programming Language: Basics, Statements, Loop, Array, String, Pointer, Execution of basic programs.

IOT and Artificial Intelligence

OBJECTIVES

- To explore the significance of Internet of Things in Urban Planning ‘
- To explore how big data, together with Internet of Things (IoT), AI and Machine Learning are being applied in every field of society, especially where complex decisions need to be made with numerous stakeholders.
- To explore more about AI’s potential to solve problems related to rapid urbanization including mobility challenges, energy shortage, health and environmental issues as well as to provide comfort, security and resilience in built environments.

Module 1 Introduction To Internet of Things

Definition & Characteristics of IoT - Challenges and Issues - Physical Design of IoT, Logical Design of IoT - IoT Functional Blocks, Security

Module 2 Components In Internet of Things

Control Units Communication modules Bluetooth Zigbee Wifi GPS- IOT Protocols (IPv6, 6LoWPAN, RPL, CoAP etc), MQTT, Wired Communication, Power Sources

Four pillars of IOT paradigm, BigData Analytics, Cloud Computing, Embedded Systems.

Module 3 From The Internet of Things to The Web Of Things

The Future Web of Things Set up cloud environment Cloud access from sensors Data Analytics for IOT- Case studies- Open Source e-Health sensor platform Be Close Elderly monitoring Other recent projects.

Module 4 IoT Applications in Urban Planning

Smart city, smart mobility and transport, smart buildings and infrastructure, smart health, environment monitoring and surveillance

Module 5 Case studies and best practices

Case studies and best practices

Mapping and Diagramming Studio

OBJECTIVES

- To introduce the basics of Mapping and its significance in Urban Planning
- To provide knowledge on visualizing, diagramming, mapping and analyzing, urban form and place
- To enable understanding of the importance of data mining and its various methods

Module 1 Basics of mapping

Introduction to urban glossary. Basics of mapping- map types. Introductory exercise. Study of an urban transect with sketch-walks.

Module 2 Basics of mapping

Cognitive Diagramming and Base Maps - Basics of mapping. Preparation of figure ground maps collating satellite images, GIS, area development maps, records and ground corroboration. Cognitive mapping of tangible and intangible layers: land-use, districts and boundaries, physical histogenesis, heritage fabric, program-movement, activity, nodes, thresholds-networks, pedestrian pathways, transit density, policy initiatives, population demographics, visual and non-visual clues, social memory, community narratives and place realms, soundscape, real estate dynamics, ecology and environmental factors, physical and social infrastructure.

Module 3 Mapping with Theory Overlays

Exploring and analyzing selected urban sites with mapping overlays of urban theories (as filters) on figure ground diagrams and base maps: imageability, permeability, variety, legibility, built, natural and cultural landscapes, perception, monuments and dwelling, spatial syntax, heritage urban form, social life of small urban spaces, life between buildings, FARMAX. Urbanism in the age of climate change, defensible space, and infrastructural urbanism, urban flows, e-cities, e-bodies, globalization and local culture, livability.

Module 4 Data Visualisation

Data Visualisation - Envisioning information. Graphical representation of data. Ben fry's seven steps in creating data visualization: Acquire, Parse, Filter, Mine, Represent, and Refine, Interact. Visual interconnection of facts& ideas: Relationship facts, contacts, connections, time-series, relational graphics, data maps, multivariate designs, scales. Quantitative; discreet; continuous; categorized data to be visualized with graphics software. Visualizing data for various urban development indices and quotients such as livability, walkability, mobility, commuting, off-peak travelling, local business, health, resilience, happiness, urban stress, surveillance and SDG, sustainable development goals.

Module 5 Data Analysis

Data Analysis - Detection of graphical deception: design variation vs. data variation. Sources of deception. Aesthetics and Data graphical displays. Urban data mining - extracting meaningful information from raw data through simple programming software, iterative data analysis and refinement for various urban development indices and quotients. Social media data analysis as a complementary tool for urban design

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Urban Planning Studio 1

This studio seeks to address the role of urban planning in the context of city cores. Students will explore the selected area of study, through experiential mapping, physical mapping, and interviews, review of policy and regulations, application of urban design theories, frameworks, data visualization and models.

Students will analyze various urban design parameters inclusive of:

- urban morphology and building types, places and landform types, in a city's socio-cultural identity
- sustainable urban planning challenges in integrating transit, pedestrian, social, health and community infrastructure
- relationship between a building and public realm

Probable projects might include urban in-fills, urban catalysts, transit, and pedestrian and community infrastructure as modes for urban revitalization, conservation guidelines, and form-based code manuals for contextual transformation, cultural landscape and place making proposals.

SEMESTER 2

GIS in Smart Cities

OBJECTIVES

- To explore the Geo spatial tools in Urban Planning
- To introduce role of GIS in urban Planning
- To give basic familiarity with the concepts, tools and techniques of GIS
- To give training in the application of GIS for Urban Planning

Module 1: Introduction

Remote sensing Practical: Indices (NDVI, NDBI, etc), Supervised and unsupervised classification with accuracy assessment, kappa coefficient, and matrix, pattern recognition (Spatial and temporal), Time series, Change detection techniques.

Module 2: Project RS

The project should contain well-composed maps prepared using various methods learned during the practical sessions

Module 3: GIS Practical

Geoprocessing tools and queries, MCDM with AHP, DSM, DTM, slope and aspect, spatial interpolation, watershed analysis, model builder

Module 4: Project GIS

Project GIS The project should contain well-composed maps prepared using various tools and analyses learned during the practical sessions. Sample project examples: Urban governance themes like (property tax, demographics, storm water, so on), identification of suitable sites for urban development, morphometric analysis.

Deliverables for viva

1. Project report (maps with a detailed summary of the project)

2. Well composed maps in suitable sheet size for viva explanation

Research methodology

OBJECTIVES

- To give introduction to the importance of critical inquiry as a way of gaining knowledge and adding to it through research.
- To give exposure to the various forms of research and research methodologies/ processes in addressing smart city solutions .
- To understand research in the specific domain of Sustainable Urban Planning

Module I INTRODUCTION

Basic research issues and concepts. Orientation to research process. Types of research: historical, qualitative, co-relational, experimental, simulation and modelling, logical argumentation, case study and mixed methods. Illustration using research samples including research in the domain of built environment.

Module 2 RESEARCH PROCESS

Elements of Research process: finding a topic, writing an introduction, stating a purpose of study, identifying key research questions and hypotheses, reviewing literature, using theory, defining, delimiting and stating the significance of the study, advanced methods and procedures for data collection and analysis. Illustration using research samples including research in the domain of built environment.

Module 3 RESEARCHING AND DATA COLLECTION

Library and archives. Internet: New information and the role of internet. Finding and evaluating sources. Misuse. Test for reliability. Ethics. Methods of data collection- Primary sources: observation and recording, interviews structured and unstructured, questionnaire, open ended and close ended questions and the advantages, sampling. Collecting data from secondary sources.

Module 4 REPORT WRITING

Research writing in general and its components. Developing the outline, referencing, writing the bibliography, presentation, etc.

Module 5 CASE STUDIES

Case studies of competent research, from project inception to completion with a focus on research in the domain of built environment. Review of research publications.

Quantitative Techniques and Data Representation

OBJECTIVES

- To acquire knowledge in statistical and numerical techniques and to take up quantitative analysis and research
- To provide in-depth understanding of various research methods in the field of planning and urban design

Module I STATISTICAL METHODS

Data: Statistical and Numerical data. Types of data measurement scale – Nominal, ordinal, interval, ratio, Variables. Discrete, continuous- Data collection, coding and decoding, methods, tabulation and graphic presentation of data. Frequency distribution. Measures of central tendency: mean, median, mode. Measures of dispersion, Correlation and Regression. Introduction to spread sheets and statistical software – SPSS, Data Fit etc.

Module II HYPOTHESIS TESTING

Sampling Distribution. Test based on Normal, t, Chi-square and F-Distributions. Discrete random variables, Completely Randomized Design. Randomized Block Design. Latin Square Design. ANOVA.

Module III QUANTITATIVE TECHNIQUES IN PLANNING & DEMOGRAPHIC ANALYSIS

Elementary association models and decision making. Index numbers, weighted and un-weighted index numbers. Application of index number in spatial planning. Calculation techniques of vital events. Methods of demography and population studies, population projections, introduction to Census data and sampling Techniques.

Module IV FORECASTING AND TIME SERIES ANALYSIS

Time series forecasting- line chart, curve fitting. Function approximation – approximation theory and numerical analysis, interpolation, extrapolation, pattern recognition, econometrics, segmentation, Univar ate linear and nonlinear measures and bivariate measures. Visualization Charts, Braided graphs, Line charts, Slope graphs, Gap Chart, Horizon graphs, reduced line chart (small multiples), Silhouette graph, Circular silhouette graph etc.

Module V DATA REPRESENTATION

Data Ideograms and the Language of Symbols- Braille, Morse Code, Sign, and Gesture Data Abstraction, Task Abstraction, Common Visualization Idioms such as Bar Chart, Pie Chart and Coxcomb Plot, Line Chart, Area Chart etc., -Spatial data, networks, trees - Making Maps-encoding, Stacked & Grouped data, Manipulate View, Facet into Multiple Views, Case Studies in Visualization and Information tools.

Big Data for Planning and Development

OBJECTIVES

- To train students in using simulation and coding, to understand and approach the emerging urban requirements
- To familiarize students with complex automation algorithms in big data analysis and urban projections

Module 1 -INTRODUCTION TO BIG DATA AND ANALYTICS

Big Data Overview Characteristics of Big Data Business Intelligence vs Data Analytics.

Module 2 -NEED OF DATA ANALYTICS

Data Analytics Life Cycle Data Analytics in Industries Exploring Big data Challenges in handling Big Data

Module 3 BIG DATA TOOLS

Need of Big data tools - understanding distributed systems - Overview of Hadoop comparing SQL databases and Hadoop Hadoop Eco System - Distributed File System: HDFS, Design of HDFS writing files to HDFS Reading files from HDFS.

Module 4 RESILIENT CITIES, URBAN PLANNING AND BIG DATA

Need for resilient cities. Integrative framework (society, environment, economy, governance, big data, technology) for resilience. Strategies for mitigation of natural & man-made disasters. E-governance, IoT and big data in urban resilience.

Module 5 OPEN SOURCE CODING TOOLS

Use of open source coding tools for Spatial data analysis, land use planning scenarios, density, place making, spatial econometrics, spatial demographics, Urban energy systems, Disaster management, TOD, livability, urban growth index, network analysis, urban mobility, urban accessibility, environmental modelling, collaborative mapping applications and policy compliance.

Urban Planning studio 2

In this studio, students will explore the unique range of land management issues that may occur in urban areas, shaped by flows - issues often related to growth patterns of the historic cores they feed off and their specific locations. Issues to be analyzed but not restricted to, may include:

- Sustainable density vs. sprawl
- Infrastructure provision and integration with land use Infrastructure framework and real estate development in continuity with local communities and settlements

- Ecological planning of environmentally sensitive zones (such as flood plains of water bodies, wetlands and protected areas)
- Development codes for sustainability
- Infrastructural urbanism

Students will employ diagramming-mapping tools, ground surveys, co-relational research, case studies and theories to understand these issues. They will audit, iterate and propose future development scenarios, for selected slices of emergent urban living. Proposals might include policy, program and detailed design development strategies.

Projects might include: TOD/TAD cores, livable mixed-use communities, infrastructural urbanism, tactical urbanism, co working and co-housing development, place-community-identity-equity, green and brownfield development with sustainable density, equitable urbanism etc. T

SEMESTER 3

Infrastructure for Smart Cities

OBJECTIVES

- To develop a basic understanding about various types of Infrastructure and Smart city.
- To explore the various programmes/codes/policies available for the smart city projects
- To enable the students to apply the basic need and planning concept to solve various Infrastructure problems.

Module 1 Fundamentals of smart city & Infrastructure Management

Introduction of Smart City, Concept of smart city, Objective for smart cities, History of Smart city world and India. Need to develop smart city, Challenges of managing infrastructure in India and world, various types of Infrastructure systems, Infrastructures need assessment

Module 2 Planning and development of Smart city

Infrastructure : Energy and ecology, solar energy for smart city, Housing, sustainable green building, safety, security, disaster management, economy, cyber security, Project management.

Module 3 Intelligent transport systems

Intelligent transport systems Smart vehicles and fuels, GIS, GPS, Navigation system, traffic safety management, mobility services, E-ticketing

Module 4 Management of water resources

Management of water resources and related infrastructure Storage and conveyance system of water, sustainable water and sanitation, sewerage system, flood management, conservation system

Module 5 Infrastructure Management

Infrastructure Management system & Policy for Smart city Integrated infrastructure management systems for smart city, Infrastructure management system applications for existing smart city

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Intelligent Transport Systems

OBJECTIVES

- To gain specialized knowledge in smart transportation systems, techniques and their integration with sustainable urban planning
- To understand the importance of emerging transport models such as transit-oriented development.
- To understand the various standards, norms & assessment methods

Module 1 - Transportation Systems

Role of transport, types of transport systems, the evolution of transport modes, transport problems, mobility issues, Urban Form, Transport patterns, land use – transport cycle, the concept of accessibility. Hierarchy, capacity, and geometric design elements of roads and intersections, Basic principles of Transport infrastructure design. Urban Road classification-Road characteristics– alignment and sight distance.

Module 2 - Urban Transport

Planning Studies Transportation surveys and studies, traffic and travel characteristics, Urban transport planning process – stages, study area, zoning, database, the concept of trip generation and distribution. Traffic surveys – Speed, Volume, Intersection Design– Rotary and Signalling system, Design of Urban Roads about different types of traffic, segregation of traffic, canalization. Parking needs, on and off-street parking, estimation of short-term and long-term parking demand, and planning including the planning of terminals. Planning, engineering, and management criteria for road junctions.

Module 3 - Traffic Management

Traffic Management and Environment Traffic management, principles, methods, Traffic operation plan, scope, and objective. Non-Motorized Transportation, Transport and Environment: Detrimental effects of traffic on human life, traffic noise, noise abatement measures. Green corridors. Analytical Transport Planning: The quantitative transport

planning process, surveys, zoning, and network building. Transport model, prediction of future use of transportation systems, transport policy, and evaluation.

Module 4 - Transport Systems

Transport Systems Role and level of Intermediate Transport mode (IPT), Public transport and private mode in Indian Scenario, Types of Public Mass transport: Mass Rapid Transit System (MRTS), BRTS, LRT, RRTS and its role in the transport system. Land-use transport Cycle, Transit-Oriented Development, Multi-Modal Transport systems, and emerging Transport systems.

Module 5 - Smart Transport Planning

Introduction to smart transport, Intelligent transportation system (ITS), GIS and GPS positioning Navigation and Identification system, Smart Automobiles and sustainable fuels, smart pedestrian walkways and cycle tracks, solar roads, electronic fee payment technology, electronic speed determination technology, smart signaling technology.

Sustainable Urban Development

OBJECTIVES

To understand challenges pertaining to climate change & sustainability,

To learn analysis tools and policy mechanisms to ensure resilient urban development

Module I CLIMATE CHANGE AND SUSTAINABILITY

Exigencies of climate change. Global warming and challenges for cities. Brundtland report - Kyoto protocol – UNFCCC - SDG 2019 - Coastal Cities. Integrated, inclusive, sustainable urban development. Science of Cities - Triple bottom of sustainability. Role of UN in climate change.

Module II GREEN URBANISM

Climatology of contemporary cities - Urban Heat Island - Microclimatic considerations in urban design - Eco Urbanism cores - Sponge cities.

Module III SUSTAINABILITY ANALYSIS TOOLS

Studying the application and use of SDGs. PEST and PESTAL economic goals. Life cycle assessments of resources: ecological & carbon foot print, benefit cost analysis & impact assessment of a site. Circular Economy. Land suitability, vulnerability assessment. Pollution modelling. Environmental assessment reports.

Module IV SUSTAINABLE POLICY

UN's initiative towards sustainable cities to be explored through Indian examples. Well planned, inclusive and integrated urban growth frameworks - sustainable transport, urban systems and public services, safety, waste management. Government of India

environmental regulations for Greenfield and brownfield development, water body's protection, coastal regulation zoning, emission and pollution controls. Energy standards for Indian cities- cases studies. Smart city projects.

Module V RESILIENT URBANISM

Regional planning and technology integration to combat climate change, pandemics and global emergencies. Best practices in ecological urbanism and urban resilience - 100 resilient cities, sponge cities. Social networks and cartography. Community based environmentalism- relevant case studies

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Urban planning studio 3

This studio will examine specific global urban design challenges, which require comprehensive understanding at a global and regional scale: it will investigate the same in various local contexts such as:

- city wide natural systems, ecological zones
- infrastructural urbanism, resilience and regional networks
- integrative governance frameworks and technology for inclusive, participatory community development

Students will analyze global trends and issues through literature review and research. They will localize their research through experiential mapping, physical mapping, diagramming, data visualization and analysis, combined with parametric analysis, GIS data sets (density analysis, spatial statistics and spatial relations to present development scenarios) and development indices, to propose regional solutions for global urban issues. They will evaluate resilient growth frameworks for inclusive, integrated urban development.

SEMESTER 4

Infrastructure Management system & Policy for Smart city

OBJECTIVES

- To explore Integrated infrastructure management systems for smart city
- To explore and analyse the policies of Smart City by Government of India - policy for smart city, Mission statement & guidelines

LIST OF ELECTIVES

ELECTIVE 1

ENVIRONMENTAL PLANNING

Module 1: Introduction

Module 2: Global Environmental Concerns and Planning of Settlements

Module 3: Emerging Concepts

Module 4: Environmental Risks, Impact, and Role of Institutions in Environment Management

Module 5: Environment planning techniques

RURAL AND REGIONAL PLANNING

Module 1 – Introduction to Village Planning

Module 2 –Schemes

Module 3 –Smart Village

Module 4 –Introduction to Regional Plan

Module 5–Levels of Planning

HOUSING AND LEGAL FRAMEWORK

Module 1: Concepts and Definitions

Module 2: Housing Demand, Supply, Need or Deficit and Housing Market

Module 3: Introduction, Concept, and Significance of Law

Module 4: Policy, Acts, and Laws.

Module 5: Housing Laws concerning Housing Policies

ELECTIVE 2

PROJECT MANAGEMENT IN SMART CITIES

Module 1- Fundamental of Research

Module -2 - Statistical Inference for Research

Module 3 – Introduction to Project Management

Module 4 – Project structure and Evaluation

Module 5 – Project structure and Evaluation

CONCEPT OF GREEN BUILDING

Module: 1- Introduction to the concept of cost effective construction

Module: 2- Environment friendly and cost effective Building Technologies

Module: 3-Global Warming

Module: 4-Green Building rating Systems

Module: 5-Utility of Solar Energy in Buildings & Green Composites for Buildings

REAL ESTATE AND URBAN ECONOMICS

Module 1 – Introduction

Module 2 – Land Economics

Module 3 – Influence of Land Market

Module 4 – Stake Holders

Module – 5- Real Estate Finance

Elective 3

URBANIZATION AND LAND MANAGEMENT

Module 1- Urbanization

Module 2- Urban development schemes and Plans

Module 3- Introduction to Land Economics

Module 4- Supply Side Management

Module 5 - Land Pricing and Information System

PLANNING FOR DISASTER MANAGEMENT

Module 1: Disaster Preparedness, Prevention, and Mitigation

Module – 2- Disaster Management

Module – 3 Planning and Resource Management

Module – 4 Man-Made Disaster

Module 5: Disaster Education

LEGISLATION AND GOVERNANCE

Module 1: Overview of Governance

Module 2: Legislations on Urbanisation

Module 3: Special Legislations

Module 4: Participatory Governance

Module 5: Smart Governance

M.S. Climate Finance and Green Investments
(PG – 2 Years)

Total Credits : 70
Curriculum and Syllabus I to IV semesters

S.No	*Course Code*	*Course Title*	*Category*	*Periods /Week*				
				L	**T**	**P**	**Total**	**Credits**
SEMESTER – I								
1	Core 1	Climate Change Science and Policy	CC	4	0	0	4	4
2	Core 2	Financial Management for Green Investments	CC	4	0	0	4	4
3	Core 3	Environmental Economics	CC	4	0	0	4	4
4	Core 4	Environmental Technology	CC	4	0	0	4	4
5	Elective 1	Sustainable Investment Strategies	FE	4	0	0	4	4
		TOTAL		**20**	**0**	**0**	**20**	**20**
SEMESTER – II								
1	Core 5	Renewable Energy Finance	CC	4	0	0	4	4
2	Core 6	Climate Risk Assessment and Management	CC	4	0	0	4	4
3	Core 7	Sustainable Supply Chain Management	CC	4	0	0	4	4
4	Core 8	Sustainable Development	CC	4	0	0	4	4
5	Elective 2	Sustainable Real Estate Investment	FE	4	0	0	4	4
		TOTAL		**20**	**0**	**0**	**20**	**20**
SEMESTER – III								
1	Core 9	Green Investment Evaluation and Due Diligence	CC	4	0	0	4	4
2	Core 10	Climate Finance and Development	CC	4	0	0	4	4
3	Core 11	Carbon Pricing, Trading, and Markets	CC	4	0	0	4	4
4	Core 12	Green Marketing	CC	4	0	0	4	4
5	Elective 3	Climate Data Analytics	FE	4	0	0	4	4
				20	**0**	**0**	**20**	**20**
		TOTAL						
	SEMESTER – IV							
1	Project Work	Capstone Project in Climate Finance and Green Investments	EEC	0	0	0	20	10
		TOTAL		**0**	**0**	**0**	**20**	**10**

CC : Core Courses
FE : Functional Elective
EEC : Employability Enhancement Courses

Program Description:

This M.Tech program is designed to equip students with the knowledge and skills necessary to navigate the complex world of climate finance and green investments. Graduates will be prepared to address environmental challenges while making informed financial decisions that promote sustainability and responsible investing.

Prerequisites:

Applicants are required to have a bachelor's degree in a relevant field such as finance, economics, environmental science, engineering, or a related discipline.

Year 1 – Semester 1

	Course Name	L	T	P	C
Core 1	Climate Change Science and Policy	4	0	0	4

Course Description:
Understanding climate change mechanisms
International climate agreements and policies
Climate finance as a tool for mitigation and adaptation

UNIT-I	**Fundamentals of Climate Change** Introduction to climate change science - Greenhouse gas emissions and sources - Climate models and predictions - Historical climate data analysis - Climate change impacts and adaptation	**12**
UNIT-II	**International Climate Agreements** Overview of international climate treaties - Kyoto Protocol and Paris Agreement - Nationally Determined Contributions (NDCs) - Monitoring and compliance mechanisms -Climate diplomacy and negotiation skills	**12**
UNIT-III	**Climate Policy and Governance** National climate policies and legislation - Climate policy implementation and challenges - Role of non-governmental organizations- Climate policy evaluation and assessment- Climate change ethics and justice	**12**

UNIT-IV	**Climate Finance and Investment** Climate finance mechanisms-Green bonds and climate investment funds-Public and private sector engagement-Risk assessment in climate investment-Financial instruments for climate projects	**12**
UNIT-V	**Climate Change Mitigation and Innovation** Renewable energy technologies-Energy efficiency measures-Carbon capture and storage-Sustainable transportation solutions-Emerging technologies for climate mitigation	**12**
	Total Contact Hours: 60	

	Course Name	L	T	P	C
Core 2	**Financial Management for Green Investments**	4	0	0	4

Course Description:

Financial analysis and modeling for green projects

Risk assessment and management in green finance

Valuation of sustainable investments

UNIT-I	**Introduction to Financial Management for Green Investments** Basics of financial management-Role of finance in sustainability-Financial analysis for green projects-Risk management in green investments-Ethical and responsible finance	**12**
UNIT-II	**Valuation Techniques for Green Assets** Asset valuation methods-Discounted cash flow analysis-Valuing renewable energy projects-Real options analysis-Valuation of green bonds	**12**
UNIT-III	**Investment Appraisal for Sustainable Projects** Cost-benefit analysis-Environmental impact assessment-Social return on investment (SROI)-Portfolio management for green investments-Sustainable investment strategies	**12**
UNIT-IV	**Green Investment Risks and Performance Metrics** Environmental, social, and governance (ESG) metrics-Measuring carbon footprint-Green investment risk assessment-Sustainable portfolio performance evaluation-Reporting and disclosure standards	**12**
UNIT-V	**Sustainable Financing and Green Markets** Green financing options-Role of banks and financial institutions-Green investment funds-Regulatory environment for green finance-Trends in sustainable capital markets	**12**
	Total Contact Hours: 60	

	Course name	L	T	P	C
Core 3	**Environmental Economics**	**4**	**0**	**0**	**4**

Course Description:
Principles of environmental economics Cost-benefit analysis for environmental projects Market-based environmental policy instruments

UNIT-I	**Introduction to Environmental Economics** Basic principles of environmental economics-Market failures and environmental problems-The role of economics in environmental decision-making-Key concepts: externalities, public goods, and property rights-Environmental valuation methods	**12**
UNIT-II	**Economic Analysis of Environmental Problems** Cost-benefit analysis in environmental decision-making-Environmental policy instruments: taxes, subsidies, and permits-Market-based approaches to pollution control-The concept of sustainable development-Environmental impact assessment	**12**
UNIT-III	**Natural Resource Economics** Economics of renewable and non-renewable resources-Fisheries and forestry economics-Land use and urban economics-Sustainable resource management-The tragedy of the commons and resource allocation	**12**
UNIT-IV	**Environmental Policy and Regulation** Environmental regulations and their economic implications -Regulatory impact assessments-Environmental policy instruments and their effectiveness-Case studies of environmental policy success and failures-Market-based approaches to environmental policy	**12**
UNIT-V	**Global Environmental Issues and International Economics** Economics of global environmental challenges-International agreements and treaties-Trade-offs between economic growth and environmental protection-Climate change economics-Transboundary pollution and international cooperation	**12**
	Total Contact Hours: 60	

	Course name	L	T	P	C
Core 4	Environmental Technology	4	0	0	4

Course Description:
Technologies addressing environmental impact
Requirements for Use of technology

UNIT-I	**Introduction to Environmental Technology** Understanding the Environmental Challenges - Role of Technology in Environmental Conservation- Historical Perspectives on Environmental Issues- Environmental Ethics and Sustainability- Key Environmental Legislation and Regulations	**12**
UNIT-II	**Environmental Monitoring and Assessment** Principles of Environmental Monitoring- Sampling Techniques in Environmental Analysis- Data Collection and Analysis Methods- Environmental Impact Assessment (EIA)- Remote Sensing and GIS in Environmental Monitoring	**12**
UNIT-III	**Pollution Control Technologies** Air Pollution Control and Management- Water Pollution Control and Treatment- Solid and Hazardous Waste Management- Industrial Pollution Prevention- Emerging Technologies in Pollution Control	**12**
UNIT-IV	**Renewable Energy and Sustainable Practices** Solar Energy Technologies- Wind Energy Systems- Biomass and Bioenergy- Energy Efficiency and Conservation- Sustainable Agriculture and Land Use Practices	**12**
UNIT-V	**Green Technologies and Future Trends** Green Building and Sustainable Architecture- Waste-to-Energy Technologies- Circular Economy and Resource Management- Emerging Trends in Environmental Technology- Ethical Considerations in Environmental Innovation	**12**
		Total Contact Hours: 60

	Course Name	L	T	P	C
Elective 1	**Sustainable Investment Strategies**	**4**	**0**	**0**	**4**

Course Description:
Impact investing and sustainable portfolio management Green bonds and other sustainable financial instruments

UNIT-I	**Fundamentals of Sustainable Investing** Introduction to sustainable investment strategies-ESG (Environmental, Social, and Governance) factors in investing-History and evolution of sustainable finance-Ethical and responsible investment principles-Sustainable development goals (SDGs) and investment	**12**
UNIT-II	**Investment Analysis and Portfolio Management** Risk and return analysis in sustainable investments-Asset allocation and diversification strategies-Building and managing sustainable investment portfolios-Impact investing and its measurement-Sustainable indices and benchmarks	**12**
UNIT-III	**Sustainable Investment Instruments** Green bonds and other fixed-income securities-Equities and stocks with ESG integration-Sustainable real estate and infrastructure investments-Alternative investments in renewables and clean technology-Private equity and venture capital in sustainable ventures	**12**
UNIT-IV	**Corporate Sustainability and Engagement** Corporate sustainability reporting and disclosure-Engagement with companies on ESG issues-Shareholder activism and proxy voting-Stakeholder engagement and collaboration-Ethical corporate governance and board diversity	**12**
UNIT-V	**Sustainable Investment Trends and Future Challenges** Emerging trends in sustainable finance-Sustainable investment in emerging markets-Regulatory frameworks and standards in sustainable investing-Climate risk and resilience in investment strategies-Future challenges and opportunities in sustainable finance	**12**
	Total Contact Hours: 60	

Year 1 – Semester 2

	Course Name	L	T	P	C
Core 5	**Renewable Energy Finance**	**4**	**0**	**0**	**4**

Course Description:
Financing models for renewable energy projects
Solar, wind, and hydropower project finance
Policy and regulatory considerations

UNIT-I	**Introduction to Renewable Energy Finance** Overview of renewable energy sources and technologies-The role of finance in renewable energy projects-Key financial concepts and terminology-Renewable energy market trends and opportunities-Challenges and risks in renewable energy finance	**12**
UNIT-II	**Project Financing for Renewable Energy** Structuring renewable energy projects-Sources of project financing-Financial modeling and cash flow analysis-Risk assessment and mitigation in project finance-Project finance case studies	**12**
UNIT-III	**Investment Analysis for Renewable Energy** Investment appraisal techniques for renewable projects-Cost estimation and optimization-Evaluating the economic viability of renewable energy ventures-Assessing the environmental and social impacts of investments-Government incentives and subsidies for renewable energy	**12**
UNIT-IV	**Renewable Energy Policy and Regulations** Regulatory frameworks for renewable energy-Feed-in tariffs and power purchase agreements (PPAs)-Renewable portfolio standards and incentives-Tax incentives and credits for renewable investments-Compliance and legal considerations in renewable finance	**12**
UNIT-V	**Renewable Energy Markets and Innovation** Renewable energy markets and trading-Renewable energy certificates (RECs) and carbon markets-Innovations in renewable energy finance-Green bonds and sustainable financing for renewables-Trends in renewable energy finance and future prospects	**12**
	Total Contact Hours: 60	

	Course Name	L	T	P	C
Core 6	**Climate Risk Assessment and Management**	4	0	0	4

Course Description:

Identifying and assessing climate-related risks

Developing strategies for climate risk mitigation

Integration of climate risk into financial decision-making

UNIT-I	**Introduction to Climate Risk Assessment** Fundamentals of climate risk assessment-Types of climate-related risks (e.g., physical, transition)-Data and methodologies for risk assessment-Climate scenarios and modelling-Regulatory and reporting requirements	**12**
UNIT-II	**Physical Climate Risks** Identifying and assessing physical climate risks-Extreme weather events and their impacts-Sea-level rise and coastal vulnerabilities-Climate-related risks to infrastructure-Case studies of physical climate risk management	**12**
UNIT-III	**Transition Climate Risks** Transition risks in a carbon-constrained world-Carbon pricing and emissions reduction strategies-Regulatory and policy risks related to climate change-Market and technology disruptions-Transition risk analysis for different sectors	**12**
UNIT-IV	**Climate Risk Mitigation and Adaptation Strategies** Mitigation strategies to reduce climate risks-Adaptation strategies for resilience-Green finance and sustainable investment-Role of insurance and risk transfer mechanisms-Developing climate risk management plans	**12**
UNIT-V	**Integrating Climate Risk into Business and Policy** Integrating climate risk assessment into corporate strategy-Climate risk disclosure and reporting-Climate risk assessment in financial institutions-Government policies and climate risk management-International cooperation and climate risk governance	**12**
	Total Contact Hours: 60	

	Course name	L	T	P	C
Core 7	**Sustainable Supply Chain Management**	**4**	**0**	**0**	**4**

Course Description:

Sustainable procurement and sourcing
Supply chain carbon footprint analysis
Circular economy principles

UNIT-I	**Introduction to Sustainable Supply Chain Management** Fundamentals of supply chain management-Importance of sustainability in supply chains-Key concepts of sustainable supply chain management-Triple bottom line approach (People, Planet, Profit)-Ethical considerations in supply chains	**12**
UNIT-II	**Sustainable Procurement and Sourcing** Sustainable sourcing strategies and practices-Supplier selection and evaluation-Ethical and environmental criteria in procurement-Supply chain transparency and traceability-Fair trade and responsible sourcing	**12**
UNIT-III	**Green Logistics and Transportation** Sustainable transportation modes and technologies-Green logistics and distribution centers-Carbon footprint measurement and reduction-Sustainable packaging and materials handling-Reverse logistics and recycling in supply chains	**12**
UNIT-IV	**Sustainable Operations and Production** Sustainable production processes and techniques-Lean and green manufacturing-Energy efficiency and waste reduction-Circular economy principles in production-Life cycle assessment (LCA) in operations	**12**
UNIT-V	**Sustainable Supply Chain Strategy** Developing a sustainable supply chain strategy-Supply chain risk management-Corporate social responsibility (CSR) in supply chains-Sustainable supply chain governance and compliance-Reporting and disclosure of sustainability performance	**12**
	Total Contact Hours: 60	

	Course name	L	T	P	C
Core 8	**Sustainable Development**	**4**	**0**	**0**	**4**

Course Description:

UN has come out with a global framework for sustainability. This course will focus on same. The goals which are relevant to the program are to be emphasized.

UNIT-I	**Introduction to Sustainable Development Goals (SDGs)** Definition and Background of Sustainable Development Goals- Historical Context: Millennium Development Goals (MDGs)- The Global Agenda for Sustainable Development, Interconnectedness of the 17 SDGs- Role of Governments, Organizations, and Individuals in Achieving SDGs	**12**
UNIT-II	**Goal 1 - No Poverty Goal 5 - Gender Equality** Understanding Poverty and Its Dimensions- Targets and Indicators for Goal 1- Strategies for Poverty Alleviation- Case Studies of Successful Poverty Reduction Programs- Addressing Inequality and Economic Disparities- The Importance of Gender Equality in Sustainable Development- Gender Disparities in Education, Workforce, and Leadership- Targets and Indicators for Goal 5- Women's Empowerment and Gender Mainstreaming- Intersectionality and Inclusivity in Gender Equality Efforts	**12**
UNIT-III	**Sustainable Cities and Communities** Challenges of Urbanization- Targets and Indicators for Goal 11- Urban Planning and Sustainable Infrastructure- Smart Cities and Innovation for Sustainable Urban Development- Promoting Inclusive, Safe, and Resilient Cities	**12**
UNIT-IV	**Goal 13 - Climate Action** Climate Change and Its Impact on Sustainable Development- Targets and Indicators for Goal 13- Mitigation and Adaptation Strategies- International Agreements and Climate Policies- Renewable Energy and Sustainable Practices	**12**
UNIT-V	**Goal 16 - Peace, Justice, and Strong Institutions** The Relationship Between Peace and Sustainable Development- Targets and Indicators for Goal 16- Access to Justice and Rule of Law- Promoting Inclusive and Accountable Institutions- Conflict Prevention and Resolution	**12**
	Total Contact Hours: 60	

	Course Name	L	T	P	C
Elective 2	Sustainable Real Estate Investment	4	0	0	4

Course Description:

Green building certification systems
Real estate sustainability metrics
Case studies in green real estate investment

UNIT-I	**Introduction to Sustainable Real Estate Investment** Fundamentals of real estate investment-The role of sustainability in real estate-Sustainable development and urban planning-Key concepts of sustainable real estate-Ethical considerations in real estate investment	**12**
UNIT-II	**Sustainable Real Estate Valuation** Valuation methods for sustainable properties-Green building certifications and their impact on value-Market trends and demand for sustainable real estate-Life cycle cost analysis for green properties-Case studies in sustainable real estate valuation	**12**
UNIT-III	**Sustainable Real Estate Financing** Financing sustainable real estate projects-Green mortgages and loans-Public and private sector involvement in green financing-Risk assessment in sustainable real estate finance-Innovative financing models for sustainable projects	**12**
UNIT-IV	**Sustainable Property Development and Management** Sustainable design and construction principles-Green building technologies and materials-Property management for sustainability-Energy efficiency and renewable energy in real estate-Green lease agreements and tenant engagement	**12**
UNIT-V	**Real Estate Investment Strategy**Developing a sustainable real estate investment strategy-ESG (Environmental, Social, and Governance) factors in real estate-Regulatory frameworks and reporting requirements-Sustainable real estate investment in global markets-Case studies of successful sustainable real estate investments	**12**
	Total Contact Hours: 60	

Year 2 – Semester 3

	Course Name	L	T	P	C
Core 9	**Green Investment Evaluation and Due Diligence**	**4**	**0**	**0**	**4**

Course Description:
Investment appraisal methods for green projects
Due diligence in climate finance
Legal and ethical considerations in green investments

UNIT-I	**Introduction to Green Investment Evaluation** Fundamentals of investment evaluation-Role of green investments in sustainability-Key concepts of green investment evaluation-Triple bottom line approach (People, Planet, Profit)-Ethical considerations in green investments	**12**
UNIT-II	**Financial Analysis for Green Investments** Financial modeling for green projects-Risk and return analysis in green investments-Cost-benefit analysis with environmental and social factors-Discounted cash flow analysis for sustainability projects-Case studies in financial analysis for green investments	**12**
UNIT-III	**Environmental and Social Due Diligence** Environmental impact assessment for investments-Social impact assessment and community engagement-Regulatory compliance and environmental permits-Supply chain sustainability assessment-Environmental and social risk management	**12**
UNIT-IV	**Sustainable Investment Appraisal** Sustainable investment criteria and metrics-ESG (Environmental, Social, and Governance) factors in investment appraisal-Measuring and quantifying sustainability performance-Sustainability reporting and disclosure-Integrated sustainability reporting in investment appraisal	**12**
UNIT-V	**Investment Decision-Making and Governance** Developing green investment strategies-Investment committee decision processes-Ethical investment governance and compliance-Sustainability reporting and disclosure requirements-Case studies of successful green investment evaluation and due diligence	**12**
	Total Contact Hours: 60	

	Course Name	L	T	P	C
Core 10	Climate Finance and Development	4	0	0	4

Course Description:
Climate finance for developing countries
Multilateral development banks and climate funding
Role of public-private partnerships

UNIT-I	**Introduction to Climate Finance and Development** Fundamentals of climate finance-The link between climate finance and sustainable development-Key concepts of climate finance and development-Climate finance in the context of global climate goals-Ethical considerations in climate finance and development	**12**
UNIT-II	**Climate Finance Mechanisms** Climate finance sources and channels-Public and private sector engagement in climate finance-Climate investment funds and financial instruments-Green bonds and climate investment mechanisms-Case studies of successful climate finance mechanisms	**12**
UNIT-III	**Climate Finance for Adaptation and Resilience** Financing climate adaptation projects-Vulnerability and risk assessment for climate adaptation-Building resilience in communities and infrastructure-Climate insurance and disaster risk financing-Climate finance for water resource management	**12**
UNIT-IV	**Climate Finance for Mitigation and Clean Energy** Financing climate mitigation initiatives-Renewable energy project finance-Carbon markets and emissions reduction financing-Sustainable transportation financing-Innovations in climate finance for clean energy	**12**
UNIT-V	**Climate Finance and Global Development Goals** Climate finance in the context of the Sustainable Development Goals (SDGs)-International cooperation and climate finance governance-Monitoring and evaluation of climate finance impacts-Ethical investment and development principles-Case studies of climate finance projects contributing to global development goals	**12**
		Total Contact Hours: 60

	Course Name	L	T	P	C
Core 11	**Carbon Pricing, Trading, and Markets**	4	0	0	4

Course Description:

Fundamentals of Carbon Pricing, Market Failures, Externalities
Carbon Taxes, Carbon Markets
International Carbon Markets and Future of Carbon Pricing

UNIT-I	**Introduction to Carbon Pricing and Markets** Fundamentals of carbon pricing mechanisms-The role of carbon markets in addressing climate change-Key concepts of carbon pricing, cap-and-trade, and carbon taxes-Ethical considerations in carbon pricing and trading-Historical overview of carbon markets	**12**
UNIT-II	**Cap-and-Trade Systems** Design and implementation of cap-and-trade systems-Allocation of emission allowances-Compliance and enforcement mechanisms-Linkages between regional and international carbon markets-Case studies of successful cap-and-trade programs	**12**
UNIT-III	**Carbon Taxes and Fee Systems** Carbon tax policy design and implementation-Carbon tax revenue allocation strategies-Impacts of carbon taxes on different sectors-Carbon tax exemptions and incentives-Comparative analysis of carbon taxes and cap-and-trade	**12**
UNIT-IV	**Carbon Market Instruments and Trading Strategies** Financial instruments for carbon trading-Carbon market intermediaries and brokers-Carbon offset projects and trading strategies-Risk management in carbon trading-Innovations in carbon market instruments	**12**
UNIT-V	**Carbon Pricing and Climate Finance** Carbon pricing as a source of climate finance-Climate finance mechanisms and funding- International cooperation in carbon pricing-Carbon pricing and sustainable development goals (SDGs)-Case studies of carbon pricing contributing to climate finance	**12**
	Total Contact Hours: 60	

	Course Name	L	T	P	C
Core 12	**Green Marketing**	4	0	0	4

Course Description:

Since consumption is a driver for environmental impact this course provides the knowledge on the sustainable marketing for better sustainable consumerism.

The course will focus on sustainable consumption behavior and policies

UNIT-I	**Introduction to Green Marketing** Understanding Green Marketing Concepts- Historical Development of Green Marketing- The Importance of Sustainability in Marketing- Key Terms and Definitions in Green Marketing- Ethical Considerations in Marketing Practices	**12**
UNIT-II	**Consumer Behavior and Sustainability** Analyzing Consumer Attitudes Towards Sustainability- Factors Influencing Green Consumer Behavior- Green Consumer Segmentation- The Psychology of Sustainable Consumption- Case Studies of Successful Green Marketing Campaigns	**12**
UNIT-III	**Sustainable Product Development** Designing Environmentally Friendly Products- Eco-friendly Packaging and Materials- Life Cycle Assessment (LCA)- Product Labeling and Eco-Certifications- Innovations in Sustainable Product Development	**12**
UNIT-IV	**Green Marketing Strategies** Market Positioning for Sustainability- Green Branding and Image- Pricing Strategies for Sustainable Products- Distribution and Green Supply Chains- Communication and Promotion of Green Products	**12**
UNIT-V	**Regulatory and Ethical Aspects of Green Marketing** International and National Green Marketing Regulations- Greenwashing and Ethical Concerns- Consumer Education and Transparency- Monitoring and Reporting Sustainability Efforts- Corporate Social Responsibility (CSR) in Green Marketing	**12**
	Total Contact Hours: 60	

	Course Name	L	T	P	C
Elective 3	**Climate Data Analytics**	**5**	**0**	**0**	**5**

Course Description:

Data collection and analysis for climate finance

Machine learning for climate modeling

Data-driven decision-making for sustainability

UNIT-I	**Introduction to Climate Data Analytics** Fundamentals of climate data analytics-The importance of data in climate science-Key concepts in data collection and analysis-Climate data sources and repositories-Ethical considerations in climate data analytics	**12**
UNIT-II	**Climate Data Visualization and Interpretation** Data visualization techniques for climate data-Interpreting climate data patterns and trends-Geographic information systems (GIS) in climate analysis-Communicating climate data insights effectively-Case studies of climate data visualization	**12**
UNIT-III	**Statistical Analysis of Climate Data** Descriptive and inferential statistics for climate data-Time series analysis in climate research-Spatial analysis and mapping of climate variables-Uncertainty and error analysis in climate data-Practical applications of statistical techniques	**12**
UNIT-IV	**Machine Learning and Climate Modelling** Machine learning algorithms for climate data-Predictive modelling in climate science-Climate modelling and simulations-Data-driven climate projections-Challenges and opportunities in machine learning for climate research	**12**
UNIT-V	**Climate Data Analytics in Policy and Decision-Making** Climate data analytics in policy development-Climate risk assessment and management using data-Climate data for sustainable development goals (SDGs)-Data-driven climate adaptation and mitigation strategies-Real-world applications of climate data analytics	**12**
	Total Contact Hours: 60	

Year 2 – Semester 4

		L	T	P	C
Capstone Project in Climate Finance and Green Investments		**0**	**0**	**20**	**10**

Course Description:

Independent research or practical project in a chosen area of climate finance and green investments

Thesis presentation and defense

SUGGESTED PEDAGOGICAL METHODS

The program will use a variety of pedagogical methods to deliver instruction and develop students' skills and knowledge in the field.

Lectures: Traditional classroom lectures are often used to deliver foundational knowledge and concepts in various subjects.

Case Studies: Case studies, which present real-world problems for students to analyze and solve. These encourage critical thinking and decision-making.

Group Discussions: Group discussions and debates foster collaboration, communication, and the sharing of diverse perspectives on topics.

Seminars and Workshops: These interactive sessions allow students to delve deeper into specific topics, often with guest speakers or industry experts.

Experiential Learning: Hands-on experiences, such as internships, consulting projects, and simulations, provide students with practical exposure to real challenges.

Team Projects: Collaborative projects require students to work together on plans, market analyses, and other tasks, simulating real-world teamwork scenarios.

Problem-Based Learning (PBL): PBL involves presenting students with open-ended problems and guiding them through the process of research and problem-solving.

Role-Playing: Role-playing exercises help students practice their negotiation, leadership, and communication skills in various scenarios.

Guest Lectures: Inviting industry professionals and experts to deliver guest lectures can provide students with insights into current practices and trends.

Online Learning: We will incorporate online courses and resources to accommodate distance learners and provide flexibility.

Simulations: Simulations are computer-based exercises that mimic real situations, allowing students to make decisions and see the outcomes.

Case Competitions: These competitive events challenge students to analyze and present solutions to real problems in front of judges or industry professionals.

Field Trips: Visiting the industries in person can help students gain a better understanding of specific sectors and organizational practices.

Research Projects: Research-oriented courses or projects encourage students to investigate and analyze -related topics in-depth.

Networking Events: Organize networking events, where students can connect with alumni, professionals, and potential employers.

Guest Panel Discussions: Panels of industry experts discuss current issues and trends, providing students with valuable insights and perspectives.

Cross-Functional Learning: Encouraging students to take courses outside their core area of study promotes a holistic understanding of .

Self-Study and Reading Assignments: Independent research and reading assignments help students deepen their knowledge in specific areas of interest.

Peer Teaching: Students may be asked to teach certain topics to their peers, which reinforces their understanding and communication skills.

Suggested Evaluation Methods:

Coursework and assignments

Continuous Assessment: Assessment methods like quizzes, assignments, and class participation are used to gauge students' progress and understanding throughout the program.

Examinations

Research papers and reports

Capstone project and presentation

References

1."Climate Finance: Theory and Practice" by Richard J. Tinsley and Heike Schroeder, World Scientific, 2017 Ed.
This book provides a comprehensive overview of climate finance, including its theories, policies, and practical applications. It covers both public and private sector perspectives.

2. "Sustainable Energy: Choosing Among Options" by Jefferson W. Tester, Elisabeth M. Drake, Michael J. Driscoll, and Michael W. Golay, MIT Press, 2012
Understanding sustainable energy is essential for anyone in climate finance. This book explores various sustainable energy options, their economics, and environmental impacts.

3."Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage" by Daniel C. Esty and Andrew S. Winston, Wiley, 2009
This book focuses on the business side of green investments, demonstrating how companies can leverage sustainability for competitive advantage. It offers practical insights and case studies.

4."Climate Change Economics and Policy: An RFF Anthology" edited by Michael A. Toman, Routledge, 2001
A collection of essays and research articles, this book delves into the economic aspects of climate change and the policies required to address it.

5."Sustainable Investing: The Art of Long-Term Performance" by Cary Krosinsky and Nick Robins. Routledge, 2008
This book explores the principles of sustainable and responsible investing (SRI). It covers strategies, performance measurement, and case studies of successful SRI portfolios.

6."The Green Investment Handbook: A Guide to Investment Opportunities and the Green Economy" by Nick Hanna, Harriman House Publishing, 2010
A practical guide for those interested in green investments, this book provides insights into various green sectors, investment opportunities, and risk assessment.

7."Environmental Economics: An Introduction" by Barry C. Field and Martha K. Field, The Mcgraw-hill, 2012
A fundamental book for understanding environmental economics, it covers concepts like externalities, market failures, and policy instruments used in environmental management.

8."Renewable Energy Finance: Powering the Future" by Charles W. Donovan, World Scientific Publishing, 2015
Focusing on the financing of renewable energy projects, this book covers investment structures, risk management, and financial modeling.

9."Sustainable Finance: The Road to a Sustainable Economy" by World Wildlife Fund (WWF),2011
This publication from WWF offers an overview of sustainable finance practices and highlights the role of financial institutions in addressing environmental challenges.

10."Climate Finance: Regulatory and Funding Strategies for Climate Change and Global Economic Stability" by Warren D. Seider, J. Doyne Farmer, and Michael C. Thompson, New York University Press, 2009

Program Justification

The curriculum and syllabus for an M.Tech program in Climate Finance and Green Investments are justified in conformance to the UN SDG'S.

SDG13	**Take urgent action to combat climate change and its impacts**	Addressing Urgent Global Challenges	Climate change is one of the most pressing global challenges of our time. The curriculum focuses on climate finance and green investments, which are essential components of mitigating climate change and transitioning to a sustainable future.
SDG8	**Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all**	Industry Demand	There is a growing demand for professionals who can navigate the financial aspects of climate change and sustainability. Graduates are well-positioned to work in roles related to sustainable finance, green investment analysis, and environmental risk assessment.

SDG7	**Ensure access to affordable, reliable, sustainable and modern energy for all**	Sustainable Investment Strategies	The program explores various sustainable investment strategies, including ESG (Environmental, Social, and Governance) investing, impact investing, and green bonds. Renewable Energy and Clean Technologies: Students gain an understanding of renewable energy projects, clean technologies, and other green investment opportunities, preparing them for roles in the rapidly growing clean energy sector.
SDG17	**Strengthen the means of implementation and revitalize the global partnership for sustainable development**	Climate Finance Innovation	The program fosters an innovative mindset, encouraging graduates to explore emerging trends and innovations in climate finance and green investments.

PG DIPLOMA IN
TRADITIONAL ARCHITECTURE AND DIGITAL RE-CREATION

(Diploma – 1 year)

Total Credits 40

Eligibility – B.Arch., BE – Civil, CS, ME, BA-History, Literature, Bsc, -Statistics, Geography, Geology, archeology

In an era where technology continually reshapes our built environment, the course "Traditional Architecture and Digital Re-creation" immerses students in the captivating journey of architectural exploration, travel, photography, and digital re-creation. This course celebrates the fusion of traditional architectural wisdom with cutting-edge digital tools. It's carefully crafted to offer students a profound grasp of traditional architectural principles while honing their skills in travel, photography, architectural documentation, and the art of digital re-creation using the photogrammetry technique. This unique blend empowers students to embark on journeys, capture architectural marvels through the lens, and not only document but also digitally re-create these treasures, ensuring their preservation and accessibility in the digital realm. Byproduct, students gain the ability to develop intricate background environments for video games, further extending the reach and impact of architectural heritage in the digital age. It's a course that harmoniously marries the art of travel, the craft of photography, the precision of architectural documentation, and the creativity of digital re-creation, ensuring that the architectural heritage of the past continues to inspire and inform our digital future, while enhancing the world of gaming aesthetics and storytelling.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

- *To empower technical professionals with a deep appreciation for the historical, cultural, and artistic dimensions of traditional architecture, facilitating them to bridge the past and present.*
- To equip students with a holistic understanding of the socio-economic, cultural, and historical factors that have shaped architectural traditions across different regions and times.
- To cultivate in students the ability to employ quantitative and qualitative research methods to analyze and interpret traditional architectural forms and styles.
- To nurture students into effective stakeholders and leaders in the domain of architectural preservation and recreation, providing them with state-of-the-art knowledge in both traditional architectural techniques and digital recreation technologies.

- To enable students to actively contribute to policy and decision-making processes related to architectural heritage and conservation.
- To equip students with recent trends and tools in heritage documentation

PROGRAMME OUTCOMES (POs):

Upon successful completion of the program, students will:

- Contribute to the preservation of architectural heritage by applying their knowledge and skills in architectural planning, recreation, and preservation.
- Demonstrate a comprehensive understanding of the socio-economic, cultural, and historical aspects of traditional architecture and propose appropriate solutions for contemporary architectural challenges.
- Exhibit critical thinking and logical reasoning skills in addressing emerging issues in architecture, offering holistic solutions that respect both tradition and innovation.
- Possess proficiency in utilizing industry-relevant tools and technologies, including digital recreation techniques, to recreate and analyze traditional architectural designs.
- Engage effectively with society, architectural organizations, and heritage conservation agencies to address architectural and cultural concerns, promoting the appreciation and protection of traditional architectural treasures.

Semester 1

	Title	L	T	P	C
PCC	Introduction to Traditional Indian Architecture	3	0	0	3
PCC	Traditional knowledge systems and Intangible heritage	3	0	0	3
PCC	Materials and Techniques for scientific preservation	3	0	0	3
PEC	Professional elective -1	3	0	0	3
PAEC	Laser Scanning / photogrammetry and 3D Modelling	2	0	4	4
PAEC	Traditional Indian Architectural Design Studio.	0	0	8	4
				Credits	**20**

Semester 2

	Title	L	T	P	C
PCC	Sustainable Design and Traditional Practices	3	0	0	3
PCC	Urban Planning and Traditional Indian Cities	3	0	0	3
PEC	Professional elective – 2	3	0	0	3
PEC	Professional elective -3	3	0	0	3
PAEC	Augmented Reality (AR) and Virtual Reality (VR) in Heritage Documentation	2	0	4	4
PAEC	Architectural Research and Thesis.	0	0	8	4
				Credits	**20**

	List of electives - 1	L	T	P	C
1.	Architectural Styles and Regional Variations	3	0	0	3
2.	Digital Tools for Architectural Preservation and Documentation	3	0	0	3
3.	Traditional Indian Landscape Design	3	0	0	3
4.	Geospatial Technologies for Heritage Mapping	3	0	0	3
	List of Elective - 2				
5.	Vernacular Architecture and Sustainability	3	0	0	3
6	Heritage Tourism and Interpretation	3	0	0	3
7	Architectural Photography and Documentation	3	0	0	3
8	Comparative Study of World Architectural Traditions	3	0	0	3

	List of Electives - 3				
9	History of Indian Art and Iconography	3	0	0	3
10	Temple architecture and ancient treatises	3	0	0	3
11	Indian philosophy and traditional design	3	0	0	3
12	Conservation and Heritage Management	3	0	0	3

PEDAGOGICAL APPROACH

The pedagogical approach for the course "Traditional Indian Architecture and Digital recreation" centers on a holistic and immersive learning experience. This course integrates various disciplines, including architecture, history, archaeology, art, and engineering, fostering a multidisciplinary perspective. Blended learning combines traditional classroom lectures with practical experiences, site visits, and digital resources. Case studies of iconic heritage sites illustrate key concepts, allowing students to analyze and propose preservation strategies. Studio-based learning encourages creative and critical thinking through design projects.

Research and thesis work develop independent research skills, while workshops provide hands-on training in traditional building techniques and digital tools.

Collaborative group projects simulate real-world scenarios, enhancing teamwork and communication. Site visits and fieldwork offer practical exposure to heritage structures and conservation efforts. Assessments include diverse methods like exams, presentations, portfolios, research papers, and oral examinations. Ethical and cultural sensitivity are emphasized throughout the course.

Continuous feedback and reflection promote self-improvement. Guest experts and practitioners share valuable insights. Capstone projects require students to tackle real-world conservation challenges. Modern technologies, such as GIS, BIM, and VR/AR, are integrated for heritage documentation, preservation, and presentation.

This pedagogical approach prepares students for careers in heritage preservation, architectural design, research, and academia. It fosters a deep appreciation for India's architectural heritage while equipping students with the skills and ethical principles needed to navigate the complex field of heritage conservation.

SEMESTER 1

Introduction to Traditional Indian Architecture

OBJECTIVES

- To provide an in-depth understanding of the concept of traditional Indian architecture, its historical significance, and its role in shaping cultural identities.
- To explore the various challenges and opportunities associated with the preservation and study of traditional Indian architectural heritage.
- To introduce students to the fundamental principles, elements, and characteristics of traditional Indian architectural styles.
- To foster an appreciation for the cultural and historical contexts that influenced traditional Indian architecture.

Unit 1: Introduction to Traditional Indian Architecture

Foundational overview of traditional Indian architecture, covering its historical evolution, cultural significance, and key elements. Broad scope of Indian architectural styles and the architectural diversity across regions and time periods.

Unit 2: Architectural Elements and Principles

Fundamental elements and principles of traditional Indian architecture. Architectural vocabulary, principles of form and proportion, and the role of symbolism and iconography in architectural design. Understanding the core elements that define traditional Indian architecture.

Unit 3: Regional Variations and Styles

Tapestry of regional architectural styles found in India. Distinct characteristics, materials, and construction techniques associated with various regions, such as North India, South India, and the various dynastic periods. Influence of geography, climate, culture, and historical context on architectural variations.

Unit 4: Temples, Palaces, and Forts

Architectural typologies that have significantly shaped India's architectural heritage. Design and construction of temples, palaces, and forts, understanding cultural, religious, and functional significance. Intricate ornamentation and layout principles unique to these structures.

Unit 5: Preservation and Contemporary Relevance

Challenges and strategies associated with the preservation and contemporary relevance of traditional Indian architecture. Conservation techniques, adaptive reuse of heritage structures, and the role of traditional architecture in sustainable design practices. Importance of preserving India's architectural legacy while integrating it into modern architectural discourse

Traditional Knowledge Systems and intangible heritage

OBJECTIVES

- To acquaint students with the traditional knowledge systems that have informed and guided Indian architectural practices throughout history.
- To explore the philosophical, cultural, and scientific foundations of traditional Indian architectural wisdom.
- To draw attention to the value of traditional knowledge in sustainable architectural design and preservation.

Unit 1: Understanding Traditional Knowledge Systems

Explore the concept of traditional knowledge systems, including indigenous wisdom, oral traditions, and cultural practices.

Study the role of traditional knowledge in shaping communities and preserving intangible heritage.

Unit 2: Documentation and Preservation of Oral Traditions

Examine methods and techniques for documenting and preserving oral traditions, including storytelling, folk songs, and rituals.

Learn about the challenges and ethical considerations in collecting and archiving intangible heritage.

Unit 3: Traditional Healing Practices and Herbal Medicine

Investigate traditional healing practices, herbal medicine systems, and the transmission of medicinal knowledge through generations.

Explore the cultural significance of traditional healing and its contemporary relevance.

Unit 4: Rituals, Festivals, and Performing Arts

Study the role of rituals, festivals, and performing arts in preserving intangible heritage.

Analyze the significance of dance, music, and ceremonies in cultural continuity.

Unit 5: Contemporary Applications and Safeguarding

Explore how traditional knowledge systems and intangible heritage can be integrated into contemporary contexts.

Discuss safeguarding measures, including UNESCO's Intangible Cultural Heritage Convention, and ethical considerations in preserving living traditions.

Materials and Techniques for scientific preservation

OBJECTIVES

- To familiarize students with the various materials and techniques used in the scientific preservation of traditional Indian architecture.
- To provide hands-on experience in the application of preservation methods, including restoration and conservation.
- To emphasize the importance of using sustainable and culturally sensitive approaches in architectural preservation.

Materials and Techniques for scientific preservation

Unit 1: Introduction to Preservation Materials and Techniques

Introduction to the fundamental concepts of scientific preservation. It covers the principles of preservation, the importance of materials selection, and an overview of various preservation techniques. Interdisciplinary nature of preservation and its role in cultural heritage conservation.

Unit 2: Materials Science and Properties

Materials science as it applies to preservation. Properties of different materials, including metals, stones, ceramics, and organic materials, with a focus on degradation mechanisms. Importance of materials analysis and testing in preservation decision-making.

Unit 3: Preservation Techniques and Restoration Methods

Preservation techniques and restoration methods used in the conservation of cultural heritage. Cleaning, consolidation, repair, and structural reinforcement. How to assess and address deterioration in heritage materials.

Unit 4: Sustainable Preservation Practices

Sustainable preservation practices. Environmentally friendly approaches to conservation, including the use of eco-friendly materials, energy-efficient restoration methods, and strategies for reducing the carbon footprint of preservation projects. Importance of balancing preservation with sustainability.

Unit 5: Case Studies and Preservation Project Management

Analysis of real-world preservation case studies and the management of preservation projects. Successful preservation projects, challenges faced, and the decision-making processes involved. Project planning, budgeting, and stakeholder collaboration in the context of scientific preservation.

Laser Scanning / photogrammetry and 3D Modeling (Theory cum Studio)

OBJECTIVES

- To equip students with the skills and knowledge to perform laser scanning, photogrammetry, and 3D modeling for architectural documentation and reconstruction.
- To emphasize the precision and accuracy required in capturing architectural details and dimensions.
- To demonstrate how 3D modeling can aid in the digital recreation and virtual exploration of traditional architectural wonders.

Design Studio (Studio)

OBJECTIVES

- To provide students with a practical platform for applying their knowledge of traditional Indian architectural principles in design projects.
- To encourage creativity and innovation in architectural design while respecting traditional aesthetics and principles.
- To enable students to develop architectural solutions that blend traditional wisdom with contemporary needs and sustainability considerations.

PROFESSIONAL ELECTIVES-1

Architectural Styles and Regional Variations

This subject provides a comprehensive exploration of architectural styles and the impact of regional variations on built environments. Beginning with an overview of architectural styles spanning classical to contemporary, students delve into the evolution of these styles over time. The course then shifts focus to regional architectural variations, driven by geography, climate, culture, and historical influences. Through case studies and site visits, students gain insights into iconic architectural examples that reflect regional identities. Cultural sensitivity and contextual design principles are emphasized, fostering the ability to bridge tradition and innovation. By course completion, students possess a global perspective on architectural diversity, enabling them to appreciate, evaluate, and apply architectural styles and regional variations in their design work, enhancing their architectural sensibilities and contextual awareness.

Digital Tools for Architectural Preservation and Documentation

This subject immerses students in the world of cutting-edge digital technologies essential for the preservation and documentation of architectural heritage. It begins by introducing students to a spectrum of digital tools, from 3D scanning and

photogrammetry to Building Information Modeling (BIM) and Geographic Information Systems (GIS).

Throughout the course, students will engage in hands-on exercises and practical workshops, gaining proficiency in using these tools for precise architectural documentation. They will learn to capture intricate details of heritage structures, produce accurate digital models, and analyze spatial data critical for conservation efforts.

Case studies and real-world applications will demonstrate the relevance and impact of digital tools in architectural preservation. Ethical considerations, such as preserving the authenticity of cultural heritage during digital documentation, will also be discussed.

By the course's conclusion, students will emerge as skilled practitioners capable of harnessing digital tools to contribute to the preservation and documentation of architectural heritage with accuracy, efficiency, and cultural sensitivity.

Traditional Indian Landscape Design

This subject offers a deep dive into the intricacies of landscape design rooted in India's rich cultural and environmental heritage. It begins by exploring the historical significance of traditional Indian landscapes, encompassing elements like Mughal gardens, temple courtyards, and vernacular landscapes.

Students will delve into the principles and philosophies that underpin traditional Indian landscape design, including concepts of Vastu, sacred geometry, and the harmonious integration of nature. Through case studies and site visits, they will gain insights into the role of water features, vegetation, and topography in shaping these landscapes.

The subject also addresses contemporary applications of traditional Indian landscape design, emphasizing sustainability, climate responsiveness, and the adaptation of ancient wisdom to modern contexts. By the course's conclusion, students will emerge with a profound appreciation for traditional Indian landscape design principles and the ability to apply them in contemporary environmental design and preservation efforts.

Geospatial Technologies for Heritage Mapping

This subject delves into the core aspects of geospatial technologies critical for accurate data collection and heritage mapping. Beginning with an introduction to Geographic Information Systems (GIS), students will learn to harness these tools for precise heritage documentation.

A significant portion of the course is dedicated to hands-on training in data collection techniques. Students will explore field data capture methods using GPS technology, terrestrial laser scanning, and remote sensing. They'll master the art of collecting spatial information, ensuring data accuracy and reliability.

The subject also delves into advanced mapping techniques, covering topics such as spatial analysis, 3D modeling, and spatial databases. Through practical exercises and case studies, students will gain a deep understanding of how geospatial technologies facilitate the creation of detailed heritage maps, aiding in preservation, management, and historical analysis. By course completion, students will emerge as proficient practitioners in data collection and mapping, prepared to contribute effectively to heritage preservation through precise spatial documentation.

SEMESTER 2

Sustainable Design and Traditional Practices

OBJECTIVES:

- To explore the principles of sustainable design and how traditional practices can inform and contribute to sustainable architectural solutions.
- To provide students with a deep understanding of eco-friendly materials, construction techniques, and energy-efficient design strategies rooted in traditional wisdom.
  To encourage students to develop innovative and environmentally responsible architectural designs that integrate traditional practices and contemporary sustainability standards.

Unit 1: Introduction to Sustainable Design and Traditional Practices

Principles of sustainable design and traditional practices. Historical context of sustainable design and the foundational principles that underpin it. Importance of integrating traditional knowledge and practices into contemporary sustainable design approaches.

Unit 2: Traditional Building Techniques and Materials

Traditional building techniques and materials used in different cultures and regions. Construction methods, indigenous materials, and vernacular architecture that have proven to be sustainable over generations. Significance of locally sourced and eco-friendly building materials.

Unit 3: Cultural and Social Aspects of Sustainable Design

Cultural and social dimensions of sustainable design. Traditional practices that are deeply rooted in cultural values, social customs, and community engagement. Role of culture in shaping sustainable design decisions and fostering a sense of identity and belonging.

Unit 4: Sustainability in Landscape and Urban Design

Sustainability in the context of landscape and urban design. Traditional landscape design principles, including water management, green spaces, and biodiversity conservation. Integration of traditional urban planning strategies for sustainable, walkable cities.

Unit 5: Contemporary Applications of Traditional Practices

Contemporary applications of traditional practices in sustainable design. Case studies and modern architectural projects that successfully incorporate traditional wisdom into sustainable design solutions. Implementation of traditional practices in current architectural and environmental challenges.

Urban Planning and Traditional Indian Cities

OBJECTIVES:

- To examine the historical urban planning principles and layouts of traditional Indian cities and their relevance in contemporary urban development.
- To analyze the sustainability and functionality of traditional urban planning concepts and their potential application in modern city planning.
- To equip students with the knowledge and skills to adapt and integrate traditional urban planning elements into contemporary urban design projects.

Unit 1: Historical Urban Planning

Explore the historical development of traditional Indian cities, tracing the evolution from ancient settlements to medieval and colonial urban centers. Analyze the layout, design principles, and socio-cultural aspects that shaped these cities.

Unit 2: Principles of Vastu Purusha Mandala

Study the concept of Vastu Purusha Mandala and its significance in traditional Indian urban planning. Understand the grid-based layout, placement of structures, and the symbolic representation of deities.

Unit 3: Traditional Elements in Urban Design

Examine the architectural and design elements unique to traditional Indian cities, including gateways, marketplaces, stepwells, and communal spaces. Explore their cultural and functional roles.

Unit 4: Challenges in Modern Urbanization

Discuss the challenges traditional Indian cities face in the modern era, including rapid urbanization, infrastructure development, and preservation of heritage. Evaluate strategies for sustainable urban growth.

Unit 5: Contemporary Revival and Preservation

Analyze efforts to revive traditional urban planning principles in modern Indian cities. Explore case studies of successful preservation and revitalization projects, emphasizing the importance of cultural heritage in urban environments.

Professional Elective-2

Vernacular Architecture and Sustainability

This course explores the profound interplay between traditional building practices and sustainability. It begins with an immersion into vernacular architecture, unveiling its rich historical tapestry and diverse regional expressions. The core theme is sustainability, emphasizing principles like local material use, passive design strategies, and climate-responsive solutions. Traditional building materials and techniques, such as mud, bamboo, and adobe, take center stage, exemplifying sustainable practices. Contemporary applications demonstrate the adaptability of vernacular wisdom in modern architecture. Alongside, challenges to preserving vernacular heritage in the face of modernization are discussed, with an emphasis on cultural and social considerations. This course inspires a profound appreciation for the wisdom embedded in vernacular architecture, instilling the capability to integrate it into environmentally responsible and culturally sensitive architectural practices while envisioning sustainable futures for our built environment.

Heritage Tourism and Interpretation

This subject delves into the dynamic intersection of heritage and tourism, providing students with a comprehensive understanding of how cultural and historical sites are interpreted and experienced by visitors. It commences by exploring the significance of heritage tourism and its economic, social, and cultural impacts. Students will learn strategies for effective heritage interpretation, including storytelling, visitor engagement, and the use of multimedia tools. Case studies and site visits will illustrate real-world examples of successful heritage tourism initiatives. Ethical considerations, such as sustainable tourism practices and the preservation of cultural authenticity, will also be addressed. By the end of this course, students will be equipped with the knowledge and skills to contribute to the development and management of heritage tourism destinations while ensuring the responsible interpretation and conservation of cultural heritage.

Architectural Photography and Documentation

This course immerses students in the art and science of capturing architectural beauty and detail through the lens. It begins with an exploration of the fundamentals of photography, including composition, lighting, and camera techniques. As the course

progresses, the focus shifts towards architectural photography's unique challenges and opportunities, emphasizing the importance of perspective, scale, and spatial awareness.

The subject also delves into the significance of architectural documentation for preservation and research purposes, equipping students with skills in measuring, sketching, and recording architectural details. Practical workshops and fieldwork sessions allow students to apply their knowledge in real-world settings, sharpening their ability to visually document buildings, interiors, and urban spaces.

By the end of this course, students will possess the expertise to capture the essence of architectural marvels and contribute to the preservation and analysis of architectural heritage through meticulous photography and documentation.

Comparative Study of World Architectural Traditions

This course invites students on a captivating journey across continents and through centuries to explore the rich tapestry of architectural traditions that have shaped our global built environment. It begins by unraveling the diverse architectural styles, historical contexts, and cultural influences that define iconic architectural traditions from around the world.

Students will delve into the intricate details of various traditions, examining the construction methods, materials, and design philosophies unique to each culture. Comparative analyses will unravel the connections, shared principles, and distinctions among these traditions, fostering a deeper understanding of the global architectural mosaic.

Throughout the course, case studies and site visits will offer tangible insights into real-world architectural wonders. By the course's conclusion, students will possess a global perspective on architectural heritage, allowing them to draw inspiration, insights, and cross-cultural lessons for contemporary design and preservation practices.

Professional Elective-3

History of Indian Art and Iconography

This subject is a captivating exploration of India's rich artistic heritage and the intricate symbolism embedded in its artistic expressions. It embarks on a chronological journey through the annals of Indian art, beginning with ancient Indus Valley civilization and culminating in contemporary art forms.

Students will delve into the diverse art styles, mediums, and techniques that have evolved over millennia, reflecting India's cultural, religious, and social dynamism. Iconography, a central aspect of Indian art, will be a focal point, unraveling the symbolism and meanings behind gods, goddesses, and mythological motifs.

The subject also examines the profound influence of Indian art on architecture, sculpture, painting, and contemporary visual culture. Through case studies and visual

analyses, students will gain insights into the broader historical, cultural, and religious contexts that have shaped India's artistic narrative, enabling them to appreciate, interpret, and preserve this invaluable heritage.

Temple Architecture and Ancient Treatises

This subject is an immersive journey into the sacred realm of temple architecture in India, where spirituality, artistry, and science converge. It begins by unraveling the profound significance of temples in Indian culture and spirituality, highlighting their role as centers of devotion and artistic expression.

Students will delve into the architectural marvels of Indian temples, exploring diverse styles, intricate ornamentation, and symbolic elements. A significant focus is placed on the study of ancient architectural treatises like the Vastu Shastra and Shilpa Shastra, which serve as guiding scriptures for temple construction.

Through case studies and site visits to renowned temples, students will gain hands-on insights into temple design principles, spatial arrangements, and the synthesis of art and religion. By the end of this course, students will possess a deep understanding of the architectural and spiritual dimensions of Indian temple art, enabling them to appreciate, analyze, and contribute to the preservation of these sacred structures.

Indian Philosophy and Traditional Design

This subject serves as a bridge between the philosophical wisdom of India and its profound influence on traditional design principles. It commences by delving into the philosophical foundations of Indian thought, encompassing concepts like dharma, karma, and moksha, which have significantly shaped Indian culture and aesthetics.

Students will explore how these philosophical underpinnings manifest in traditional design, whether in architecture, art, or other creative expressions. The subject examines the intricate relationship between Indian philosophy and design, emphasizing concepts like sacred geometry, symbolism, and the representation of cosmic order.

Through in-depth analyses of historical and contemporary examples, students will gain insights into how Indian philosophy continues to influence architectural and design choices, fostering a deeper appreciation of the cultural and spiritual significance inherent in traditional Indian design. This course equips students with the ability to engage in thoughtful, culturally sensitive design practices rooted in India's profound philosophical heritage.

Conservation and Heritage Management

This subject is a comprehensive exploration of the principles, strategies, and ethical considerations essential for the preservation and management of cultural heritage. It begins by establishing the critical importance of conserving heritage sites, emphasizing their cultural, historical, and economic value.

Students will delve into the methodologies and best practices of heritage conservation, covering areas such as documentation, structural analysis, restoration techniques, and

risk assessment. The subject also addresses the challenges posed by modernization and tourism, focusing on sustainable and responsible management strategies.

Ethical aspects, including community engagement, cultural sensitivity, and the preservation of intangible heritage, are central themes throughout the course. Through case studies and practical exercises, students will acquire the skills and knowledge necessary to contribute effectively to the preservation and sustainable management of cultural heritage, ensuring its continued relevance and significance for future generations.

Augmented Reality (AR) and Virtual Reality (VR) in Heritage Documentation

OBJECTIVES:

- To introduce students to the concepts of Augmented Reality (AR) and Virtual Reality (VR) and their applications in documenting heritage sites and architectural details.
- To provide hands-on experience in using AR and VR technologies for capturing and preserving cultural heritage in immersive digital formats.
- To foster an appreciation for the role of AR and VR in enhancing the accessibility and educational value of heritage documentation.

"Augmented Reality (AR) and Virtual Reality (VR) in Heritage Documentation" is an immersive studio-based course that plunges students into the forefront of technological innovation in cultural preservation. This hands-on journey equips students with the skills and knowledge needed to utilize AR and VR technologies for the documentation, conservation, and presentation of cultural heritage. Starting with the fundamentals of AR and VR, students learn to master the hardware, software, and development tools that drive these cutting-edge platforms. Through practical exercises, they delve into 3D scanning techniques to capture precise data from heritage sites and then proceed to reconstruct digital representations that adhere to historical accuracy and spatial authenticity. The course also guides students in creating interactive AR and VR experiences, allowing users to virtually explore heritage sites, interact with historical content, and gain a profound understanding of their cultural significance. Ethical considerations, such as cultural sensitivity and responsible technology usage, are woven throughout the curriculum. By course end, students emerge as adept creators of AR and VR applications, prepared to digitally preserve and dynamically present our rich cultural heritage, bridging the past and present through innovative technology.

Architectural Research and Thesis

OBJECTIVES:

- To equip students with the research skills and methodologies necessary for conducting in-depth architectural research.
- To guide students in selecting and formulating research topics related to architectural history, theory, or contemporary practice.
- To support students in developing and executing a comprehensive architectural thesis project that demonstrates their research findings, design capabilities, and critical thinking.

This subject marks the culmination of the academic journey, guiding students in conducting profound research and crafting an original architectural thesis within the realm of traditional architecture and digital re-creation. The course commences by equipping students with comprehensive research methodologies, enabling them to formulate research questions, conduct literature reviews, and select appropriate methodologies tailored to the preservation and revival of traditional architectural heritage.

Throughout the curriculum, students will analyze case studies, exploring significant examples of traditional architecture and digital re-creation initiatives. They will cultivate critical analytical skills, evaluating the role of digital technologies in documenting, preserving, and reviving traditional architectural marvels in cultural, social, and environmental contexts.

The heart of this subject lies in the development and execution of an architectural thesis with a focus on digital re-creation in traditional architecture. Students will identify a research topic within this niche, undertake original research, and synthesize their findings into a comprehensive thesis document. Presentations of their research and design proposals will encourage meaningful discussions and constructive feedback.

Upon completion of this course, students will emerge as adept researchers and designers, ready to contribute to the field of traditional architecture and digital re-creation through rigorous inquiry, creative problem-solving, and innovative digital design solutions.

PG DIPLOMA IN AGILE PROJECT MANAGEMENT

(Diploma – 1 Year)

CURRICULUM AND SYLLABI I & II SEMESTERS (SEMESTER PATTERN)

Semester I

S.No	Course Code	Course title	Category	L	T	P	Total	Credits
01		Foundations of Project Management	CC	3	0	0	3	3
02		Agile Principles and Mind set	CC	3	0	0	3	3
03		Value Driven Delivery	CC	3	0	0	3	3
04		Stakeholder Engagement	CC	3	0	0	3	3
05		Leading teams in Agile Environment	CC	4	0	0	4	4
06		Problem Detection and Resolution	CC	4	0	0	4	4

Semester II

S.No	Course Code	Course title	Category	L	T	P	Total	Credits
01		Adaptive Planning	CC	3	0	0	3	3
02		Continuous Improvement	CC	3	0	0	3	3
03		Risk and Change Management	CC	4	0	0	4	4
04		Agile Leadership	CC	4	0	0	4	4
05		Project	CC	0	0	6	6	6

Total Credits :40

Course Duration: 1 year

Prerequisites:

There are no formal prerequisites for this course, but a basic understanding of project management concepts can be helpful.

Course Description:

This course provides a comprehensive understanding of Agile Project Management principles and practices. Participants will learn how to apply Agile methodologies to effectively manage projects, improve team collaboration, and deliver value to customers.

Course Objectives:

By the end of this course, participants will be able to:

- Understand the Agile philosophy, principles, and values.
- Apply Agile frameworks such as Scrum, Kanban, and Lean to project management.
- Plan and execute Agile projects, including sprint planning and backlog management.
- Foster effective teamwork and collaboration within Agile teams.
- Continuously improve project processes and outcomes through retrospectives.
- Manage project risks and adapt to changing requirements.
- Deliver high-quality products with a focus on customer satisfaction.
- Prepare for Agile certification exams (e.g., Certified Scrum Master).

Teaching Pedagogies

- Lectures: Traditional classroom lectures are often used to deliver foundational knowledge and concepts in various subjects.
- Case Studies: Case studies, which present real-world problems for students to analyze and solve. These encourage critical thinking and decision-making.
- Group Discussions: Group discussions and debates foster collaboration, communication, and the sharing of diverse perspectives on topics.
- Experiential Learning: Hands-on experiences, such as internships, consulting projects, and simulations, provide students with practical exposure to real challenges.
- Online Learning: We will incorporate online courses and resources to accommodate distance learners and provide flexibility.
- Project based learning: Research-oriented courses or projects encourage students to investigate and analyze -related topics in-depth
- Flipped classrooms

Assessment Methods:

- Coursework and assignments
- Examinations

- Publication of research papers
- Submission of reports
- Capstone project and presentation

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Foundations of Project Management	CC	3	0	0	3

UNIT-I	**Introduction**	**09**
Basics of Project Management – Project Management life cycle – Skills of Project Manager. Project – Scope of a project		
UNIT-II	**Initiating a Project**	**09**
Project teams – Identifying risks – Work breakdown structure – sequencing activities – Creating a project schedule – Determine project costs		
UNIT-III	**Planning for project risks, communication and change control**	**09**
Analysing risk to a project – create a communication plan – change control		
UNIT-IV	**Managing and Closing the project**	**09**
Begin and execute project work – track project progress – report performance – implement change control Project closeout process – Creating a final report		
UNIT-V	**Agile Project Management**	**09**
Principles/Values of Agile – Agile project management model – Agile Manifesto (values and principles)		
		Total Contact Hours: 45

Text Book(s):

1. A Guide to the Project Management Body of Knowledge (PMBOK® Guide) – Seventh Edition and The Standard for Project Management (ENGLISH). United States, Project Management Institute, 2021.

Reference Books(s)

- Fundamentals of Project Management. Joseph Heagney. American Management Association (AMACOM), 2016.
- Layton, Mark C.. Agile Project Management For Dummies. United Kingdom, Wiley, 2012.
- Phillips, Joseph. PMI-ACP Agile Certified Practitioner All-in-One Exam Guide. United States, McGraw Hill LLC, 2018.

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Agile Principles and Mindset	CC	3	0	0	3

UNIT-I	**Introduction**	**07**
Introduction to Agile - Agile Engineering Practices		
UNIT-II	**Agile Manifesto**	**11**
The Agile Manifesto - Principles of Agile Manifesto - Applying the Principles of Agile Manifesto - Agile Core Principles and Practices Benefits of Agile Project Life Cycle Characteristics		
UNIT-III	**Agile Methodologies and Scrum**	**09**
Agile Methodologies - Agile Mind set - Where to Apply Agile Meaning of Scrum - Features of Scrum - Three Pillars of Scrum - Scrum Roles - Key Terms of Scrum - Scrum Meetings - Scrum: An Empirical Process		
UNIT-IV	**Extreme Programming and Crystal Method**	**09**
Extreme Programming - Extreme Programming Practices - Roles in Extreme Programming - Process Diagram of XP Crystal Method - Properties of Crystal Method - Key Categories of Crystal Method		
UNIT-V	**Dynamic Systems Development Method**	**09**
Dynamic Systems Development Method (DSDM) - Basic Principles of Atern - Planning Philosophy in DSDM - DSDM Techniques - DSDM Phases - Feature-Driven Development. Agile Project Management		
		Total Contact Hours: 45

Text Book(s):

1. Broza, Gil. The Agile Mind-Set: Making Agile Processes Work. Canada, CreateSpace Independent Publishing Platform, 2015.
2. Clark, Wesley. Agile Methodology: A Beginner's Guide to Agile Method and Principles. N.P., Independently Published, 2019.

Reference Books(s)

- Layton, Mark C. Agile Project Management For Dummies. United Kingdom, Wiley, 2012.
- Phillips, Joseph. PMI-ACP Agile Certified Practitioner All-in-One Exam Guide. United States, McGraw Hill LLC, 2018.

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Value Driven Delivery	CC	3	0	0	3

UNIT-I	**Introduction**	**09**
Quantifying Customer Value - Time Value of Money – Examples - The Financial Feasibility of Projects		
UNIT-II	**Project Management techniques**	**09**
Return on Investment ROI - Net Present Value (NPV) & Examples - Internal Rate of Return (IRR) & Examples - Payback Period & Examples		
UNIT-III	**Requirements**	**09**
Prioritization of Functional Requirements - MoSCoW - Kano Model - Relative Weighting - Prioritization of Non-Functional Requirements - Risk Management in Agile		
UNIT-IV	**Project Planning & Agile Compliance**	**09**
Minimal Viable Product - Project Planning Using MVP - Agile Compliance - Key Drivers of Agile Compliance - Incremental Delivery - Review and Feedback - Earned Value Management - Earned Value Metrics & Examples		
UNIT-V	**Agile contracts**	**09**
Agile Contracts: Components - Agile Contracting Methods - Fixed-Price or Fixed-Scope Contract - Time and Materials (T and M) Contract - T and M with Fixed Scope and Cost Ceiling - T and M with Variable Scope and Cost Ceiling - Bonus or Penalty Clauses - Rolling Agile Contracts - Terms Used in Agile Contracts		
		Total Contact Hours: 45

Text Book(s):

1. Collier, Ken. Agile Analytics: A Value-driven Approach to Business Intelligence and Data Warehousing. United Kingdom, Addison-Wesley, 2012.

Reference Books(s)

- Layton, Mark C.. Agile Project Management For Dummies. United Kingdom, Wiley, 2012.
- Phillips, Joseph. PMI-ACP Agile Certified Practitioner All-in-One Exam Guide. United States, McGraw Hill LLC, 2018.

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Stakeholder Engagement	CC	3	0	0	3

UNIT-I	**Introduction**	**09**
Stakeholder Engagement - Project Charter - Understanding Stakeholder Needs		
UNIT-II	**Agile Wireframes, Personas & Story Maps**	**09**
Agile Wireframes - User Story - Story Card Information - Agile Personas - Theme and Epic - Agile Story Maps		
UNIT-III	**Community**	**09**
Community and Stakeholder Values - Community Management - Communication and Knowledge Sharing - Social Media Communication - Information Radiators		
UNIT-IV	**Management**	**09**
Burnup and Burndown Charts - Kanban or Task Board - Impediment Logs - Characteristics of Information Radiators - Agile Modeling - Active Listening - Key Elements of Active Listening		
UNIT-V	**Globalisation and its effects**	**09**
Globalization Diversity and Cultural Sensitivity - Cultural Diversity Issues: Recommendations - Agile Facilitation Methods - Agile Negotiation and Conflict Management - Five Levels of Conflict		
		Total Contact Hours: 45

Text Book(s):

1. Vii, Paul. Agile Product Management: Stakeholder Engagement: 21 Tips for a New Approach to Stakeholder Management with Scrum. N.p., CreateSpace Independent Publishing Platform, 2016.

Reference Books(s)

- Layton, Mark C.. Agile Project Management For Dummies. United Kingdom, Wiley, 2012.
- Phillips, Joseph. PMI-ACP Agile Certified Practitioner All-in-One Exam Guide. United States, McGraw Hill LLC, 2018.

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Leading teams in Agile Environment	CC	4	0	0	4

UNIT-I	**Introduction**	**12**
Teams - Features and Composition of Agile Teams - Stages of Agile Team Formation Agility in large companies - Agility in small and medium enterprises (SMEs)		
UNIT-II	**Teams & organising**	**12**
High Performance Teams - Generalizing Specialist - Team Responsibility - Self-Organization		
UNIT-III	**Agile Leadership**	**12**
Agile Leadership - Best Practices of Agile Leadership - Management vs Leadership - Servant Leadership - Coaching and Mentoring - Agile Coaching - Agile Emotional Intelligence		
UNIT-IV	**Motivation and Space**	**12**
Team Motivation - Maslow's Theory - Frederick Herzberg's Theory - McClelland's Theory - Boehm's Theory - Team Space - Co-Located Teams - Distributed Teams - Co-Located vs. Distributed Teams		
UNIT-V	**Communication, Velocity and Tools**	**12**
Osmotic Communication - Team Collaboration and Coordination - Collaboration Technology - Communication Gap & Examples - Brainstorming Sessions - Team Velocity & Examples - Sample Velocity Chart - Agile Tools		
		Total Contact Hours: 60

Text Book(s):

1. Medinilla, Ángel. Agile Management: Leadership in an Agile Environment. Germany, Springer, 2012.
2. Adkins, Lyssa. Coaching Agile Teams: A Companion for ScrumMasters, Agile Coaches, and Project Managers in Transition. India, Pearson Education, 2010.
3. Rose, Doug. Leading Agile Teams. United States, Project Management Institute, 2015.

Reference Books(s)

- Layton, Mark C.. Agile Project Management For Dummies. United Kingdom, Wiley, 2012.
- Phillips, Joseph. PMI-ACP Agile Certified Practitioner All-in-One Exam Guide. United States, McGraw Hill LLC, 2018.

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Problem Detection and Resolution	CC	4	0	0	4

UNIT-I	**Agile Problem Detection**	**12**
Agile Problem Detection - Problem Detection Techniques - Fishbone Diagram - Five Whys Technique - Control Charts - Lead Time and Cycle Time		
UNIT-II	**Techniques**	**12**
Kanban - Kanban Process - Example of Kanban Board - Work In Progress - Managing Constraints - Little's Law - Escaped Defects		
UNIT-III	**Agile Problem Solving**	**12**
Agile Problem Solving - Adaptive Planning - Metrics and Measures - Benefits of Metrics - Examples of Metrics - Baseline Metrics - Variance and Trend Analysis		
UNIT-IV	**Risk Management Life cycle**	**12**
Risk Management Life Cycle - Step One : Risk Identification - Step Two : Risk Assessment - Step Three : Risk Response Strategies - Step Four : Risk Review		
UNIT-V	**Risk Log**	**12**
Risk Log - Risk Burndown Chart - Risk Profile Graph - Spike - Agile Failure Modes - Agile Coach Failure Modes - Troubleshooting Guidelines		
		Total Contact Hours: 60

Text Book(s):

1. Stellman, Andrew, and Greene, Jennifer. Head First Agile: A Brain-Friendly Guide to Agile Principles, Ideas, and Real-World Practices. United States, O'Reilly Media, 2017.

Reference Books(s)

- Layton, Mark C.. Agile Project Management For Dummies. United Kingdom, Wiley, 2012.
- Phillips, Joseph. PMI-ACP Agile Certified Practitioner All-in-One Exam Guide. United States, McGraw Hill LLC, 2018.

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Adaptive Planning	CC	3	0	0	3

UNIT-I	**Introduction**	**09**
Planning Philosophy - Aligning Agile Projects - Rolling Wave Planning - Timeboxing - Best Practices of Timeboxing - Advantages of Timeboxing		
UNIT-II	**Agile Estimation - 1**	**09**
Agile Estimation - Story Points - Assigning Story Points - Story Points Estimation - Story Points Estimation Scale: Example - Value Points - Ideal Days - Story Points vs. Ideal Days		
UNIT-III	**Agile Estimation - 2**	**09**
Wideband Delphi Technique - Planning Poker - Planning Poker: Example - Affinity Estimation		
UNIT-IV	**Agile Estimation - 3**	**09**
Project Size Estimation - Release Plan - Release Plan: Example - Iteration Plan - Types of Iteration Planning - Iteration Lifecycle: Example - Release Plan vs. Iteration Plan		
UNIT-V	**Agile Product Roadmap**	**09**
Agile Product Roadmap - Backlog Refinement - Value-Based Analysis and Decomposition - Agile Cone of Uncertainty - Velocity Variations - Sprint Reviews - Sprint Retrospectives - Mid-Course Corrections		
		Total Contact Hours: 45

Text Book(s):

1. Worsley, Louise M., and Worsley, Christopher. Adaptive Project Planning. United States, Business Expert Press, 2019.

Reference Books(s)

- Layton, Mark C.. Agile Project Management For Dummies. United Kingdom, Wiley, 2012.
- Phillips, Joseph. PMI-ACP Agile Certified Practitioner All-in-One Exam Guide. United States, McGraw Hill LLC, 2018.

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Continuous Improvement	CC	3	0	0	3

UNIT-I	**Kaizen**	**09**
Kaizen - Kaizen in Agile - Lean - Defining Waste Manufacturing and Software Development		
UNIT-II	**Agile practices**	**09**
A Five Step Process to Becoming Lean - Value Stream Mapping - Agile Retrospectives - Cargo Smells - Conducting a Retrospective - Brainstorming Techniques		
UNIT-III	**Agile Process**	**09**
Process Analysis Techniques - Agile Process Tailoring - Project Factors That Influence Tailoring		
UNIT-IV	**Best Practices**	**09**
Quality in Agile - Best Practices for Quality in Agile - Best Practice One: Verification and Validation - Best Practice Two: Exploratory Testing - Best Practice Three: Usability Testing - Best Practice Four: Test-Driven Development - Test-Driven Development Advantages - Acceptance Test-Driven Development Cycle (ATDD)		
UNIT-V	**Best Practices**	**09**
Best Practice Five: Continuous Integration - Best Practice Six: Definition of Done - Testing Pyramid and Quadrant - Checklist for Story Completion - Agile Flowchart - Agile Spaghetti Diagram - Organizational Self Assessment		
		Total Contact Hours: 45

Text Book(s):

1. Agile Kaizen: Managing Continuous Improvement Far Beyond Retrospectives : [Summary].. N.p., Skillsoft, 2018.
2. Medinilla, Ángel. Agile Kaizen: Managing Continuous Improvement Far Beyond Retrospectives. Germany, Springer Berlin Heidelberg, 2014.

Reference Books(s)

- Layton, Mark C.. Agile Project Management For Dummies. United Kingdom, Wiley, 2012.
- Phillips, Joseph. PMI-ACP Agile Certified Practitioner All-in-One Exam Guide. United States, McGraw Hill LLC, 2018.

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Risk and Change Management	CC	4	0	0	4

UNIT-I	**Roadmap**	**12**
Developing a roadmap for change – Using a roadmap – Applying the roadmap to change		
UNIT-II	**Business Need**	**12**
Business need – Bringing the elements of business need together – capturing and prioritizing business need – aligning business need to roadmap – developing business understanding		
UNIT-III	**Relationship building**	12
Personal awareness – Personal leadership – developing relationship with others – identifying potential relationships – Steps in building relationships		
UNIT-IV	**Environment**	**12**
Environment and its link to organisational culture – criteria for effective environment – establishing environment – Environment that provides reassurance, encouragement and motivation – building a sustaining environment		
UNIT-V	**Coaching for change**	**12**
Understanding behavioural change – Coping techniques – Practical application of coping techniques – Interest – Participation – Positivity – Creating resilience – Creating enjoyment		
		Total Contact Hours: 60

Text Book(s):

1. Franklin, Melanie. Agile Change Management: A Practical Framework for Successful Change Planning and Implementation. United Kingdom, Kogan Page, 2021.

Reference Books(s)

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- Layton, Mark C.. Agile Project Management For Dummies. United Kingdom, Wiley, 2012.
- Phillips, Joseph. PMI-ACP Agile Certified Practitioner All-in-One Exam Guide. United States, McGraw Hill LLC, 2018.

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Agile Leadership	CC	4	0	0	4

UNIT-I	**Introduction**	**12**
Leader – Basics of Leadership – Leadership Theories – Agile Leader – Roles of Agile leader		
UNIT-II	**Tool 1 & 2**	**12**
Leader as co-creator of inspiring goals Tool 1 : Key Value Indicator Tool 2 : Impact ladder		
UNIT-III	**Tool 3 & 4**	**12**
Leader's responsibility to facilitate ownership in teams Tool 3 : Ownership model Tool 4 : Freedom Matrix		
UNIT-IV	**Tool 5 & 6**	**12**
Agile leader as experimenter Tool 5 : T2L Tool 6 : VLB		
UNIT-V	**Tool 7 & 8**	**12**
Agile leader as Culture leader Tool 7 : Habit Matrix Tool 8 : TO-GRIP		
		Total Contact Hours: 60

Text Book(s):

1. Koning, Peter. Agile Leadership Toolkit: Learning to Thrive with Self-Managing Teams. United Kingdom, Pearson Education, 2019.
2. Hayward, Simon. The Agile Leader: How to Create an Agile Business in the Digital Age. United Kingdom, Kogan Page, 2021.

Reference Books(s)

- Layton, Mark C.. Agile Project Management For Dummies. United Kingdom, Wiley, 2012.
- Phillips, Joseph. PMI-ACP Agile Certified Practitioner All-in-One Exam Guide. United States, McGraw Hill LLC, 2018.

The curriculum and syllabus for Agile Project Management are in conformance to the following sustainable goals .

SDG 4	Quality Education	Meeting Industry Demand	Agile methodologies have become the standard in project management across various industries, from software development to marketing and beyond. The curriculum aligns with industry needs, ensuring that graduates are equipped with the skills and knowledge demanded by employers.
SDG8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Adaptability to Change	Agile Project Management emphasizes adaptability and responsiveness to change. This is essential in today's fast-paced business environment where requirements and priorities can shift rapidly. Graduates are prepared to manage projects that can pivot and evolve as needed.
SDG9	Industry, Innovation and Infrastructure	Resource Optimization	Agile methodologies focus on optimizing resource allocation and minimizing waste. Graduates learn how to allocate resources efficiently, making the most of available talent, time, and budget.

PG Diploma in
Artificial Intelligence and Cognitive Psychology
(Diploma – 1 year)

Program Duration: One year

Semester 1: Foundation Courses and AI and Human Cognition

1. **Introduction to Artificial Intelligence**
    - Overview of AI and its subfields
    - History and evolution of AI
    - Ethical considerations in AI
2. **Cognitive Psychology Basics**
    - Introduction to cognitive psychology
    - Human cognitive processes: perception, memory, and problem-solving
    - Cognitive development and learning theories
3. **Machine Learning Fundamentals**
    - Supervised and unsupervised learning
    - Data pre-processing and feature selection
    - Machine learning libraries (e.g., Python, scikit-learn)
4. **Cognitive Psychology and AI Applications**
    - Cognitive modelling and simulation
    - Cognitive psychology in user interface design
    - User-centered design principles
5. **Elective 1**

Semester 2: Advanced Topics

6. **Deep Learning and Neural Networks**
    - Introduction to deep learning
    - Convolutional neural networks (CNNs) and recurrent neural networks (RNNs)
    - Deep learning applications in cognitive psychology

7. **Natural Language Processing (NLP) for Human-Computer Interaction**
    - NLP fundamentals
    - Sentiment analysis and Chabot development
    - Ethical considerations in NLP
8. **Elective II**
9. **Capstone Project**
    - Research or applied project combining AI and cognitive psychology concepts
    - Project design, implementation, and presentation
    - Final assessment and diploma completion

Elective Courses (Choose 1-2 based on student interest):

- AI Ethics and Responsible AI Development
- Human-Computer Interaction (HCI) Design
- User Research and Usability Testing
- Computational Cognitive Modelling

References:

"Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig.

"Artificial Intelligence: Structures and Strategies for Complex Problem Solving" by George F. Luger

"Cognitive Psychology: Connecting Mind, Research, and Everyday Experience" by E. Bruce Goldstein.

"Cognitive Psychology and its Implications" by John R. Anderson.

"Cognitive Psychology: A Student's Handbook" by Michael W. Eysenck and Mark T. Keane.

"Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron.

Online courses and materials from platforms like Coursera, edX, and fast.ai.

"Natural Language Processing in Action" by Lane, Howard, and Hapke.

"Designing User Interfaces for an Aging Population" by Jeff Johnson.

"AI Ethics" by Mark Coeckelbergh.

"Robot Ethics: The Ethical and Social Implications of Robotics" edited by Patrick Lin, George Bekey, and Keith Abney.

"Introduction to the Practice of Statistics" by David S. Moore, George P. McCabe, and Bruce A. Craig.

PG Diploma in Applied Economics and Data Analytics
(Diploma – 1 Year)

Curriculum and Syllabus I & II semesters

S.No	*Course Code*	*Course Title*	*Category*	*Periods /Week*				
				L	**T**	**P**	**Total**	**Credits**
SEMESTER – I								
1	Core 1	Micro Economics and Decision Making	CC	4	0	0	4	4
2	Core 2	Macro-Economic and Policies	CC	4	0	0	4	4
3	Core 3	Research Methods for Economics	CC	4	0	0	4	4
4	Core 4	Fundamentals of Econometrics	EEC	0	0	8	4	4
5	Core 5	Data Visualization and Interpretation	CC	4	0	0	4	4
		TOTAL		**16**	**0**	**8**	**20**	**20**

SEMESTER – II								
1	Core 6	Applied Financial Economics	CC	4	0	0	4	4
2	Core 7	Big data and Machine learning	EEC	0	0	8	4	4
3	Core 8	Economic Forecasting Methods	CC	4	0	0	4	4
4	Core 9	Time series and Panel data analysis	EEC	0	0	8	4	4
5	Project work	Research Project in Applied economics and data analysis	EEC	0	0	0	4	4
		TOTAL		**8**	**0**	**16**	**20**	**20**

Total Credits: 40

CC : Core Courses
EEC : Employability Enhancement Courses

Pre requisites:

Candidates must have a bachelor's degree in economics, business, finance, math's or a related field.

Programme Description:

This Programme is enabling the students to gain in depth knowledge and expertise skill in the field of applied economics with data analysis tool in analyzing various economic data, make informed policy decisions and drive data -driven strategies in various industries.

Year 1: Semester 1

Total Credits: 20

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Micro Economics and Decision Making	CC	4	0	0	4

UNIT-I	**Introduction to Micro Economics**	**12**
• Scope & Methods-Opportunity Cost-Science of economics-Basic competitive model-Comparative advantage and trade		
UNIT-II	**Supply & demand**	**12**
• Determinants of individual demand and supply -Demand and supply curve-Shift in supply and demand curve-Elasticity and its application-Consumer surplus		
UNIT-III	**Household**	**12**
• Consumption decision-Budget Line-Indifference Curve-Income and substitution effect-Labour supply and savings decision.		
UNIT-IV	**Market Structure**	**12**
• Production function cobb Douglas and CES function- Cost and output decision in short run and long run-Perfect market structure-Imperfect market structure-Anti-Trust policy		
UNIT-V	**Input Market**	**12**
• Labour and land market • Basic concept: Marginal productivity of labour & Marginal revenue • Demand for labour • Input demand curve • Shift in input demand curve • Competitive labour markets		
Total Contact Hours: 60		
Text / Reference Books Book(s):		
1. J.M. Henderson and R.E.Quandt: Micro Economic Theory, Tata McGraw Hill		
2. . 2. Hal R.Varian: Intermediate Micro Economics, East West Press.		
3. 3. A. Koutsoyiannis: Modern Microeconomics, Macmillan		
4. Walter Nicholson & Christopher Snyder Microeconomic Theory: Basic Principles and Extensions, 11th edition.		

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Macro-Economic and Policies	CC	4	0	0	4

UNIT-I	**Introduction to Macroeconomics and National Income**	**12**
• Basic concepts-Gross domestic product -Circular flow of Income-Real vs nominal GDP-Balance of payments		
UNIT-II	**Monetary Policy**	**12**
• Functions of money -Theories of Money-Determination of money supply and demand-Credit creation -Monetary policy tools		
UNIT-III	**Unit III: Unemployment and Inflation**	**12**
• Unemployment -Inflation-Inflation and its social cost-Hyper inflation		
UNIT-IV	**Closed economy in short run**	**12**
• Classical and Keynesian Concept-Model of income distribution • IS-LM model-Fiscal and monetary Multiplier		
UNIT-V	**International Trade**	**12**
• History of Trade agreement GAAT to NAFTA-Currency exchange rate-World Trade Organization-Foreign direct Investment-Trade Policies-Case studies		
	Total Contact Hours: 60	

Text / Reference Books Book(s):

1. Abel, A., Bernanke, B. (2016). Macroeconomics, 9th ed. Pearson Education

2. Blanchard, O. (2018). Macroeconomics, 7th ed. Pearson Education.

3. Dornbusch, R., Fischer, S., Startz, R. (2018). Macroeconomics, 12th ed. McGraw-Hill.

4. Jones, C. (2016). Macroeconomics, 4th ed. W. W. Norton. 5. Mankiw, N. (2016). Macroeconomics, 9th ed. Worth Publishers.

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Research Methods for Economics	CC	4	0	0	4

UNIT-I	**Introduction to Research**	**12**
Research a scientific approach -Types of Research -Research Methods versus Research Methodology-Criteria of Good Research -Problems Encountered by Researchers in India		
UNIT-II	**Literature Review**	**12**
Identifying a Research Problem-Literature Review and tools for reference collection-Critical Evaluation of Literature Review -Formulation of hypotheses -Research Design-Data analysis Interpretation of result		
UNIT-III	**Research Design**	**12**
Meaning and necessity of Research Design-Framework and parameters -Approaches to Research Design -Types of Research Design: Explanatory, Descriptive, Diagnostic, Experimental, Exploratory and Hypothesis Testing Design		
UNIT-IV	**Data Collection**	**12**
Collection of Primary Data -Observation, Interview Methods and Collection of Data through Schedules -Difference between Questionnaires and Schedules -Collection of Secondary Data Selection of Appropriate Method for Data Collection -Case Study Method		
UNIT-V	**Data Analysis & Report Writing**	**12**
Techniques of Data Analysis -Importance of Statistics in Research -Descriptive Statistics – Mean, Median, Mode standard deviation, variance, skewness and kurtosis-Simple Regression Analysis -Multiple Correlation and Regression Analysis-Report Writing		
	Total Contact Hours: 60	

Text / Reference Books Book(s):

1. C.R. Kothari, Research Methodology, Methods and Technique, New Age International Publishers.
2. John W. Creswell; Research Methodology, Research design, Quantitative, Qualitative approach and mixed methods

Course Code	Course Title (Lab course)	Category	L	T	P	C
	Fundamentals of Econometrics	EEC	0	0	8	4

UNIT-I	**Introduction to Econometrics**	**12**
Econometrics – definitions – scope – methodology – types-Importance		
UNIT-II	**Hypothesis testing and Analysis**	**12**
Two variable regression model – assumptions – method of least squares – properties – BLUE – R-square – maximum likelihood method – testing of hypotheses using point and interval estimates – forecasting – solving problems using SPSS and STATA		
UNIT-III	**Foundation of Econometric Modeling**	**12**
Nonlinear relationships – transformation of variables – functional forms – three variable regression model – applications using SPSS and STATA.		
UNIT-IV	**Regression Models**	**12**
General linear model (matrix approach) – specification – OLS estimators – testing significance of individual and overall regression coefficients – restricted least squares – structural regression models – dummy variables – problems and application using STATA		
UNIT-V	**Assumption and Extension of Econometric modeling**	**12**
Violation of classical assumptions – multicollinearity – autocorrelation – heteroscedasticity – problems – causes – consequences – remedial measures – model specification and diagnostic testing.		
	Total Contact Hours: 60	

Text / Reference Books Book(s):

1. Jeffery M. Wooldridge, Introductory Econometrics: A Modern Approach, 5th edition.
2. Pindyck, R.S. and Daniel, L. R.,"Econometric Models and Business Forecasts", McGraw Hill, New York.

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Data Visualization and Interpretation	CC	4	0	0	4

UNIT-I	**Introduction & Visualization design principles**	**12**
Role of visualization in data science -Two flavors of data visualization: exploratory and communicative -Course projects overview		
UNIT-II	**Visualization design principles**	**12**
Data and task abstraction -Best practices for encoding -Marks and channels d. Tableau assignment -Effectiveness and expressiveness - critique visualizations-Design problems and consequences -How not to cause misinterpretation		
UNIT-III	**Exploratory visualization techniques & Interactive**	**12**
Why interactivity is needed -Handling multiple views -Brushing and Linking - instructions and assignments		
UNIT-IV	**Data Interpretability**	**12**
Causes of misinterpretation -Role of communicative visualization in sciences -Graphical interpretability: metrics and approaches.		
UNIT-V	**Visualization in data science**	**12**
Machine learning models -Interpretability challenges and solutions -Transparency and human-machine trust impactful case studies: biology, healthcare, cyber security, climate science, social science		
	Total Contact Hours: 60	

Text / Reference Books Book(s):

1. Kieran Healy, Data Visualization
2. Colin Ware, "Information Visualization
3. Scott Murray, Interactive Data Visualization for the Web

Year 1: Semester 2 **Total Credits: 20**

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Applied Financial Economics	CC	4	0	0	4

UNIT-I	**Introduction**	**12**
Risk & Return-Time value of money-Financial Markets-Regulation of Financial Markets in India- Fama's formulation of efficient market model-Securities price and random walk-Testing for market efficiency-Behavioral finance		
UNIT-II	**Valuation of Bond and equity**	**12**
Bond pricing -Valuation of bond-Valuation of shares: Book value & Market value Tobin Q-Market capitalization-NIFTY and SENSEX		
UNIT-III	**Portfolio Analysis**	**12**
Selection of optimal portfolio-The market models-Random error terms-Graphical Representation-Beta-Capital Assets Pricing model		
UNIT-IV	**Fundamental Analysis**	**12**
Fundamental Analysis: Top-down Vs Bottom up-Forecasting-Econometric Models-Review of Accounts Statement Ratio Analysis		
UNIT-V	**Technical Analysis**	**12**
Technical Analysis-Dow Theory-Types of Charts: Point & figure, Bar, line and candlestick Trend Analysis		
	Total Contact Hours: 60	

Text / Reference Books Book(s):

1. S.A.Ross, R.W.Westerfield, J.Jaffe and Roberts: Corporate Finance, McGraw-Hill.
2. 2. Zvi Boodie, Alex Kane and Alan J.Marcus: Investments, McGraw-Hill.
3. John Hull: Futures, Options and Other Derivatives, Prentice Hall.

Course Code	Course Title (Lab course)	Category	L	T	P	C
	Big data and machine learning	EEC	0	0	8	4

UNIT-I	**Introduction**	**12**
Big data analytics-Hadoop-IBM Big data strategy-Introduction to infosphere Big insights and Big sheet		
UNIT-II	**HDFS (Hadoop Distributed File system)**	**12**
Concepts, Design-Command line interface-Hadoop File system Interface		
UNIT-III	**Map Reduce**	**12**
Anatomy of a Map Reduce Job Run-Failures, Job Scheduling-Shuffle and Sort, Task Execution-Map Reduce Types and Formats-Map Reduce Features.		
UNIT-IV	**Hadoop Eco system**	**12**
Pig-hive-hbase-Big SQL		
UNIT-V	**Data analytics with R**	**12**
Machine learning-Supervised and unsupervised learning-Collaborative Filtering-Big data analysis with big R		
	Total Contact Hours: 60	

Text / Reference Books Book(s):

1. "R for Data Science" by Hadley Wickham and Garrett Grolemund, 2nd edition.
2. Python for Data Analysis" by Wes McKinney, 2017

Course Code	Course Title (Theory course)	Category	L	T	P	C
	Economic Forecasting Methods	CC	4	0	0	4

UNIT-I	**Introduction to forecasting:**	**12**
The forecasting problem-Basic Data Analysis-Reporting and Evaluating Forecasts-Review of Regression methods		
UNIT-II	**Forecasting with Classical Regression Methods**	**12**
Overview-Least Squares Prediction-Cross-sectional Forecasting		
UNIT-III	**Time Series Methods I**	**12**
Time series decomposition -trend component-cyclical component-seasonal component -irregular component -Moving averages -Seasonal Adjustment		
UNIT-IV	**Time Series Methods II**	**12**
Properties of Time Series -stationarity and non-stationarity – making time series stationary Forecasting with univariate ARIMA models -Dynamic time series models		
UNIT-V	**Time-Series Modeling and Data Generating Process (DGP)**	**12**
Time-Series-Time-Series Forecasting Process, Diagnosis-Modeling and Model Selection Criteria, and Forecast Model Selection, AIC, BIC, MSE		
	Total Contact Hours: 60	

Text / Reference Books Book(s):

1. Pindyck, R.S. and Daniel, L. R.,"Econometric Models and Business Forecasts", McGraw Hill, New York.
2. J. Johnston, Econometric Methods, McGraw Hill.
3. STATA Version 8.0: User's Guide, Texas: Stata Press

Course Code	Course Title (Lab course)	Category	L	T	P	C
	Time series and Panel Data analysis	EEC	0	0	8	4

UNIT-I	**Modern time series**	**12**
Tools of modern time series analysis-Dickey fuller and augmented Dickey fuller test-error correction method-stationarity vs non-stationarity.		
UNIT-II	**Univariate and multi variate time series analysis**	**12**
ARIMA tools-AR, MA, ARMA-Specification, estimation and Testing- VAR models-Johanson co-integration test-Granger causality test application in finance.		
UNIT-III	**Modeling volatility & Auto correlation in time series**	**12**
Modeling volatility & Auto correlation in time series-Auto regressive conditional heteroscedasticity (ARCH)-GARCH method		
UNIT-IV	**Introduction to panel data**	**12**
Data structure – cross section-pooled and panel data-Unobserved heterogeneity – balance and unbalance panel-one way and two-way error components.		
UNIT-V	**Panel estimation**	**12**
Fixed effects model-random effects model-LSDV estimation-Hausman specification test-dynamic panel model-GMM estimation		
	Total Contact Hours: 60	

Text / Reference Books Book(s):

1. T.M.J.A. Cooray: Applied Time Series – Analysis and Forecasting, Narosa Publications.
2. Johnston, J.: Econometric Methods, McGraw Hill.
3. 3. Greene, W.: Econometric Analysis, Pearson Education

Course Code	Course Title (Project work)	Category	L	T	P	C
	Research Project in Applied economics and data analysis	CC	0	0	0	4

- Carry out independent research project applying data analytics to an economic problem
- Thesis presentation

SUGGESTED PEDAGOGICAL METHODS

The program will use a variety of pedagogical methods to deliver instruction and develop students' skills and knowledge in the field.

Lectures: Traditional classroom lectures are often used to deliver foundational knowledge and concepts in various subjects.

Case Studies: Case studies, which present real-world problems for students to analyze and solve. These encourage critical thinking and decision-making.

Group Discussions: Group discussions and debates foster collaboration, communication, and the sharing of diverse perspectives on topics.

Seminars and Workshops: These interactive sessions allow students to delve deeper into specific topics, often with guest speakers or industry experts.

Experiential Learning: Hands-on experiences, such as internships, consulting projects, and simulations, provide students with practical exposure to real challenges.

Team Projects: Collaborative projects require students to work together on plans, market analyses, and other tasks, simulating real-world teamwork scenarios.

Problem-Based Learning (PBL): PBL involves presenting students with open-ended problems and guiding them through the process of research and problem-solving.

Guest Lectures: Inviting industry professionals and experts to deliver guest lectures can provide students with insights into current practices and trends.

Online Learning: We will incorporate online courses and resources to accommodate distance learners and provide flexibility.

Simulations: Simulations are computer-based exercises that mimic real situations, allowing students to make decisions and see the outcomes.

Case Competitions: These competitive events challenge students to analyze and present solutions to real problems in front of judges or industry professionals.

Research Projects: Research-oriented courses or projects encourage students to investigate and analyze -related topics in-depth.

Guest Panel Discussions: Panels of industry experts discuss current issues and trends, providing students with valuable insights and perspectives.

Self-Study and Reading Assignments: Independent research and reading assignments help students deepen their knowledge in specific areas of interest.

Peer Teaching: Students may be asked to teach certain topics to their peers, which reinforces their understanding and communication skills.

Suggested Evaluation Methods:
Conduct Continuous Assessment, Quizzes, Real case Assignment and class participants Research papers and reports End semester examination for both theory and lab Evaluation Project: Regular meeting with Guide and attending review meeting Submission of report and Viva voce

The curriculum and syllabus for Applied Economics and data Analytics are in conformance to the following sustainable goals .

SDG 1	End poverty in all its forms everywhere	Global Relevance	Economic challenges are not limited to one region or country. The curriculum prepares students to work on global economic issues and collaborate with organizations worldwide.
SDG4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	Real-World Relevance	The program addresses the increasing demand for professionals who can apply economic principles and data analytics techniques to real-world challenges. Graduates are well-equipped to tackle complex economic problems using data-driven insights.
SDG 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Economic Policy Analysis	In today's data-rich environment, organizations rely on data analytics to make informed decisions. The curriculum ensures that students acquire the skills needed to analyze data and provide valuable economic insights to support decision-making processes.

PG DIPLOMA IN BEHAVOIURAL ECONOMICS AND FINTECH

(Diploma – 1 Year)

CURRICULUM AND SYLLABUS REGULATIONS – 2023

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

- Graduates will be able to demonstrate a strong understanding of the key concepts, technologies, and applications of digital banking.
- Graduates will be able to apply digital banking technologies and solutions to real-world problems in the financial industry.
- Graduates will be able to communicate effectively about digital banking, both orally and in writing.

PROGRAM OUTCOMES (PO)

- Apply knowledge of mathematics, science, and computer science to solve complex digital banking problems.
- Design and implement digital banking systems and applications.
- Analyze and evaluate digital banking technologies and solutions.
- Work effectively in teams to design and develop digital banking solutions.
- Communicate effectively about digital banking, both orally and in writing.
- Demonstrate professional ethics and social responsibility in the use of digital banking technologies.

CURRICULUM AND SYLLABI I TO III SEMESTERS (TRI SEMESTER PATTERN)

Semester I

S.No	Course Code	Course title	Category	L	T	P	Total	Credits
01	BF231101	Introduction to behavioural economics	CC	3	0	0	3	3
02	BF231102	Introduction to FinTech	CC	3	0	0	3	3
03	BF231103	Financial System in India	CC	3	0	0	3	3
04	BF231104	Behavioural Finance	CC	3	0	0	3	3
05	BF231105	Financial Technology Services & Management	CC	2	0	0	2	2

Semester II

S.No	Course Code	Course title	Category	L	T	P	Total	Credits
01	BF232101	Basic Econometrics and Research Methodology	CC	3	0	0	3	3
02	BF232102	Blockchain technology and Cryptography	CC	3	0	0	3	3
03	BF232103	Applied Behavioural Economics	CC	3	0	0	3	3
04	BF232104	Global Financial Markets and Instruments	CC	3	0	0	3	3
05	BF232105	Behavioural Game Theory	CC	2	0	0	2	2

Semester III

S.No	Course Code	Course title	Category	L	T	P	Total	Credits
01	BF233101	Behavioural Economics in Public Policy	CC	3	0	0	3	3
02	BF233102	Digital Banking	CC	3	0	0	3	3
03	BF233103	Capstone Project	CC	0	0	6	6	6

Total Credits : 40

Semester I

Course Code	Course Title (Theory course)	Category	L	T	P	C
BF231101	Introduction to Behavioural Economics	CC	3	0	0	3

Prerequisite:
Basic understanding of economics and psychology

Objectives:
This syllabus is designed to provide students with a comprehensive overview of the field of behavioural economics. It covers all of the key concepts and theories, as well as their applications to real-world behaviour. It also includes a mix of theoretical and empirical material, and it provides students with the opportunity to apply what they have learned to a real-world problem through a case study or research project.

UNIT-I	Foundations of Behavioural Economics	**09**
Behavioural Economics - History of Behavioural Economics - Methodological Approach of Behavioural Economics - Neoclassical vs. Behavioural Economics - Psychology and Economics		
UNIT-II	Preferences, Choices, and Values	**09**
Values, Preferences, and Choices - Choice Under Uncertainty - The Standard Model of Choice - Behavioural Models of Choice - Cognitive Biases		
UNIT-III	Decision Making	**09**
Decision Making Under Risk and Uncertainty - Prospect Theory - Other Behavioural Models of Decision-Making - Implications for Public Policy and Business Practice		
UNIT-IV	Behavioural Time Discounting	**09**
Types of Time Discounting - Behavioural Models of Time Discounting - Applications of Present-Biased Preferences		
UNIT-V	Behavioural Welfare Economics, Libertarian Paternalism, and Nudge Agenda	**09**
Behavioural Welfare Economics - Libertarian Paternalism and Nudging - Ethical Implications of Nudges Challenges of Implementing Nudges		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
Define and explain the key concepts and theories in behavioural economics.
Identify and apply behavioural insights to real-world problems in a variety of domains, including public policy, business, and personal finance.
Critically evaluate the empirical evidence for behavioural economic theories
Communicate effectively about behavioural economics, both orally and in writing.
Develop and conduct their own research on behavioural economic topics

Text Book(s):
• Morris, A, “Contemporary Behavioural Economics: Foundations and Developments”, M E Sharpe, 2006.
• Erik, A, "A Course in Behavioural Economics”, Palgrave Macmillan, 2012.
• Peter, D & Variainen, “Behavioural Economics and its applications”, PUP 2007
• David, J. R., “Introduction to Behavioural Economics”, Wiley, 2014.
• Wilkinson N and Hales M, “An Introduction to Behavioural Economics”, Palgrave

Reference Books(s)
• Angner, Eric, A Course in Behavioural Economics, Palgrave Macmillan, 2016.
• Dhami, Sanjit, The Foundations of Behavioural Economics, Oxford University Press, 2016.
• Nermend, Kesra and Malgorzata Latuszynska (eds.), Problems, Methods and Tools in Experimental and Behavioural Economics, Springer, 2017.
• Cartwright, Edward, Behavioural Economics, 3rd edition, Routledge, 2018.
• Corr, Philip and Anke Plagnol, Behavioural Economics: The Basics, Routledge, 2019.
• Abdukadirov, Sherzod (eds.), Nudge Theory in Action: Behavioural Design in Policy and Markets, Palgrave Macmillan, 2016.

Course Code	Course Title (Theory course)	Category	L	T	P	C
BF231102	Introduction to FinTech	CC	3	0	0	3

Prerequisite:
Basic understanding of finance and technology

Objectives:
This syllabus is designed to provide students with a comprehensive overview of the fintech industry. It covers the key concepts and technologies, as well as the impact of fintech on different sectors of the financial industry. It also includes a discussion of the regulatory and compliance challenges facing the fintech industry

UNIT-I	Introduction to Fintech	**09**
Fintech – Definition, History and Evolution of Fintech, Key Concepts and Technologies in Fintech, Benefits and Challenges of Fintech - The Impact of Fintech on the Financial Industry - Regulation and Policy for Fintech		
UNIT-II	Fintech in the Payment Industry	**09**
Mobile Wallets and Peer-to-Peer Payments - Digital Currencies and Blockchain Technology - Online Payment Processing and Fraud Detection - Regulatory and Compliance Challenges in the Fintech Payment Industry		
UNIT-III	Fintech in the Lending Industry	**09**
Peer-to-Peer Lending and Crowdfunding - Online Lending and Alternative Credit Scoring - Marketplace Lending and Invoice Financing - Regulatory and Compliance Challenges in the Fintech - Lending Industry		
UNIT-IV	Fintech in the Insurance Industry	**09**
InsurTech and the Future of Insurance - Peer-to-Peer Insurance and On-Demand Insurance - Blockchain-Based Insurance and Smart Contracts - Regulatory and Compliance Challenges in the Fintech Insurance Industry		
UNIT-V	Fintech in Wealth Management and Investment	**09**
Robo-Advisors and Automated Investing - Fractional Investing and Social Investing - Impact Investing and Sustainable Investing - Regulatory and Compliance Challenges in the Fintech Wealth Management and Investment Industry		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
● Define and explain the key concepts and technologies in fintech.
● Analyze the impact of fintech on different sectors of the financial industry and the global economy.
● Evaluate the regulatory and compliance challenges facing the fintech industry.
● Identify and apply fintech insights to real-world problems.
● Communicate effectively about fintech, both orally and in writing.

Text Book(s):
Arner D., Barbers J., Buckley R, The evolution of FinTech: a new post crisis paradigm, University of New South Wales Research Series, 2015
Susanne Chishti, Janos Barberis, The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, Wiley Publications, 2016
Richard Hayen, FinTech: The Impact and Influence of Financial Technology on Banking and the Finance Industry, 2016

Reference Books(s) / Web links:
Parag Y Arjunwadkar, FinTech: The Technology Driving Disruption in the financial service industry CRC Pr
Sanjay Phadke, Fintech Future : The Digital DNA of Finance Paperback .Sage Publications, 2020
Pranay Gupta, T. Mandy Tham, Fintech: The New DNA of Financial Services Paperback, 2018

Course Code	Course Title (Theory course)	Category	L	T	P	C
BF231103	Basic understanding of economics and finance	CC	3	0	0	3

Prerequisite:
Basic understanding of finance and technology

Objectives:
This syllabus is designed to provide students with a comprehensive overview of the financial system in India. It covers all of the key components and institutions of the financial system, as well as the recent trends and developments in each sector. It also includes a discussion of the regulatory framework for the financial system.

UNIT-I	Introduction to the Financial System	**09**
Financial System – Definition, Components, Functions, Importance of the Financial System for Economic Growth and Development, The Indian Financial System: An Overview		
UNIT-II	Banking in India	**09**
The Reserve Bank of India (RBI) - Commercial Banks - Development Banks - Cooperative and Rural Banks - Banking Regulations and Supervision - Recent Trends and Innovations in Banking in India		
UNIT-III	Capital Markets in India	**09**
The Primary Market - The Secondary Market - Stock Exchanges in India - Securities and Exchange Board of India (SEBI) - Other Capital Market Institutions and Regulations - Recent Trends and Developments in Capital Markets in India		
UNIT-IV	Insurance in India	**09**
The Insurance Industry in India - Life Insurance - General Insurance - Insurance Regulation and Supervision - Recent Trends and Developments in Insurance in India		
UNIT-V	Other Financial Institutions and Markets in India	**09**
Non-Banking Financial Companies (NBFCs) - Mutual Funds - Pension Funds - Foreign Institutional Investors (FIIs) - Commodity Markets - Money Markets - Government Securities Market		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
● Define and explain the key concepts and components of the financial system in India.
● Analyze the role of different financial institutions and markets in the Indian financial system.
● Evaluate the regulatory framework for the financial system in India.
● Identify and apply financial system insights to real-world problems.
● Communicate effectively about the financial system in India, both orally and in writing.

Text Book(s):
Khan M.Y, Financial Services, Tata McGraw Hill, Latest Edition
ThummuluriSiddaiah, Financial Services, Pearson India, Latest Edition
Meir Kohn, Financial Institutions and Markets, McGraw Hill Publishing Company, New York, Latest Edition

Reference Books(s) / Web links:
Bhole M.K., Financial Markets and Institutions, Macmillan Publishing Co. Inc., New York. , Latest Edition
Auerbach Robert D., Finance Markets and Institutions, Macmillan Publishing Co. Inc., New York. , Latest Edition
https://www.nseindia.com/education, https://certifications.nism.ac.inhttps://onlinecourses.nptel.ac.in

Course Code	Course Title (Theory course)	Category	L	T	P	C
BF231104	Behavioural Finance	CC	3	0	0	3

Prerequisite:
Introduction to behavioural economics and Introduction to finance

Objectives:
This syllabus is designed to provide students with a comprehensive overview of the field of behavioural finance. It covers the key concepts, theories, and biases that influence financial decision-making. It also discusses the impact of behavioural finance on traditional finance and its applications in practice.

UNIT-I	Introduction to Behavioural Finance	**09**
Behavioural Finance – Intrdocution, History and Evolution, Key Concepts and Theories - The Impact of Behavioural Finance on Traditional Finance - Ethical Implications of Behavioural Finance		
UNIT-II	Cognitive Biases in Financial Decision-Making	**09**
Heuristics and Shortcuts - Framing and Prospect Theory - Mental Accounting - Overconfidence and Self-Attribution - Other Cognitive Biases		
UNIT-III	Emotion and Financial Decision-Making	**09**
The Role of Emotion in Financial Decision-Making - Emotion Regulation and Financial Well-Being - Investor Sentiment and Market Behavior - Gender and Financial Decision-Making		
UNIT-IV	Behavioural Finance in Practice	**09**
Behavioural Finance and Investment Management - Behavioural Finance and Personal Finance - Behavioural Finance and Financial Policy - Behavioural Finance and Corporate Finance		

UNIT-V	Future of Behavioural Finance	09
Emerging Trends in Behavioural Finance - Challenges and Opportunities for Behavioural Finance -Research - Applications of Behavioural Finance to Real-World Problems		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
● Define and explain the key concepts and theories in behavioural finance.
● Identify and apply behavioural insights to real-world financial decision-making problems.
● Critically evaluate the empirical evidence for behavioural finance theories.
● Communicate effectively about behavioural finance, both orally and in writing.
● Develop and conduct their own research on behavioural finance topics.

Text Book(s):
Michael M Pompian, Behavioural Finance and Wealth management: How to build optimal portfolios that account for investor biases, John Wiley, and Son New Jersey, 2002.
Hersh Shefrin, Beyond Greed and Fear: Understanding Behavioural Finance and the psychology of investing, Oxford University Press, New York, 2002.
Richard H Thaler, Advances in Behavioural Finance, Russell Sage Foundation, New York, 2006.

Reference Books(s) / Web links:
Andrei Shleifer, Inefficient Markets: An introduction to behavioural Finance, Oxford University Press, New York, Reprint 2003.
Arnold S. Wood, Amos Tversky, Werner F M De Bondt and Meir Stateman, Behavioural Finance & Decision Theory in Investment Management, AIMR (CFA Institute), New York, 1995.
Daniel Kahneman, Paul Slovic, and Amos Tversky (eds.). (1982) Judgment under Uncertainty: Heuristics and biases, Oxford; New York: Oxford University Press.

Course Code	Course Title (Theory course)	Category	L	T	P	C
BF231105	Financial Technology Services & Management	CC	2	0	0	2

Prerequisite:
Introduction to FinTech and Financial System in India

Objectives:
This syllabus is designed to provide students with a comprehensive overview of the field of financial technology services and management. It covers the key concepts, technologies, and trends in the industry, as well as the regulatory and legal landscape. The syllabus also discusses the impact of fintech on the financial industry and the global economy

UNIT-I	Introduction to Fintech	**09**
Fintech – Introduction, Evolution of Fintech, The Impact of Fintech on the Financial Industry, Fintech Typology, Fintech in Emerging Markets, The Future of Fintech, Fintech Regulation		
UNIT-II	Payments and Cryptocurrencies	**09**
Introduction to Payment Systems - Digital Payments - Mobile Money – Cryptocurrencies - Blockchain Technology - The Future of Payments		
UNIT-III	Digital Finance and Alternative Finance	**09**
The Digitization of Financial Services – Crowdfunding - Peer-to-Peer Lending - Marketplace Lending - Initial Coin Offerings (ICOs) - The Future of Digital Finance		
UNIT-IV	Fintech Regulation and RegTech	**09**
The Evolution of Fintech Regulation - The RegTech Ecosystem - The Use of Artificial Intelligence in Fintech Regulation - Regulatory Sandboxes - The Future of Fintech Regulation		
UNIT-V	Data and Technology in Fintech	**09**
The Role of Data in Fintech - Data Analytics in Fintech - Data Protection and Privacy in Fintech - Artificial Intelligence in Fintech - The Future of Data and Technology in Fintech		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
● Define and explain the key concepts and technologies in fintech.
● Analyze the impact of fintech on the financial industry and the global economy.
● Evaluate the regulatory and legal landscape for fintech.
● Identify and apply fintech insights to real-world problems.
● Communicate effectively about fintech, both orally and in writing.

Text Book(s):
Agustin Rubini, "Fintech in a Flash: Financial Technology Made Easy", Zaccheus, 3rd Edition, 2018
Susanne Chishti and Janos Barberis, " The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries", John Wiley, 1st Edition, 2016 3.
Theo Lynn, John G. Mooney, Pierangelo Rosati, Mark Cummins, "Disrupting Finance: FinTech and Strategy in the 21st Century", Palgrave, 1st edition, 2018 4.

Reference Books(s) / Web links:
Abdul Rafay, "FinTech as a Disruptive Technology for Financial Institutions", IGI Global, January, 2019
Bernardo Nicoletti , The Future of FinTech: Integrating Finance and Technology in Financial Services, Palgrave Macmillan, August, 2018

Semester II

Course Code	Course Title (Theory course)	Category	L	T	P	C
BF232101	Basic Econometrics and Research Methodology	CC	3	0	0	3

Prerequisite:
Basic understanding of mathematics and statistic

Objectives:
This syllabus is designed to provide students with a comprehensive overview of the field of econometrics and research methodology. It covers the key concepts, theories, and methods used in econometrics, as well as applications to real-world problems. It also includes a unit on research methodology, which covers the scientific method, types of research, steps in the research process, and data collection and analysis.

UNIT-I	Introduction to Econometrics	**09**
Econometrics – Introduction, History and Evolution of Econometrics, The Econometric Approach to Modeling Economic Relationships, Types of Econometric Models, Estimation of Econometric Models, Testing and Evaluating Econometric Models		
UNIT-II	Regression Analysis	**09**
The Simple Linear Regression Model - The Multiple Linear Regression Model - Nonlinear Regression Models - Assumptions of Regression Analysis - Testing and Evaluating Regression Models		
UNIT-III	Time Series Analysis	**09**
Introduction to Time Series Data - Stationarity and Non-Stationarity - Autoregressive Integrated Moving Average (ARIMA) Models - Other Time Series Models		
UNIT-IV	Research Methodology	**09**
Scientific Research Method - Types of Research - Steps in the Research Process - Data Collection and Measurement - Data Analysis and Interpretation - Reporting Research Findings		
UNIT-V	Applied Econometrics	**09**
Applications of Econometrics to Public Policy - Applications of Econometrics to Business and Finance - Applications of Econometrics to Other Fields		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
● Define and explain the key concepts and theories in econometrics and research methodology.
● Apply econometric methods real-world problems.
● Critically evaluate econometric research.
● Communicate effectively about econometrics and research methodology, both orally and in writing.
● Design and conduct their own research projects.

Text Book(s):
Gujarathi , D.&Sangeetha, N. (2007). Basic Econometrics (4thed) New Delhi: McGraw Hill
Koutsoyianis, A. (1977). Theory of Econometrics (2nded). London .The Macmillian Press Ltd.
Kothari, C. R. (2004). Research Methodology Methods & Techniques, New Age International Publishers, Delhi.
Gerald Guthrie(2012),Basic Research Methods, Sage, New Delhi.
Majumdar, P.K. (2011), Research Methods in Social Sciences, Viva Books, New Delh
Rowena Murray(2010), How to Write a Thesis, Tata McGraw Hill, New Delhi.

Reference Books(s) / Web links:
Cochran, W. G. (1999).Sampling Techniques, John Wiley & Sons (Asia) Ltd.
Greene W. H. (1997). Econometric Analysis, New Delhi, Pearson.
Johnston J. (1991).Econometric Methods, NewYork, McGraw Hill.
Intriligator M. D. (1991) Econometric Methods, Techniques and Applications, Prentice Hall, Englewood Cliffs, New Jersey

Course Code	Course Title (Theory course)	Category	L	T	P	C
BF232102	Blockchain and Cryptography	CC	3	0	0	3

Prerequisite:
Basic understanding of computer science and mathematics

Objectives:
• To define and explain the key concepts and theories in blockchain technology and cryptography. • To describe the different types of blockchains and how they work. • To analyze and evaluate the potential applications of blockchain technology.

UNIT-I	BlockChain	**09**
Introduction to crypto economics -Byzantine agreement-Extensions of BFT(Ripple,Stellar)-Blockchain Dynamics -Public and private blockchains –Hard and soft forks-Sharing, Side chain-Verifiers-trust, cost and speed-Proof of work and other models.		
UNIT-II	Contracts	**09**
Smart Contracts -Distributed Virtual Machines, Smart Contracts, Oracles-Basics of contract law-Smart contracts and their potential, Trust in Algorithms, -Integration with existing legal systems-Open Zeplin, Open Law-Writing smart contracts.		
UNIT-III	Cryptography	**09**
Cryptography and Other Technologies: Application of Cryptography to Blockchain–Using hash functions to chain blocks-Digital Signatures to sign transactions – Using hash functions for Proof-of-Work.-Putting the technology together- examples of implementations with their tradeoffs.		

UNIT-IV	Implementation	09
Supply Chain and Identity on Blockchain- Blockchain interaction with existing infrastructure- Trust in blockchain data- Scaling Blockchain- reading and writing data. Differentiate nodes, sparse data and Merkle trees –Fixing on the fly-Layer 2 solutions-Lightning and Ethereum state channels		
UNIT-V	Bitcoin	**09**
The big picture of the industry- size, growth, structure, players-Bitcoin versus Cryptocurrencies versus Blockchain -Distributed Ledger Technology (DLT) - Strategic analysis of the space- Major players: Blockchain platforms, regulators, application providers, etc.-Bitcoin, Hyper Ledger, Ethereum, Litecoin, Zcash.		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :

- Define and explain the key concepts and theories in blockchain and cryptography.
- Apply blockchain and cryptography concepts to real-world problems.
- Critically evaluate blockchain and cryptography research.
- Communicate effectively about blockchain and cryptography, both orally and in writing.
- Develop and conduct their own research projects on blockchain and cryptography topics.

Text Book(s):

Blockchain Revolution: How the Technology Behind Bitcoin and Other Cryptocurrencies Is Changing the World, Don Tapscott and Alex Tapscott, Portfolio, 2018.

The Age of Cryptocurrency: How Bitcoin and the Blockchain Are Challenging the Global Economic Order, Paul Vigna and Michael J. Casey, Picador.2016

Blockchain Technology Explained: The Ultimate Beginner's Guide About Blockchain Wallet, Mining, Bitcoin, Ethereum, Litecoin, Zcash, Monero, Ripple, Dash, IOTAAnd Smart Contracts, Alan T. Norman, Create Space Independent Publishing Platform, 2017

Course Code	Course Title (Theory course)	Category	L	T	P	C
BF232103	Applied Behavioural Economics	CC	3	0	0	3

Prerequisite:

Introduction to behavioural economics and Basic Econometrics and Research Methodology

Objectives:

To provide students with a comprehensive overview of the field of applied behavioural economics, and to enable them to apply behavioural insights to real-world problems in a variety of domains, including public policy, development economics, labor markets, health economics, and organizational behavior.

UNIT-I	Conceptualising Welfare	09
Behaviour economics on Welfare and Policy Analysis Conceptualising and measuring welfare- saving, addiction and public good		

UNIT-II	Behavioural Economics and Development Economics	**09**
Immediate barriers in education- demand for commitment – default settlement and savings- default setting and financial institution- Status Quo Bias and Diffusion of Innovations- Self Serving Bias and Evaluation		
UNIT-III	Behaviour economics and labour market	**09**
Wage rigidity, Fairness, reciprocity and wage rigidity- evidence from surveys by economists- evidence from surveys from experimental economists- evidence from organisational psychology and managerial science		
UNIT-IV	Behavioural economics and health economics	**09**
Introduction and background- models of physician behaviour- health care demand and insurance		
UNIT-V	Behavioural economics and organisational behaviour	**09**
Complicating the single-agent risk-incentive model- workers as members of multi-agent firms- top managers and corporate finance- organisational reactions: sorting, repairs and exploitation.		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
● Define and explain the key concepts and theories in applied behavioural economics.
● Identify and apply behavioural insights to real-world problems in a variety of domains.
● Critically evaluate the empirical evidence for applied behavioural economic theories.
● Communicate effectively about applied behavioural economics, both orally and in writing.
● Develop and conduct their own research on applied behavioural economic topics.

Text Book(s):
Introduction to Behavioural Economics and Its Applications- Peter Diamond and Hannu Vartiainen (ed.), Princeton University Press, 2012
Handbook of Behavioural Economics-Foundations and Applications - BD Bernheim, S DellaVigna, D Laibson(ed), North Holland ,2019
The foundations of behavioural economics –Sanjit Dhami, Oxford, 2020
Applied Behavioural Economics Research and Trends, Rodica Ianole, IGI Global, 2016

Course Code	Course Title (Theory course)	Category	L	T	P	C
BF232104	Global Financial Markets and Instruments	CC	3	0	0	3

Prerequisite:
Financial System in India and Behavioural Finance

Objectives:
To introduce the basic concepts of international financial system, institutions involved, instruments traded and the nature of short term and long term markets operate in it. To highlight the role and functioning of different international financial institutions facilitating the working of global financial markets Learning Outcome:

UNIT-I	Currency system	**09**
Euro Currency system – Initial years 1958-69 – Mature Years 1970 – 74 – Decline and Fall of Breton Woods System – Role of Central Banks – Monetary controls – Problems of Intermediation.		
UNIT-II	Central Banks	**09**
Central Banks – US Federal – European Central Banks – Central Bank of Japan – Bank of England – Peoples bank of China – Central bank of Russia – Brazil – Saudi Arabia Monetary Agency.		
UNIT-III	Financial Crisis	**09**
Latin American and African Debt crisis 1982 – Asian Financial and Economic crisis 1963 – The Argentina crisis of 2001 – GFC 2008 – International Response to GFC		
UNIT-IV	Regulatory Frameworks	**09**
The Brady plan of 1989 to 1994 – Post GFC – International Financial Regulators – Dodd Frame Act of USA – Global Measures – IMF Regulations – Bank Levis& Financial Taxes – A sovereign Bankruptcy Regime.		
UNIT-V	Euro Markets	**09**
Euro Debt Markets – Euro currency Markets – Evolution of Euro and Markets – Types – Volumes – operations across countries		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
● Helps the students to work in the global financial consultancy firms
● Acquire practical knowledge and understanding in global financial markets and trade Methodology:

Text Book(s):
1. Ross P. Buckley, Douglas Arner, "From Crisis to Crisis, The global Financial System and Regulatory Failure", Kluwer Law International, ISBN 9789041133540, 2011.
2. Antonio G. Fazio, Luigi De Rosa, "International Banking and Financial Systems: Evolution and Stability", 2003.
3. Lessambo, Felix I, "The International Banking System Capital Adequacy, Core Businesses and Risk Management", 2012, Palgrave Macmillan UK

Reference Books(s) / Web links:
George W. McKenzie, "The Economics of the Euro-Currency System", Macmillan Publishers Limited 1976 5. Daniel Gros, Karel Lannoo, "The Euro Capital Market", ISBN: 978-0-471-99762-7, Wiley
https://dbie.rbi.org.in/ https://www.imf.org/en/Data https://www.nasdaq.com/

Course Code	Course Title (Theory course)	Category	L	T	P	C
BF232105	Behavioural Game Theory	CC	2	0	0	2

Prerequisite:
Introduction to behavioural economics and Basic Game Theory

Objectives:
To introduce students to the basic concepts and theories of behavioural game theory. To develop students' ability to apply behavioural game theory to real-world problems. To enhance students' critical thinking and problem-solving skills.

UNIT-I	Introduction to Behavioural Game Theory	**09**
Behavioural game theory - History and evolution, Key concepts and theories, Rationality and bounded rationality, Cognitive biases, Emotions and social preferences, Social learning and norms		
UNIT-II	Behavioural Game Theory in Practice	**09**
Applications of behavioural game theory to a variety of real-world problems - Public policy. Business strategy, Marketing, Negotiations, Conflict resolution		
UNIT-III	Behavioural Game Theory Experiments	**09**
An overview of the experimental methods used to study behavioural game theory - Discussion of selected experimental findings - Design and implementation of a behavioural game theory experiment		
UNIT-IV	Behavioural Game Theory Modeling	**09**
An overview of the mathematical models used to study behavioural game theory - Development of a behavioural game theory model		
UNIT-V	Future of Behavioural Game Theory	**09**
Emerging trends in behavioural game theory research - Challenges and opportunities for behavioural game theory		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
● Define and explain the key concepts and theories of behavioural game theory.
● Identify and apply behavioural game theory insights to real-world problems.
● Critically evaluate the empirical evidence for behavioural game theory theories.
● Communicate effectively about behavioural game theory, both orally and in writing.
● Develop and conduct their own research on behavioural game theory topics.

Text Book(s):
Osborne, M.J. An Introduction to Game Theory, Oxford University Press, 2004
Mas-Colell, A., M.D. Whinston and J.R. Green Microeconomic Theory, Oxford University Press, 1995
Gibbons, R. A Primer in Game Theory, Pearson Education, 199

Semester III

Course Code	Course Title (Theory course)	Category	L	T	P	C
BF233101	Behavioural Economics in Public Policy	CC	3	0	0	3

Prerequisite:
Introduction to behavioural economics and Public Policy

Objectives:
To provide students with a comprehensive overview of the application of behavioural economics to public policy, and to enable them to design and implement public policies that are more effective in addressing real-world problems

UNIT-I	Introduction	**09**
Behaviour economics –cognition – choice - policy design- bounded rationality- bounded self-control- bounded self-interest- public policy implications and application		
UNIT-II	Incentives and norms for public policy	**09**
Incentives, norms and public policy- social forces in markets and collective action problem- social norms versus market incentives- getting incentives and norms right		
UNIT-III	Nudge and policy design	**09**
Behaviour economics and regulatory policy- nudge- policy design- simplification of information and choice-default and convenience- salience and attention- debasing and decision quality- regulatory methods- regulatory delivery		
UNIT-IV	Government policy –taxation	**09**
Taxation and tax compliance- tax attitude by individual tax payers- regulation- strategies- interaction between tax payers and tax authorities-practical implications		
UNIT-V	Behaviour and environment	**09**
Standard economic approach to environment- psychology of environmentally sustainable- image motivation-loss aversion- saliency and availability bias- mental accounting- discounting- psychology of unsustainable consumption		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
● Define and explain the key concepts and theories in behavioural economics and public policy.
● Identify and apply behavioural insights to the design and implementation of public policies in a variety of domains.
● Critically evaluate the empirical evidence for the effectiveness of behavioural public policies.
● Communicate effectively about behavioural economics and public policy, both orally and in writing.

Text Book(s):
Behaviour economics and policy designs, Ed, Donald Low, World Scientific, 2012
Economic Psychology (ed) Rob Rinyard, Wiley, 2018, chapter 16
Bounded Rationality and Public Policy- perspectives from behavioural economics, Alistar Munro, Springler, 2009

Reference Books(s) / Web links:
Scarcity, Why having too little means so much, Sendhil Mullainathan and Eldar Shafir; Time Books,
Regulatory Policy and Behavioural Economics, by Pete Lunn, OECD, 2014
Thinking Fast and Slow, Daniel, Kahneman,2011
Predictably irrational: the hidden forces that shape our decision; Dan Ariely, HarperCollins, 2008
Scarcity, Why having too little means so much, Sendhil Mullainathan and Eldar Shafir; Time Books,

Course Code	Course Title (Theory course)	Category	L	T	P	C
BF233102	Digital Banking	CC	3	0	0	3

Prerequisite:
Introduction to FinTech and Financial System in India

Objectives:
To familiarise the students about banking in a digitalised environment with prime focus on the need for digitalisation of banking industry, innovative banking products, banking management in a technological environment and banking and information security.

UNIT-I	Information Technology in Banking	**09**
Trends in information technology- Recent development in Banking- usage and impact of IT in Banking- opportunities in banking industry- Development of technology in Banks- Development of ICT based banking products- Role of IDBRT (Institute of Development & Research in Banking) in banking technology Development- status of E-Banking in India- process of E-Banking		
UNIT-II	Digital Banking	**09**
Meaning- Definition- Need for digitalization- Advantages to the customers- opportunities to the Bank- Dimensions of digital Banking- Customer dimension (customer in a digitalized environment)- Regulatory dimension- Technology dimension- Data dimension- Analytical dimension (customer analysis, analytical CRM, fraud analytics, risk analytics, operational analytics, HR analysis, network analysis)- Internal dimension- channels of digital payment (ATM, Kiosk, Mobile Banking, etc.)		

UNIT-III	Digital Banking and Cash-less Payments	**09**
Cash less payments- meaning- benefits of cashless payment-methods of cash less payments (cards, USSD, AEPS, UPI, point of sale) NFC cards- wallet platform- E-KYC- features of E-KYC services- Aadhaar based payment- UIDAI- ASAs- AUA- NEFT- smart cards- cyber security for digital payment		
UNIT-IV	CRM and digital Banking	**09**
CRM- Meaning- definition- role of CRM in banking- CRM in a digitalized environment- current status of e-CRM in banks- e-CRM techniques- benefits of eCRM- data warehousing and data mining- analytical CRM- customer retention.		
UNIT-V	Cyber Security and Banking	**09**
Information security- software based security systems- hardware based security systems (smart card, M chip)- hackers- techniques used by the hackers- phishing- pharming- key loggers- screen loggers- phishing Trojans- transaction poisoning- card related fraud- site cloning- false merchant site- authentication methodologies and security measures (password protection- smart cards- biometric characteristics)- encryption and security- customer confidentiality- regulatory environment of internet banking.		
		Total Contact Hours: 45

Course Outcomes: After completing the course, the Learners will be able to :
● Define and explain the key concepts and technologies in digital banking.
● Analyze the impact of digital banking on the financial industry and the global economy.
● Evaluate the regulatory and legal landscape for digital banking.
● Apply digital banking technologies and solutions to real-world problems.
● Communicate effectively about digital banking, both orally and in writing.

Text Book(s):
1. Avasthi, A (2015). Impact of technology in Banking Sector: Mumbai: Shroff.
2. Indian Institute of Banking (2016). IT security. Mumbai: Taxman.
3. Indian Institute of Banking (2016). Digital banking. Mumbai: Taxman.

Reference Books(s) / Web links:
Muraleedharan, D (2014). Modern Banking: Kerala: Prentice Hall India Learning Private Limited.
Skinner, C. (2014). Digital bank: strategies to launch or become a digital bank. Singapore: Marshall Cavendish international (Asia).
Shroff, T F. (2007). Modern Banking Technology: New Delhi: Northern Book Centre. PGDFBT – 104: Legal and Regulatory Aspects of Banking Objectives:

Course Code	Course Title (Theory course)	Category	L	T	P	C
BF233103	Capstone Project	CC	0	0	6	6

Prerequisite:
All other subjects in the program

Objectives:
To develop problem and address the problem through models, prototype etc. for the problem

	Guidelines	
Students under the guidance of Faculty in-charge(s) of the given project work, carry out the background work, identify a tentative Title for the Project work, Review20-25 Research papers, prepare a Review Paper, surveying and preparing report Final Project Report must contain the following Components: (75-100 Pages) 1. Title Page (Soft Binding) 2. 4-5Chapters (Back ground work, Methodology/Algorithm/Mathematical Model) 3. The final project report should be prepared by following the template provided by the department.		

Course Outcomes: After completing the course, the Learners will be able to :
● To understand and appreciate various concepts in related current and previous semesters
● To acquire required knowledge and demonstrate skills learned in the semester

Teaching Methodology & Assessment Structure:

The curriculum is designed to provide students with a strong foundation in the key concepts and theories of behavioral economics and fintech. The curriculum offers students opportunities to apply what they have learned to real-world situations.

The first semester of the curriculum should focus on introducing students to the basics of behavioral economics and fintech.

The second semester should focus on more advanced topics, such as behavioral game theory and global financial markets.

The third semester should focus on applying the concepts and theories of behavioral economics and fintech to public policy and digital banking.

They encourage learners to question, challenge and formulate their ideas, opinions and conclusions.

The teaching methodology used are:

- Problem Based Learning
- Learning Constructivist Approach
- Case Studies
- Peer Tutorials
- E-Learning
- Blended Learning
- Flipped Classrooms
- Experiential Learning
- Industrial Visits
- Practical

Assessment Structure

The course has a trimester-based structure. Each quarter consisting of 4 months, approximately12 weeks of teaching. The schedule of trimesters is as follows:

Year	Trimester	Scheme oftrimesters
1	T1	Theory
1	T2	Theory
1	T3	In-plant

Evaluation:

The marks allotted for evaluation to all subjects would be 100. The weightage to different modes of assessments shall be as under.

	In-term Evaluation		End Term Exam	Components of continuous mode
	Continuous Assessment	Mid Term Exam		
Theory	50	-	50	Quizzes, class tests (open or closed book), home assignments, group assignments, *viva-voce* assignments, discussions
Practical	50	-	50	Attendance, *viva -voce*, journal, assignments, project, experiments, tests

The curriculum and syllabus for BEHAVOIURAL ECONOMICS AND FINTECH are in conformance to the following sustainable goals .

SDG 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	Interdisciplinary Synergy	The program combines two highly relevant and complementary fields—behavioral economics and FinTech. Behavioral economics explores how human behavior influences economic decisions, while FinTech leverages technology to transform financial services. The curriculum allows students to understand the interplay between these domains, fostering innovative solutions and strategies
SDG16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	Ethical Considerations	The curriculum integrates ethical considerations in FinTech development and deployment. Graduates are trained to make ethical decisions when designing and marketing financial products, promoting responsible financial practices, and maintaining consumer trust
SDG9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Innovation and Entrepreneurship	The curriculum fosters innovation and entrepreneurial thinking, preparing graduates to contribute to the development of new FinTech startups and solutions that leverage behavioral insights.

PG DIPLOMA IN FIN TECH & CONSUMER PSYCHOLOGY

(Diploma – 1 Year)

CURRICULUM AND SYLLABUS

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

- To demonstrate a strong understanding of the key concepts, technologies, and applications of Fin Tech .
- To apply Fin Tech and solutions to real-world problems in the financial industry.
- To communicate effectively about Fin Tech, both orally and in writing.
- To understand the consumer psychology about Fin Tech products

PROGRAM OUTCOMES (PO)

- Apply knowledge of consumer psychology to solve complex real life situations.
- Design and implement digital banking systems and applications.
- Analyze and evaluate financial technologies and solutions.
- Work effectively in teams to design and develop Fin Tech.
- Demonstrate professional ethics and social responsibility in the use of Financial technologies

CURRICULUM AND SYLLABUS

Semester I

S.No	Course Code	Course title	Category	L	T	P	Total	Credits
01	FCP231101	Introduction to Behavioral Economics	CC	3	0	0	3	3
02	FCP231102	Consumer Psychology Fundamentals	CC	3	0	0	3	3
03	FCP231103	Behavioral Economics in Finance	CC	3	0	0	3	3
04	FCP231104	Digital Marketing and Consumer Behavior	CC	3	0	0	3	3
05	FCP231105	Financial Data Analysis	CC	2	0	1	3	3

Semester II

S.No	Course Code	Course title	Category	L	T	P	Total	Credits
01	FCP 232101	Neuro economics and Decision Neuroscience	CC	3	0	0	3	3
02	FCP 232102	Fin Tech Products and user experience	CC	3	0	0	3	3
03	FCP 232103	Digital Banking	CC	3	0	0	3	3
04	FCP 232104	Fin Tech and Regulatory Compliance	CC	3	0	0	3	3
05	FCP 232105	Fin Tech Security and Ethics	CC	3	0	0	3	3
06	Elective	Digital Business	EC	3	0	0	3	3
07	Elective	Fin Tech and SDG's	EC	3	0	0	2	3
08	Elective	Cyber Laws	EC	3	0	0	3	3
09	Project	Capstone Project	EEC	0	0	04	4	4
Total Credits								**40**

CC : Core Courses

EC : Elective Course (Choose any Two)

EEC : Employability Enhancement Courses

Prerequisites:

Applicants are required to have a bachelor's degree in finance, psychology, business, or a related field. Proficiency in statistics and data analysis tools is recommended but can be addressed through foundational courses if necessary.

Program Description: This program aims to equip students with a deep understanding of the intersection between Fin Tech and consumer behavior. Graduates will be prepared to design, analyze, and optimize financial products and services with a focus on the psychology of consumer decision-making.

SEMESTER -1

Course Code	Course Title (Theory course)	Category	L	T	P	C
FCP231101	**Introduction to Fin Tech**	CC	3	0	0	3

Unit-1 Overview of Fin Tech	**09**
History and evolution of Fin Tech, the shifting financial landscape, the future of AI in finance, Decentralized finance – the golden 9, Libra-the latest innovation.	
Unit-2 Key technologies in Fin Tech	**09**
Nurturing new Fin Tech companies, Block chain and Distributed Ledger Technology (DLT), Artificial Intelligence (AI) and Machine Learning (ML), Crypto-currencies, Robotic Process Automation (RPA), Cloud Computing, Chabot's and Natural Language Processing (NLP)	
Unit-3 Block chain Technology and Infrastructure	09
Block chain Foundations, Blocks and Block chain, the Chain, Nodes and Network ,Block chain in Use Trust Framework and Consensus Mechanisms, Public, Consortium, Private Block chains, Block chain Interoperability	
Unit-4 Regulatory Landscape for Fin Tech	09
Jurisdiction and Compliance, Licensing and Registration, Consumer Protection, Data Privacy and Security, Crowdfunding and Peer-to-Peer Lending	
Unit-5 The Future of Fin Tech	09
Emerging Markets and Social Impact, Enterprise Innovation, the Rise of BancTec – The Beauty of a Hybrid Model for Banks, Embracing the Connected API Economy, Eliminating Friction in Customers' Financial Lives, A Future Without Money, Ethics in Fin Tech.	
	Total contact Hours : 45

References

1. "Fin Tech Innovation: From Robo-Advisors to Goal-Based Investing and Gamification" by Paolo Sironi
2. "Fin Tech For Dummies" by Anteneh Ayanso and Brendan Y. Harris
3. "Blockchain Basics: A Non-Technical Introduction in 25 Steps" by Daniel Drescher
4. "Fin Tech and the Remaking of Financial Institutions" by Bennet Vallet and Stéphane Goutte
5. "Behavioral Risk Management: Managing the Psychology That Drives Decisions and Influences Operational Risk" by Hersh Shefrin

Course Code	Course Title (Theory course)	Category	L	T	P	C
FCP231102	**Fundamentals of Consumer Psychology**	CC	3	0	0	3

Unit-1 Introduction Of Consumer Psychology	**09**
Concept and need for studying consumer behavior , Understanding the Diversity of consumer behavior , The value of consumer research , Application: consumer behavior and marketing management	
Unit-2 Consumer Modelling	**09**
Learning model ,Psychoanalytic model, The sociological model, Application: Webster and wind model of organizational buying behavior	
Unit-3 Individual Consumer Behaviour	**09**
Perception - Meaning of perception & related terms , External and internal factors, The perceptual process & factors responsible for perceptual distortion , memory and learning-, Mood, emotion and involvement, Consumer attitude, Marketing Communication.	
Unit-4 Consumer Decision Making	**09**
Situational Influences , Consumer Decision Process and Problem Recognition , Information Search, Alternative Evaluation and Purchase , Social influence on consumer behavior	
Unit-5 Interpersonal and Social Consumer Psychology	**09**
Identity-Signaling Behavior, Coping Research in the Broader Perspective: Emotions, Threats, Mindsets, and More, Power and Consumer Behavior, Social Hierarchy, Social Status, and Status Consumption, Word of Mouth and Interpersonal Communication, Interpersonal Influences in Consumer Psychology: When Does Implicit Social Influence Arise? Agency and Communion as a Framework to Understand Consumer psychology.	
	Total contact Hours : 45

References:

Consumer Behavior – Building Marketing Strategy, tenth edition. Hawkins, Mothersbaugh, Best; McGraw-Hill, 2007. ISBN-10: 0-07-310137-0

2. Curtis P Haugtvedt- Handbook of Consumer Psychology, Psychology Press

3. Barrie Gunter- The Psychology of Consumer Profiling in a Digital Age. Routledge

4.Schiffman,L.G, Kanuk,l.l.(1999). Consumer Behavior. New Delhi: Prentice Hall of India Ltd

Course Code	Course Title (Theory course)	Category	L	T	P	C
FCP231103	**Behavioral Economics in Marketing**	CC	3	0	0	3

Unit-1 Introduction to Behavioral Economics	**9**
History and evolution of behavioral economics, relationship with other disciplines, Objectives scope and structure, methods of behavioral economics, Current directions	
Unit-2 Introduction to Behavioral Psychology	**9**
Behaviorism- History and evolution, Techniques in behavioral psychology , Social psychology, Social interaction, Work and environment	
Unit-3 Foundation of Marketing	**9**
Marketing- Concepts, Market Information system, Marketing Mix, marketing matrix, emerging trends in marketing	
Unit-4 Behavioral aspects of Marketing	**9**
Consumer motivation, Perception, Attitudes and beliefs, learning and memory, Cultural and social influences, perceived risk, Brand loyalty and Trust, Sensory Marketing	
Unit-5 Behavioral Economics: Summary and Outlook	**9**
The agenda of behavioral economics, Criticisms of behavioral economics, Methodology , Are we really irrational?, Welfare and happiness ,Problems in pursuing happiness , Policy implications , Future directions for behavioral economics	
	Total contact Hours : 45

References

1. Robert B. Cialdini , 2009 . Influence: The Psychology of Persuasion
2. Phil Barden , 2013. Decoded: The Science Behind Why We Buy
3. An introduction to Behavioural Economics by Nick Wilkinson and Matthias Klaes
4. "Nudge: Improving Decisions About Health, Wealth, and Happiness" by Richard H. Thaler and Cass R. Sunstein

Course Code	Course Title (Theory course)	Category	L	T	P	C
FCP231104	**Digital Marketing and Consumer Behavior**	CC	3	0	0	3

Unit-1 Digital marketing strategies and consumer engagement	**9**
Introduction to digital marketing, understanding digital transformation, Data driven marketing , users of digital marketing, techniques of digital marketing -Social media marketing, email marketing, content marketing, Search engine optimization, pay per click.	
Unit-2 Social media marketing	**9**
Social media optimization- meaning and concepts, social media networks, types of social media websites, Facebook, Google+, LinkedIn, YouTube, Pinterest, Social Media Analytics	
Unit-3 Analyzing online consumer behavior	**9**
Consumer buying habits and perceptions of emerging non-store choices, Web analytics, Social media listening, Customer surveys, Focus groups, target marketing.	
Unit-4 Groups and Social Media	**9**
The power of online communities in influencing consumer opinions, Subcultures & Culture- The impact of social groups, forums.	
Unit-5 Strategic marketing applications	**9**
Market segmentation strategies - Positioning strategies for existing and new products, Re-positioning, Perceptual Mapping - Marketing communication - Store choice and shopping behavior - In-Store stimuli, store image and loyalty - Consumerism - Consumer rights and Marketers' responsibilities	
	Total contact Hours : 45

References:

1. Ryan Deiss, Russ Henneberry 2020: Digital Marketing For Dummies
2. Donald Miller 2017 : Building a StoryBrand: Clarify Your Message So Customers Will Listen
3. Puneet Singh Bhatia 2019: Social Media & Mobile Marketing: Includes Online Worksheets
4. Seema Gupta 2022: Digital Marketing

Course Code	Course Title (Theory course)	Category	L	T	P	C
FCP231105	**Financial Data Analysis**	CC	3	0	1	4

Unit-1 Introduction to data analysis	**9**
Data analytics, the data ecosystem, Technologies & Domains involved in Analytics ,Different types of Analytics – Descriptive, Predictive and Prescriptive Analytics.	
Unit-2 Data analysis in Fin Tech	**9**
Data collection , data aggregation, Data cleaning, data preprocessing, Analyze data, data visualization and communication.	
Unit-3 Introduction to Data tools	**9**
Artificial intelligence, block chain, Business analytics with excel Programming Basics and Data Analytics with Python, R Programming for Data Science, SQL, PowerBI, SAS (Statistical Analysis System)	
Unit-4 Data reporting and visualization	**9**
Purpose and audience, Data Preparation, types of visualization- bar charts, line charts, pie charts, Tree maps, heatmaps;Accessibilty, feedback and iteration.	
Unit -5 Recent trends in data analysis	**9**
AI, Business Intelligence, Edge computing, Data democratization, Data mesh architecture.	
	Total contact Hours : 45

References

1. Python for Data Analysis" by Wes McKinney
2. "Practical Statistics for Data Scientists" by Andrew Bruce and Peter Bruce
3. "Quantitative Financial Analytics: The Path to Investment Profits" by Kenneth L. Grant
4. "Advances in Financial Machine Learning" by Marcos López de Prado
5. "Statistics and Data Analysis for Financial Engineering" by David Ruppert and David S. Matteson
6. "Financial Analytics with R: Building a Laptop Laboratory for Data Science" by Mark J. Bennett and Dirk L. Hugen

SEMESTER 2

Course Code	Course Title (Theory course)	Category	L	T	P	C
FCP 232101	**Neuro economics and Decision Neuroscience**	CC	3	0	0	3

Unit-1 Introduction to neuro economics	**9**
History and evolution, neoclassical economics, cognitive neuroscience, Axiomatic Neuroeconomics	
Unit-2 Decision making	**9**
Formal Models of Decision Making and Cognitive Neuroscience, factors affecting decision making process, axiomatic decision theory, static stochastic choice, random walk model, decision in perpetual talks.	
Unit-3 Experimental Neuroeconomics and Non-cooperative Games	**9**
Extensive form games, normal and strategic form games, mixed strategy equilibrium, trembling hand equilibrium, Neuroeconomics experiments	
Unit-4 Decision neuroscience	**9**
Neural Basis of Decision Making, Behavioral Experiments, Value-based Decision Making, Implications for Behavior and Disorders, Computational Models, Neuroethics	
Unit 5 Recent trends in Neuroeconomics	**9**
Integration with machine learning and AI, temporal dynamics and decision making, neuroeconomics in public policy, neuroeconomics of morality and ethics, Neuroeconomics and Behavioral Economics Integration .	
	Total contact Hours : 45

References

1. "Neuroeconomics: Decision Making and the Brain" by Paul W. Glimcher and Ernst Fehr
2. "Foundations of Neuroeconomics Analysis" by Paul W. Glimcher and Ernst Fehr
3. Risk and Rationality: Philosophical Foundations for Populist Reforms" by Kevin D. Hoover
4. Neuroeconomics: A Guide to the New Science of Making Choices" by Peter Politser
5. "Advances in Behavioral Economics" edited by Colin F. Camerer, George Loewenstein, and Matthew Rabin

Course Code	Course Title (Theory course)	Category	L	T	P	C
FCP 232102	**Fin Tech Products and user experience**	CC	3	0	0	3

Unit-1 Designing Fin tech Products	**9**
Types of Fin Tech products, steps in designing Fin Tech product, cost of design, pricing of Fin Tech products	
Unit-2 Marketing of Fin tech products	**9**
Understand your audience, clear value proposition, Content marketing, influencer partnerships, email marketing.	
Unit -3 Fin tech Applications	**9**
Applications in Banking- Digital payment and mobile wallets, online banking and digital accounts, applications in insurance- Insuretech, startups, digital distribution and aggregators, P2P insurance, applications in Investment- AI powered trading algorithms, Robo-advisors, online brokerage platforms, Crowd funding platforms.	
Unit-4 Fin Tech & Consumer Experience	**9**
Importance of consumer experience, UX design, Fin Tech UX, e-commerce websites, perception of consumers towards Fin Tech products**.**	
Unit-5 Case studies of Successful Fin Tech Companies	**9**
Paytm, pinelabs, CRED, Razorpay, Billdesk, Phonepay, Googlepay, Zeta, Groww	
Total contact Hours : 45	

References

1. "The Age of Cryptocurrency: How Bitcoin and the Blockchain Are Challenging the Global Economic Order" by Paul Vigna and Michael J. Casey
2. "Blockchain Basics: A Non-Technical Introduction in 25 Steps" by Daniel Drescher –
3. "The Fin Tech Effect" by Susanne Chishti and Janos Barberis -
4. "Digital Bank: Strategies to Launch or Become a Digital Bank" by Chris Skinner -
5. "InsurTech: Revolutionizing the Insurance Industry through Technology" by Sabine L.B VanderLinden, Shân M. Millie, Nicole Anderson -
6. "AI in Financial Services: Technology, Applications, and Impact" by Susan Gourvenec and Mark Bishop -
7. "Fin Tech and the Remaking of Financial Institutions" by Anthony M. Townsend - Townsend exam

Course Code	Course Title (Theory course)	Category	L	T	P	C
FCP 232103	**Digital Banking**	CC	3	0	0	3

Unit-1	**Information Technology in Banking**	**9**
Trends in information technology- Recent development in Banking- usage and impact of IT in Banking- opportunities in banking industry- Development of technology in Banks- Development of ICT based banking products- Role of IDBRT (Institute of Development & Research in Banking) in banking technology Development- status of E-Banking in India- process of E-Banking		
Unit-2	**Introduction to Digital Banking**	**9**
Meaning- Definition- Need for digitalization- Advantages to the customers- opportunities to the Bank- Dimensions of digital Banking- Customer dimension (customer in a digitalized environment)- Regulatory dimension- Technology dimension- Data dimension- Analytical dimension (customer analysis, analytical CRM, fraud analytics, risk analytics, operational analytics, HR analysis, network analysis)- Internal dimension- channels of digital payment (ATM, Kiosk, Mobile Banking, etc.)		
Unit-3	**Digital Banking and Cash-less Payments**	**9**
Cash less payments- meaning- benefits of cashless payment-methods of cash less payments (cards, USSD, AEPS, UPI, point of sale) NFC cards- wallet platform- E-KYC- features of E-KYC services- Aadhaar based payment- UIDAI- ASAs- AUA- NEFT- smart cards- cyber security for digital payment		
Unit-4	**CRM and digital Banking**	**9**
CRM- Meaning- definition- role of CRM in banking- CRM in a digitalized environment- current status of e-CRM in banks- e-CRM techniques- benefits of eCRM- data warehousing and data mining- analytical CRM- customer retention.		
Unit-5	**Cyber Security and Banking**	**9**
Information security- software based security systems- hardware based security systems (smart card, M chip)- hackers- techniques used by the hackers- phishing- pharming- key loggers- screen loggers- phishing Trojans- transaction poisoning- card related fraud- site cloning- false merchant site- authentication methodologies and security measures (password protection- smart cards- biometric characteristics)- encryption and security- customer confidentiality- regulatory environment of internet banking.		
		Total contact Hours : 45

References

1. Muraleedharan, D (2014). Modern Banking: Kerala: Prentice Hall India Learning Private Limited.
2. Skinner, C. (2014). Digital bank: strategies to launch or become a digital bank. Singapore: Marshall Cavendish international (Asia).
3. Shroff, T F. (2007). Modern Banking Technology: New Delhi: Northern Book Centre. PGDFBT – 104: Legal and Regulatory Aspects of Banking Objectives:

Course Code	Course Title (Theory course)	Category	L	T	P	C
FCP 232104	**Fin Tech and Regulatory Compliance**	CC	3	0	0	3

Unit-1 Regulatory Challenges in Fin Tech	**9**
Regulatory uncertainty, licensing and compliance, cross border regulations, data privacy and security, consumer protection.	
Unit-2 Complying with consumer protection regulations	**9**
Consumer protection- meaning, regulations, consumer protection Act, Fair price, unfair trade practices. Case studies.	
Unit-3 A Conceptual Framework: Private, Public and Regulatory Nudges	**9**
Introduction, Nudge design and implementation: making distinctions, Nudging intersects the law, Private nudges, Self-regulatory nudging, Nudge products, other private nudges Challenges and solutions.	
Unit-4 Ethical considerations in financial technology	**9**
Ethics in Fin Tech, data privacy, innovation with purpose, overregulation, data monopolies, innovation constraints.	
Unit-5 Application of Fin Tech in Policy Making	**9**
Data analytics and insights, regulatory technology, digital identity and authentication, financial inclusion, crowdfunding and p2p lending, monitoring and surveillance	
	Total contact Hours : 45

References

1. "Fin Tech: The Beginner's Guide to Financial Technology" by Matthew Driver
2. RegTech Revolution: A Regulatory Technology Primer" by KPMG International
3. The Fin Tech Book: The Financial Technology Handbook for Investors, Entrepreneurs, and Visionaries" by Susanne Chishti and Janos Barberis
4. RegTech for Dummies" by Swami Natarajan and Matt Savare

Course Code	Course Title (Theory course)	Category	L	T	P	C
FCP 232105	**Fin Tech Security and Ethics**	CC	3	0	0	3

Unit-1 Fin Tech Security	**9**
Meaning , cybersecurity challenges in Fin Tech industry- malware attack, identity theft, money laundering risks, third party risks, insider threats, compliance.	
Unit-2 Ethical Issues in the Use of Financial Technology	**9**
Privacy and Data Security, transparency and disclosure, fair lending and discrimination, financial inclusion and accessibility, ethical investing and sustainability, greenwashing.	
Unit-3 Overcoming Fin Tech Threats	**9**
Data encryption, Multi factor Authentication, Secure API's, regular security audit and testing, identity verification and KYC, Data backup and disaster recovery.	
Unit-4 Security Considerations in Fin Tech Applications	**9**
Data-at-Rest Encryption, Authentication and Authorization, Secure Password Policies Input Validation and Sanitization, Regular Security Audits and Penetration Testing, Monitoring and Logging, Secure Cloud Infrastructure.	
Unit -5 Privacy and Data Protection	**9**
Data privacy and protection – regulatory measures, Case studies on data privacy and data protection	
	Total contact Hours : 45

References :

1. "Block chain Basics: A Non-Technical Introduction in 25 Steps" by Daniel Drescher
2. "Digital Gold: Bitcoin and the Inside Story of the Misfits and Millionaires Trying to Reinvent Money" by Nathaniel Popper
3. "The Basics of Bitcoins and Block chains" by Antony Lewis
4. "The Age of Cryptocurrency: How Bitcoin and Digital Money Are Challenging the Global Economic Order" by Paul Vign

Elective 1: Digital Business

Unit-1. Electronic Commerce	**9**
The Digital Revolution and Society, The Digital and Social Worlds - The DigitalEconomy, The Digital Enterprise, Virtual Communities, Online Communities, Defining Electronic Commerce,Emerging E-Commerce Platforms. E-Business, Electronic Markets and Networks, Impact of E-Commerce on business, government, customers, citizens and society.	
Unit-2. Social Commerce :	**9**
Social Commerce: Social Commerce, Social Business(Enterprise), Social Business Networks and Social Enterprise, Social Media, Platforms for Social Networking; SocialMedia Marketing, Enterprise 2.0, Improved Business Models. Entrepreneur Networks, Enterprise Social Networks, Benefits to Customers, Retailers, Employees, players in the ecosystem.	
Unit-3. Digital Business Ecosystem:	**9**
Electronic Commerce Mechanisms, Online Purchasing Process, E-Marketplaces- Types, Electronic Catalogs, Search Engines, and Shopping Carts, Changing Supply Chains, Digital Payments: Smart Cards, Stored-Value Cards, EC Micropayments, Payment Gateways, Mobile Payments, Digital and Virtual Currencies.	
Unit-4. Digital Business Applications I-	**9**
Electronic Retailing: B2C Electronic Retailing, Classification of Models by Distribution Channel, Social Shopping – Concept, Benefits and Drivers, Social Shopping Aids –Digital Government: E-Government and Social Networking, M-Government. E-Learning, E-Training, and E-Books,Social Networks and E-Learning, E-Learning Management Systems	
Unit-5. Digital Business Applications - II:	**9**
Online Travel and Tourism Services: E-Employment: Online Job Market, Social Recruiting, Virtual Job Fairs and Recruiting Events, E-Health: Definition, Electronic Medical Record Systems (EMR), Entertainment, Media & Gaming: Service Industry Consumer Applications. Social Entertainment.	
	Total contact Hours : 45

References :

1. Introduction to E Commerce & Social Commerce, Turban E , Whiteside J , King D, Outland J Springer
2. E-Business and E-Commerce Management- Strategy, Implementation and Practice, Dave Chaffey, Pearson Education.
3. Electronic Commerce – A Managerial Perspective, Efraim Turban, David King, Dennis Viehland, Jae Lee, Pearson Education.

Elective 2: Fin Tech and Sustainable Development Goals

Unit-1 Sustainable development goals	**9**
SDG- Meaning, adoption, implementation, 17 SDG's, Costs, Monitoring Mechanism, Challenges, Criticism, Communication advocacy	
Unit-2 Big Fin Tech and Sustainable Development Goals	**9**
Payment platforms, Financial Inclusion, e commerce platforms, micropayment, Bigtech cloud service, tech fin platforms.	
Unit-3 Big Fin Tech Companies	**9**
Alipay (Ant technology group), Apple Pay, Fnality, Facebook, Google Pay, JPM Coin, MTN, Paytm, People's Bank of China, Safaricom, Tencent (WeChatPay)	
Unit-4 Impact of Fin Tech on SDG	**9**
CSR-ESG-SDG combined lens, Fin Tech in banking, Fin Tech in marketing, Fin Tech in supply chain management, Fin Tech in HR.	
Unit-5 Big Fin Tech case studies	**9**
Cloud data services, Payments platforms, Business model, SDG impact	

Total contact Hours: 45

References

1. Six Essential Steps in Implementing CSR (2016) By V Reddappa Reddy and C Dheeraja.
2. The Corporate Social Responsibility in India (Cases & Development after Legal Mandate) by Dr.Rene Schumpeter

Elective 3 Cyber Laws

Unit-1. Information Technology Act	**9**
Evolution of the IT Act, Genesis and Necessity, Salient features of the IT Act,2000; various authorities under IT Act and their powers; Penalties & Offences, amendments, Cyber SpaceJurisdiction, Jurisdiction issues under IT Act, 2000.	
Unit-2. E-commerce and Laws in India	**9**
Digital/ Electronic Signature in Indian Laws, E-Commerce; Issues andprovisions in Indian Law, E-Governance; concept and practicality in India, E-Taxation issues in Cyberspace, EContracts and its validity in India, Cyber Tribunal & Appellate Tribunal, Cyber Regulations.	
Unit-3. Intellectual Property Rights	**9**
Domain Names and Trademark Disputes, Concept of Trademark/ in Internet Era,Cyber squatting, Reverse Hijacking, Jurisdiction in Trademark Disputes, Copyright in the Digital Medium, Copyrightin Computer Programmes, Copyright and WIPO Treaties, Concept of Patent Right, Relevant Provisions of PatentAct 1970.	
Unit-4. Personal Data Security	**9**
Sensitive Personal Data or Information (SPDI) in Cyber Law, SPDI Definition andReasonable Security Practices in India, Reasonable Security Practices – International perspective, Cloud Computing& Law.	
Unit-5. Cyber Law: International Perspective	**9**
EDI **:**Concept and legal Issues, UNCITRAL Model Law, Electronic Signature, Cryptography Laws, Cyber Laws of Major Countries, EU Convention on Cyber Crime.	
	Total contact Hours : 45

References:

1. 1.The Information technology Act, 2000, Bare Act- Professional Book Publishers, New Delhi
2. Computer Forensics: Principles and Practices by Linda Volonino, Reynaldo Anzaldua and Jana Godwin; Pearson Prentice-Hall
3. First Responder's Guide to Computer Forensics by Richard Nolan et al; Carnegi Mellon

Capstone Project in Fin Tech and Consumer Psychology

Independent research or practical project applying consumer psychology principles to Fin Tech product design

Assessment Methods:

- Coursework and assignments
- Examinations
- Research papers and reports
- Capstone project and presentation

Teaching Pedagogies

- Lectures: Traditional classroom lectures are often used to deliver foundational knowledge and concepts in various subjects.

- Case Studies: Case studies, which present real-world problems for students to analyze and solve. These encourage critical thinking and decision-making.

- Group Discussions: Group discussions and debates foster collaboration, communication, and the sharing of diverse perspectives on topics.

- Experiential Learning: Hands-on experiences, such as internships, consulting projects, and simulations, provide students with practical exposure to real challenges.

- Online Learning: We will incorporate online courses and resources to accommodate distance learners and provide flexibility.
- Project based learning: Research-oriented courses or projects encourage students to investigate and analyze -related topics in-depth

- Flipped classrooms

Justification for the programme

The curriculum and syllabus for a program in Fin Tech and Consumer Psychology are in conformance to the following sustainable goals .

SDG 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Behavioral Economics Integration	Consumer psychology often intersects with behavioral economics, which explores how psychological biases affect economic decisions. Graduates gain insights into how behavioral economics principles can be applied in FinTech to optimize user experiences and decision-making processes.
SDG12	Ensure sustainable consumption and production patterns	User-Centered Design	Consumer psychology plays a pivotal role in designing Fin Tech products that are user-friendly and meet the needs of consumers. By understanding consumer preferences and behaviors, graduates are better equipped to create Fin Tech solutions that are intuitive, engaging, and effective.
SDG16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	Ethical Decision Making	The program emphasizes ethical considerations in the development and deployment of FinTech solutions. Graduates are trained to make ethical decisions in designing and marketing financial products, which is essential for maintaining consumer trust.

B.A. Indian Traditional Sports and Management

(UG – 3 years)

Objective

- To provide adequate practice on fundamental skills and techniques in selected indigenous sports discipline.
- To train on coaching, officiating, equipment and marking in selected indigenous sports discipline.

Curriculum

Semester 1: Yoga

S. No.	Course Name	L	T	P	Credits
1	Introduction to Yoga	3	0	0	3
2	Yoga Anatomy and Physiology	3	0	0	3
3	Yoga Asanas (Postures)	2	0	2	3
4	Pranayama (Breathing Exercises)	2	0	2	3
5	Yoga Meditation	2	0	2	3
6	Yoga Philosophy and Lifestyle	3	0	0	3
7	Report Preparation	0	2	0	2
Total		**15**	**2**	**6**	**20**

Semester 2: Sports Psychology, Sociology and Management

S. No.	Course Name	L	T	P	Credits
1	Introduction to Sports Psychology	3	0	0	3
2	Motivation and Arousal in Sports	3	0	0	3
3	Anxiety and Stress Management in Sports	3	0	0	3
4	Team Dynamics and Leadership in Sports	3	0	0	3
5	Sociology of Sports	3	0	0	3
6	Sports Management	3	0	0	3
7	Case Study	0	2	0	2
Total		**15**	**2**	**6**	**20**

Semester 3: Kabaddi

S. No.	Course Name	L	T	P	Credits
1	Introduction to Kabaddi	3	0	0	3
2	Footwork and Stances	2	0	2	3
3	Kabaddi Techniques	2	0	2	3
4	Kabaddi Fitness and Conditioning	2	0	2	3
5	Kabaddi Strategy and Tactics	2	0	2	3
6	Kabaddi Officiating	2	0	2	3
7	Report Preparation	0	2	0	2
Total		**15**	**2**	**6**	**20**

Semester 4: Silambam

S. No.	Course Name	L	T	P	Credits
1	Introduction to Traditional Sports and Silambam	3	0	0	3
2	Footwork and Stances	2	0	2	3
3	Silambam Weapon Training	2	0	2	3
4	Silambam Forms	2	0	2	3
5	Silambam Sparring	2	0	2	3
6	Advanced Silambam Techniques	2	0	2	3
7	Report Preparation	0	2	0	2
Total		**15**	**2**	**6**	**20**

Semester 5: Kho - Kho

S. No.	Course Name	L	T	P	Credits
1	Introduction to Kho Kho	3	0	0	3
2	Footwork and Stances	2	0	2	3
3	Different types of footwork	2	0	2	3
4	Kho Kho Techniques	2	0	2	3
5	Kho Kho Fitness and Conditioning	2	0	2	3
6	Kho Kho Strategy and Tactics	2	0	2	3
7	Report Preparation	0	2	0	2
Total		**15**	**2**	**6**	**20**

Semester 6: Statistics & Data Analytics in Sports

S. No.	Course Name	L	T	P	Credits
1	Introduction to Statistics in Sports	3	0	0	3
2	Descriptive Statistics	3	0	0	3
3	Inferential Statistics	3	0	0	3
4	Computer Applications in Sports	3	0	0	3
5	Case Studies in Sports Analytics	3	0	0	3
6	Ethical Considerations in Sports Analytics	3	0	0	3
7	Statistical Case Study	0	2	0	2
Total		**15**	**2**	**6**	**20**

Total Credits earned at the end of third year: 120 Credits

Syllabus

Semester 1: Yoga

Course 1: Introduction to Yoga

- Cultural Significance of Traditional Sports - Preservation and Conservation
- What is yoga?
- History and philosophy of yoga
- Different types of yoga
- Benefits of yoga

Course 2: Yoga Anatomy and Physiology

- The human body systems
- How yoga affects the body
- Common yoga injuries and how to prevent them

Course 3: Yoga Asanas (Postures)

- Basic yoga postures
- Alignment and modifications
- Breathing techniques
- Sequences and flows

Course 4: Pranayama (Breathing Exercises)

- Different types of pranayama
- Benefits of pranayama
- How to practice pranayama safely and effectively

Course 5: Yoga Meditation

- Different types of yoga meditation
- Benefits of yoga meditation
- How to practice yoga meditation

Course 6: Yoga Philosophy and Lifestyle

- The eight limbs of yoga
- Yoga ethics
- How to apply yoga principles to your daily life

Course 7: Report Preparation

- Report on the National and International events conducted
- Preparation of sample competition score sheets
- Report on the various policies/schemes of the Central and State government in promoting/supporting Yoga

Assessment:

Observation – 10%, Paper and pen – 40%, Physical test – 50 %

Pedagogy:

- Class room lectures – hybrid mode
- Seminar
- Simulation videos
- Group Activities
- Practice session in the ground

Semester 2: Sports Psychology, Sociology and Management.

Course 1: Introduction to Sports Psychology

- What is sports psychology?
- History of sports psychology
- Theories of sports psychology
- Application of sports psychology to athletes, coaches, and sports organizations

Course 2: Motivation and Arousal in Sports

- What is motivation?
- Types of motivation
- Intrinsic and extrinsic motivation
- Goal-setting theory
- Arousal theory
- How to enhance motivation and arousal in sports

Course 3: Anxiety and Stress Management in Sports

- What is anxiety?
- Types of anxiety in sports
- Symptoms of anxiety in sports
- Causes of anxiety in sports
- Stress management techniques for athletes

Course 4: Team Dynamics and Leadership in Sports

- What is team dynamics?
- Stages of team development
- Types of team leadership
- Effective team leadership strategies
- How to build and maintain a cohesive team

Course 5: Sociology of Sports

- What is the sociology of sports?
- The role of sports in society
- Socialization through sports
- Sports and social inequality
- Sports and deviance
- Sports and the media

Course 6: Sports Management

- What is sports management?
- Functions of sports management
- Sports marketing
- Sports event management
- Sports finance

Course 7: Case Study

- Perform a case study and submit a report in Sport Psychology and Management
- **Assessment:** paper and pen - 50%, project 50%

Pedagogy:

- Class room lectures – hybrid mode
- Seminar
- Case studies
- Group Activities

Exit Option at the End of Year 1: At the end of the first year, students can opt for a Certificate in Traditional Sports and Management, which is a one-year program. This can serve as an intermediate qualification for those who wish to exit the program early.

Semester 3: Kabaddi

Course 1: Introduction to Kabaddi

- Cultural Significance of Traditional Sports - Preservation and Conservation
- History of Kabaddi
- Basic rules and regulations
- Different types of Kabaddi
- Safety precautions

Course 2: Footwork and Stances

- Different types of footwork and stances
- How to move and shift weight effectively
- How to maintain balance and stability

Course 3: Kabaddi Techniques

- Basic Kabaddi techniques, such as raiding, defending, and blocking
- More advanced techniques, such as feints, dodges, and tackles
- Combinations and drills

Course 4: Kabaddi Fitness and Conditioning

- Importance of fitness and conditioning for Kabaddi players
- Different types of fitness and conditioning exercises
- How to create a personalized fitness and conditioning routine

Course 5: Kabaddi Strategy and Tactics

- Individual and team strategies and tactics
- How to read the game and make adjustments accordingly
- How to develop a game plan

Course 6: Kabaddi Officiating

- Roles and responsibilities of Kabaddi officials
- Rules and regulations related to officiating
- How to officiate a Kabaddi match fairly and impartially

Course 7: Report Preparation

- Report on the National and International events conducted
- Preparation of sample competition score sheets
- Report on the various policies/schemes of the Central and State government in promoting/supporting Kabaddi

Assessment:

Observation – 10%, Paper and pen – 40%, Physical test – 50 %

Pedagogy:

- Class room lectures – hybrid mode
- Seminar
- Simulation videos
- Group Activities
- Practice session in the ground

Semester 4: Silambam

Course 1: Introduction to Traditional Sports and Silambam

- Cultural Significance of Traditional Sports - Preservation and Conservation
- History of Silambam
- Basic principles and techniques
- Different types of Silambam
- Safety precautions

Course 2: Footwork and Stances

- Different types of footwork and stances
- How to move and shift weight effectively
- How to maintain balance and stability

Course 3: Silambam Weapon Training

- Different types of Silambam weapons
- How to grip and hold the weapons safely
- Basic strikes, thrusts, and blocks
- Combinations and drills

Course 4: Silambam Forms

- What are Silambam forms?
- Benefits of practicing Silambam forms
- Different types of Silambam forms
- How to learn and practice Silambam forms

Course 5: Silambam Sparring

- What is Silambam sparring?
- Benefits of practicing Silambam sparring
- How to spar safely and effectively
- Different types of Silambam sparring drills

Course 6: Advanced Silambam Techniques

- More advanced strikes, thrusts, and blocks
- Advanced combinations and drills
- Disarming techniques
- Counters and reversals

Course 7: Report Preparation

- Report on the National and International events conducted
- Preparation of sample competition score sheets
- Report on the various policies/schemes of the Central and State government in promoting/supporting Silambam.

Assessment:
Observation – 10%, Paper and pen – 40%, Physical test – 50 %
Pedagogy:

- Class room lectures – hybrid mode
- Seminar
- Simulation videos
- Group Activities
- Practice session in the ground

Exit Option at the End of Year 2: At the end of the second year, students can earn a Diploma and also opt for an UG in Traditional Sports and Management, which is a three-year program.

Semester 5: Kho – Kho

Course 1: Introduction to Kho Kho

- History of Kho Kho
- Preservation and Conservation
- Basic rules and regulations
- Different types of Kho Kho
- Safety precautions

Course 2: Footwork and Stances

- Different types of footwork and stances
- How to move and shift weight effectively
- How to maintain balance and stability

Course 3: Kho Kho Techniques

- Basic Kho Kho techniques, such as running, chasing, dodging, and tackling
- More advanced techniques, such as feints, blocks, and counters
- Combinations and drills

Course 4: Kho Kho Fitness and Conditioning

- Importance of fitness and conditioning for Kho Kho players
- Different types of fitness and conditioning exercises
- How to create a personalized fitness and conditioning routine

Course 5: Kho Kho Strategy and Tactics

- Individual and team strategies and tactics
- How to read the game and make adjustments accordingly
- How to develop a game plan

Course 6: Kho Kho Officiating

- Roles and responsibilities of Kho Kho officials
- Rules and regulations related to officiating
- How to officiate a Kho Kho match fairly and impartially

Course 7: Report Preparation

- Report on the National and International events conducted
- Preparation of sample competition score sheets
- Report on the various policies/schemes of the Central and State government in promoting/supporting Kho - Kho

Assessment:

Observation – 10%, Paper and pen – 40%, Physical test – 50 %

Pedagogy:

- Class room lectures – hybrid mode
- Seminar
- Simulation videos
- Group Activities
- Practice session in the ground

Semester 6: Statistics & Data Analytics in Sports

Course 1: Introduction to Statistics in Sports

- What is statistics?
- Importance of statistics in sports
- Types of statistical data
- Statistical methods used in sports

Course 2: Descriptive Statistics

- Central tendency and variability
- Frequency distributions
- Probability and sampling

Course 3: Inferential Statistics

- Hypothesis testing
- Confidence intervals
- Regression analysis

Course 4: Computer Applications in Sports

- Introduction to sports analysis software
- Data collection and management
- Statistical analysis and visualization
- Machine learning in sports

Course 5: Case Studies in Sports Analytics

- Performance analysis
- Injury prediction
- Match prediction
- Scouting and recruitment

Course 6: Ethical Considerations in Sports Analytics

- Responsible use of data
- Privacy and security
- Fairness and equity

Course 7: Statistical Case Study

- Perform a statistical case study on any one of the traditional sport using data analytics and submit a report.

Assessment: exam – 50%, project 50%

Pedagogy:

- Class room lectures – hybrid mode
- Seminar
- Case studies
- Group Activities

Exit Option at the End of Year 3: At the end of the third year, students receive an UG degree in Traditional Sports and Management.

Mapping of the course with SDG:

This course, Traditional Sports and Management is mapped with following SDGs:

1. Goal 3: Good health and well-being
2. Goal 4: Quality education
3. Goal 8: Decent Work and economic growth