Engineering Economics (3-0-0)

Sub Code: EE6C05 **CIE:50% Marks**

Hrs/Week:3+0+0 **SEE:50% Marks**

SEEHrs: 3 **Max.Marks:100**

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

1. Recall the basic concepts of decision making, problem solving, tactics and strategy.
2. Understand Micro and Macro Economic terms.
3. Defining the time value of money concept, interest formulae.
4. Explain the concepts of depreciation and replacement criteria.
5. Calculate the total cost of a component and explain the process for estimating simple components.

Module - 1

Decision Making – Introduction: engineering decision – makers, engineering and economics, problem solving, intuition and analysis, tactics and strategy.

7 Hours

SLE:

Module - 2

Micro Economics: Law of Demand, Law of supply, Market equilibrium and Determination of Price.

Macro Economics: Consumption goods, Capital goods, Final goods, Intermediate goods; stocks and flows; gross investment and depreciation. Circular flow of income (two sector model); Methods of calculating National Income - Value Added or Product method, Expenditure method, Income method. Aggregates related to National Income: Gross National Product (GNP), Net National Product (NNP), Gross and Net Domestic Product (GDP and NDP)

8 Hours

SLE: Real and Nominal GDP

Module -3

Interest and Interest Factors: Interest rate, simple interest compound interest, interest formulae, time value equivalence exercises, problems and discussion.

7 Hours

SLE: : Cash flow diagrams

Module – 4

Depreciation: Introduction, methods of depreciation, problems. Replacement Analysis: Reasons- Deterioration, obsolescence, inadequacy, replacement criteria problems

7 Hours

SLE: Causes of depreciation, reasons for replacement

Module – 5

Estimating and Costing: Components of costs such as direct material cost, direct labour cost, Fixed, over – heads, factory costs, administrative – over heads, first cost, selling price, calculation of the total cost of various components, Mensuration, estimation of simple components. Break Even Analysis.

10 Hours

SLE: Marginal Cost, Sunk Cost

Text Books :

1. Engineering economy – Riggs J.L., McGraw Hill, 2002.

2. Engineering economy – Paul Degarmo, Macmillan Pub, Co., 2001.

3. Engineering Economy – Theusen. G. PHI, 2002.

Reference Books:

1. Engineering economics-R. Panneerselvam (2nd Edition), PHI Learning Pvt. Ltd., 2013
2. Industrial Management, D K Bhattacharyya Vikas Publishing
3. Financial Management- I.M. Pandey (9th Edition) "Financial Management", Vikas publication, 2011

Electric vehicles and Battery Management systems (3-0-0)

Sub Code: EE0353 **CIE: 50%Marks**
Hrs/week: 3 **SEE: 50%Marks**
SEE Hrs: 3 **Max marks :100**

Course Outcomes

On successful completion of the course, students will be able to:

1. Efficiency comparison, Development of Vehicle model, Various characteristic parameters of vehicle load.
2. Fuel economy of drives and Architecture of hybrid electric drive train
3. Configuration and performance of Electric vehicles
4. Describe the basic functions, topology and requirements of a battery-management system
5. Analyze the Equivalent-Circuit Models of lithium-ion cells and its applications to simulate the response of a battery pack to an input stimulus
6. Discuss theory basis and implementation details of state of charge and state of health estimation algorithms.

UNIT 1: History of hybrid electric and electric vehicles, EV advantage,Efficiency comparison with conventional vehicles, Roadway fundamentals, Laws of motion and vehicle kinetics. Dynamic equations for the vehicle, Force velocity characteristics, maximum gradability, velocity and acceleration, Velocity profile, Energy required.

07 Hours

SLE: EV Market and Infrastructure and propulsion system designbasics

UNIT 2: Fuel economy characteristics of internal combustion engine, Basic techniques to improve fuel economy, Braking performance, Hybrid electric vehicles-Concept, Architecture, Series hybrid electric drive train, parallel hybrid electric drive train

07 Hours

SLE: Torque-Coupling and Speed-Coupling Parallel Hybrid Electric Drive Trains

UNIT 3: Configuration of Electric Vehicles, Performance of Electric vehicles-Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance

06 Hours

SLE: Tractive effort in normal driving and Energy consumption

UNIT 4: Overview of Battery and Its Management: Introduction -Application Requirements for Batteries and BMS, Development Background of the Battery, Principles and Classification of the Lithium-Ion Battery. Battery-pack topology, Battery Management System (BMS) - basic functions,topology and development process of the BMS. BMS design requirements.

7 Hours

SLE: Communication via Control Area Network bus

Unit 5: Equivalent-Circuit Models: Introduction, Model construction, Parameters Identification, Open-circuit voltage, SOC dependence, Equivalent series resistance, Diffusion voltages , Rough parameter values, Warburg impedance ,Hysteresis voltages , Enhanced self-correcting (ESC) cell model, OCV-relationship lab tests Dynamic-relationship tests , overall process of Creating the ESC model.

7 Hours

SLE: Laboratory equipment for cell-data collection

Units 6: Battery SOC and SOH Estimation: SOC estimation, classification, Model based SOC estimation, Battery SOC Estimation Based on AEKF Algorithm, SOC Estimation Based on HIF Algorithm, SOH Estimation , Classification of SOH Estimation Methods, Capacity Estimation Based on SOC Estimation , Available Capacity Estimation Method Based on Response Surface.

SLE : Advantages and disadvantages of various SOH estimation methods and their application scope **6 Hours**

Text Books:

1. Iqbal Hussein, ***Electric and Hybrid Vehicles: Design Fundamentals***, CRC Press, 2003
2. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, ***Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals***, Theory and Design, CRC Press, 2004
3. RuiXiong "***Battery Management Algorithm for Electric Vehicles",*** SpringerPublisher, 2020
4. Gregory L. Plett, ***Battery Management Systems Volume II-EquivalentCircuitMethods*** **,**ARTECH house,2016

Reference Books

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Fundamentals of Digital Communication (3-0-0)

Sub Code: EE6E102 **CIE:50% Marks**

Hrs/Week: 3+0+0 **SEE:50% Marks**

SEEHrs: 3 **Max.Marks:100**

Course Outcomes

On successful completion of the course, the students will be able to:

1. Describe the fundamental concepts of electronic communication, AM and FM.
2. Discuss the principles of digital communication and digital data transmission.
3. Discuss the communication technologies.

MODULE-1: Introduction To Electronic Communication: Communication system, types of electronic communication, modulation and multiplexing, electromagnetic spectrum, bandwidth, gain, attenuation, decibels, tuned circuits, filters.

6 Hours

SLE: Survey of communication applications

MODULE-2: Amplitude and Frequency modulation:

Amplitude Modulation: AM concepts, modulation index and percentage of modulation, AM power, single sideband modulation, Basic principles of AM, AM modulators and demodulators.

Frequency Modulation: Basic principles of FM, principles of phase modulation, modulation index and sidebands, frequency modulators and demodulators.

8 Hours

SLE: Phase modulators

MODULE-3: Digital Communication Techniques, Radio transmitter and Receiver: Digital data transmission, parallel and serial transmission, data conversion, pulse modulation, digital signal processing.

Transmitter fundamentals, carrier generators, impedance matching networks.

Principles of signal reproduction, super heterodyne receivers, frequency conversion, Noise.

9 Hours

SLE: Power Amplifiers

MODULE-4: Digital Data Transmission and Optical communication:

Digital Data Transmission: Digital codes, principles of digital transmission, transmission efficiency, Modem and broadband concepts, wideband modulation, error detection and correction.

Optical communication: Optical principles, optical communication systems, fiber optic cable, optical transmitter and receiver.

7 Hours

SLE: Protocols

MODULE-5: Communication Technologies:

Satellite Communication: Satellite orbits, satellite communication systems, satellite subsystems, ground station, and satellite application.

Telecommunication system: Telephone, Telephone system, Internet telephony.

Cell Phone technologies: Cellular telephone system, 2G and 3G digital cell phone systems, long term evolution and 4G systems

9 Hours

SLE: Base Station and Small cells.

Text Books:

1. Louis E. FrenzelJr, *"**Principles of communication systems**"*, Tata-McGraw Hill Publications, 4th Edition, 2014.

Philips Elective on Machine Learning (3-0-0)

Sub Code: EE0354 **CIE: 50%Marks**
Hrs/week: 3+0+0 SEE: 50%Marks
SEE Hrs: 3 Max marks :100

Course Outcomes

On successful completion of the course, the students will be able to:

1. Know Vectors as starting point for Machine Learning and apply pytorch for simple analytics
2. Relate from data to possibilities, to know about problem solving methods and recognize AI system
3. Understand linear algorithms and non-linear techniques for Machine Learning
4. Understand Neural Networks and Logistic Regression
5. Applying basic text interpretation and understanding KNN
6. Know off the shelf AI utilities and apply ML in real life system

UNIT 1: Intro to ML, python, numpy and pytorch:
Data Types: Numerical, Imaging, NLP voice – Classification, Regression – Vector data and Linear Algebra – Application in Word embedding – Dealing with vectors and basic ML
6 Hours

SLE: Algorithms using python and numpy

UNIT 2: Learning principles, estimation, Methods of classification and prediction:
Occam's razor – Sampling, Bias – Training vs Testing – Overfitting – Variance – Bias Metrics – AUC – Sensitivity – Recall – Precision – Bayes Rule – Conditional Independent Hypothesis testing – Confidence Intervals – Recognizing AI and ML – Probabilistic model – Learning problem – Supervised and Unsupervised Learning
7 Hours

SLE: Identify solved and unsolved repetitive problems

UNIT 3: Linear methods-I and Non-linear methods
Linear Regression: Generative / Discriminative – Minimising squared error and maximizing data – Likelihood Regularization – Bias-Variance decomposition –
Decision Trees – Inductive Biases – Issues in Decision Tree Learning 7 Hours
SLE: Implementation of decision tree algorithm

UNIT 4: Neural Networks and Linear methods-II
Representation Learning – Perceptron – Back Propagation – Regularization – Logistic Regression – Maximising Conditional Likelihood – Gradient Ascent / descent
7 Hours

SLE: Logistic Regression implementation using Neural Network

UNIT 5: Introduction to NLP, Instance based learning and Unsupervised learning
Bag of words – Tokenisation – Stemming – Lemmatization – BERT via pytorch – KNN and the benefits – Kmeans – PCA with examples 7 Hours

SLE: KNN on word embeddings

UNIT 6: Intro to deep learning and Deployment aspects of ML
Handwritten digit recognition using MNIST database – Face Detection Example – Explore limitations of YOLO implementations – Deploy and use ML in the product
6 Hours

SLE: Part Failure prediction

Text Books:
1) Tom M. Mitchell, "**Machine Learning**", India Edition 2013, McGraw Hill Education.
2) Ethem Alpaydın, "**Introduction to machine learning**", second edition, MIT press.

Design of Photovoltaic Systems (3-0-0)

Sub code	**: EE5M05**	**CIE : 50% Marks**
Hrs/Week	**: 3+0+0**	**SEE : 50% Marks**
SEE Hrs	**: 3**	**Max. Marks : 100**

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

1. Describe the fundamental concepts of energy from the sun and solar PV.
2. Apply the MPPT algorithms for solar PV.
3. Analyse the grid integration of solar PV with and without battery storage.
4. Discuss the applications of solar PV.

MODULE 1: The PV Cell: Historical Perspective, PV cell characteristics and equivalent circuit, model of PV cell, cell efficiency, effect of temperature, fill factor. Series and parallel connection of identical and non-identical cells, protecting cell in series and parallel, interconnecting modules.

8 Hours

SLE: Data sheet study

MODULE 2: Energy from sun: Insolation and irradiance, solar geometry, insolation and energy on horizontal plate, sunrise and sunset hour angles. **Incident energy estimation**: energy on a tilted flat plate, energy plots in octave, atmospheric effects, airmass, **Sizing PV**: sizing PV applications without batteries, Batteries, battery selection, PV system design.

8 Hours

SLE: Other energy storage methods

MODULE 3: Maximum Power Point tracking: MPPT concept, DC-DC converters, MPPT algorithms-Impedance control methods.

8 Hours

SLE: MPPT for non-resistive loads

MODULE 4 :PV Battery Interfaces: Direct PV- Battery connection, charge controller, battery charger, batteries in series and parallel. **Peltier Cooling**: peltier device, peltier element, thermal aspects.**PV and Water Pumping:** water pumping principle, hydraulic energy and power, total dynamic head, centrifugal pumps, reciprocating pump.

8 Hours

SLE- pumped hydro application

MODULE 5: PV grid Interface: Grid connection principles, PV to Grid Topologies, 3phase d-q controlled grid connection- AC to DC transformation, DC to AC transformation,

complete 3 phase grid connection. SVPWM-discrete and analog implementation, application of integrated magnetics.

7 Hours

SLE: 1phase d-q controlled grid connection

Text Books:

1. Chenming, H. and White, R.M., Solar Cells from B to Advanced Systems, McGraw Hill Book Co, 1983.

Reference Books:

1. Ruschenbach, HS, Solar Cell Array Design Hand Varmostrand, Reinhold, NY, 1980
2. Proceedings of IEEE Photovoltaics Specialists Conferences, Solar Energy Journal.

Introduction to Robotics (3-0-0)

Sub code	**: EE5M06**	**CIE : 50% Marks**
Hrs/Week	**: 3+0+0**	**SEE : 50% Marks**
SEE Hrs	**: 3**	**Max. Marks : 100**

Course Outcomes

On successful completion of the course, students will be able to:

1. Discuss various application of robotics.
2. Use different motors and sensors for design and control of robot.
3. Apply AI concepts in robotics.

MODULE 1: Introduction to robotics- History, growth; Robot applications- Manufacturing industry, defense, rehabilitation, medical etc. Robot mechanisms; Kinematics- coordinate transformations, DH parameters.

8 Hours

SLE:Laws of Robotics

MODULE 2: Forward kinematics, Inverse Kinematics, Jacobians, Statics, Trajectory Planning, Actuators (electrical)- DC motors, BLDC servo motors.

8 Hours

SLE: Pros and cons of DC motors and BLDC for robotic application

MODULE 3: Sensors, sensor integration, Control – PWM, joint motion control, feedback control, Computed torque control.

8 Hours

SLE: Challenges in sensor integration

MODULE 4 : Perception, Localisation and mapping, Probabilistic robotics, Path planning, BFS; DFS; Dijkstra; A-star; D-star; Voronoi; Potential Field.

8 Hours

SLE- Hybrid Approaches

MODULE 5: Simultaneous Localization and Mapping, Introduction to Reinforcement Learning.

7 Hours

SLE: Practical Application of reinforcement learning

Text Books:

1. Robert J Schilling, Fundamentals of Robotics, Prentice Hall India, 200
2. John J Craig, Introduction to Robotics, Prentice Hall International, 2005

Introduction to Industry 4.0 and Industrial IoT (3-0-0)

Sub code	**: EE5M08**	**CIE : 50% Marks**
Hrs/Week	**: 3+0+0**	**SEE : 50% Marks**
SEE Hrs	**: 3**	**Max. Marks : 100**

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

1. Discuss the features of Industry 4.0.
2. Describe communication, networking and big data analytics in IIoT.
3. Use IIoT for various industrial applications.

MODULE 1: Introduction: Sensing & actuation, Communication, Networking, Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective.

8 Hours

SLE: Smart Factories

MODULE 2: Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artifical Intelligence, Big Data and Advanced Analysis, Cyber security in Industry 4.0, Basics of Industrial IoT: Industrial Processes, Industrial Sensing & Actuation, Industrial Internet Systems.IIoT-Introduction, Industrial IoT: Business Model and reference Architecture: IIoT-Business Models.

8 Hours

SLE: IIoT Reference Architecture

MODULE 3: Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, Industrial IoT- Layers: IIoT Communication, IIoT Networking. Industrial IoT: Big Data Analytics and Software Defined Networks: IIoT Analytics - Introduction, Machine Learning and Data Science, R and Julia Programming.

8 Hours

SLE: Data Management with Hadoop

MODULE 4 : Industrial IoT: Big Data Analytics and Software Defined Networks: SDN in IIoT, Data Center Networks, Industrial IoT: Security and Fog Computing: Cloud Computing in IIoT.Fog Computing in IIoT, Industrial IoT- Application Domains: Factories and Assembly Line, Food Industry.

8 Hours

SLE- Security in IIoT

MODULE 5: Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management. Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries.

7 Hours

SLE: Real time case studies

Text Books:

1. "Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress). "Industrial Internet of Things: Cyber manufacturing Systems" by Sabina Jeschke

Op-Amp Practical Applications: Design, Simulation and Implementation (3-0-0)

Sub code	**: EE5M07**	**CIE : 50% Marks**
Hrs/Week	**: 3+0+0**	**SEE : 50% Marks**
SEE Hrs	**: 3**	**Max. Marks : 100**

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

1. Describe the fundamentals of Op-amp and use of op-amp in switching circuits.
2. Analyse Op-amp circuits
3. Develop skill to design, build and troubleshoot analog circuits for various applications.

MODULE 1: Understanding the Datasheet of Op-Amps, Introduction to op-amps and discussion on its characteristics by simulation and experiment, Understand the basics of Hysteresis and the need of hysteresis in switching circuits.

8 Hours

SLE: Positive and Negative feedback in op-amp circuits

MODULE 2: Op-Amp Circuits Analog-to-Digital Converter (ADC), Digital-to-Analog Converter (DAC) using Op-Amps.

8 Hours

SLE: Application of data converters

MODULE 3: To design and build a function generator capable of generating square wave and a triangular wave of a known frequency using simulation and experiment by TI analog system lab kit pro. To design and build a voltage-controlled oscillator using simulation and TI analog system lab kit pro. To design and build an automatic volume control using simulation and TI analog system lab kit pro.

8 Hours

SLE: Working principle of voltage controlled oscillator

MODULE 4 : To design and build a constant current drive circuit for measuring unknown resistance using simulation and Experiment on bread board. To design and build a temperature controlled system using op-amps as ON-OFF controller and Proportional controller by simulation and Experiment on bread board

8 Hours

SLE- instrumentation amplifier

MODULE 5: To design and build a signal conditioning circuit for the thermocouple to compensate for temperature correction. To design and Implement a speed controller of a DC motor using simulation and experiment

7 Hours

SLE: Necessity of signal conditioning circuit

Text Books:

1. Gray, Hurst, Lewis, and Meyer, Analysis and Design of Analog Integrated Circuits, John Wiley & Sons, 5th edition, 2009
2. Horowitz and Hill, The Art of Electronics, Cambridge Univ. Press, 1999

Reference Books:

1. BehzadRazavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill, 2001
2. Phillip E. Allen and Douglas R. Holberg, CMOS Analog Circuit Design, Oxford University Press, 2nd edition, 2002
3. Johan H. Huijsing, Operational Amplifiers – Theory and Design, 3rd edition, Springer

Python Programming

Sub code : EE6E106 **CIE: 50% Marks**
Hrs/week : 2+0+2 **SEE: 50% Marks**
SEE Hrs: 2 **Max mark : 50**

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

1. Understand fundamentals of python programming.
2. Implement conditional statements and iterations in python.
3. Create and use functions in python.
4. Implement objects and lists in python.

Module 1: Introduction to Python: Introduction to Python, Writing Python Code: Basic Syntax. Values and Variables: numeric values, strings, variables, assignment identifiers and reserved words. Expressions and Arithmetic.

Conditional Execution: Boolean Expressions, The Simple if Statement, The if/else Statement, Compound Boolean Expressions, The pass Statement, Floating-point Equality, Nested Conditionals, Multi-way Decision Statements, Multi-way Versus Sequential Conditionals, Conditional Expressions,.

08 Hours

SLE: Errors in Conditional Statements

Module 2: Iteration: The while Statement, Definite Loops vs. Indefinite Loops, The for Statement, Nested Loops, Abnormal Loop Termination, Infinite Loops. Functions: Introduction to Using Functions, Functions and Modules, The Built-in Functions, Standard Mathematical Functions, time Functions, Random Numbers, The eval and exec Functions, Turtle Graphics, Other Techniques for Importing Functions and Modules. Writing Functions: Function Basics, Parameter Passing, Documenting Functions, Function Examples and Refactoring to Eliminate Code Duplication.

08 Hours

SLE: Logic Complexity

Module 3: Objects: Using Objects, String Objects, File Objects, Fraction Objects, Turtle Graphics Objects, Graphics with tkinter Objects, Object Mutability and Aliasing.

Lists: List Traversal, Building Lists, List Membership, List Assignment and Equivalence, List Bounds, Slicing, List Element Removal, Lists and Functions, List Methods, Command-line Arguments, List Comprehensions, Multidimensional Lists. Introduction to Tuples, Dictionaries, and Sets

10 Hours

SLE: Garbage Collection

List of Experiments:

1. Write a program to print “Hello World”

2. Write a program to add two intergers.

3. Write a program for simple calculator.

4. Write a program to calculate GCD of two numbers.

5. Write a program for binary conversion.

6. Write a program compute a square root of a given number.

7. Write a program to generate prime numbers using function.

8. Write a program to store data and retrieve data from a text file.

9. Write a program to generate list of non-negative numbers form the user input.

10. Program to count the number of prime numbers using list in a given range

Textbooks:

1. Richard L. Halterman, “Fundamentals of Python Programming” Southern Adventist University (2019).

Reference Books:

Chun, J Wesley, “Core Python Programming”, Second Edition, Pearson, 2007 Reprint 20

Energy Audit, Management and Conservation (3-0-0)

Sub Code: EE6E107 **CIE:50% Marks**
Hrs/week: 3+0+0 **SEE:50% Marks**
SEE Hrs: 3 **Max marks:100**

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

1. Understand different terms & principles of energy conservation, audit and management.
2. Familiarise and conduct energy audit and prepare reports.
3. Understand efficient electricity utilization, saving and recovery in different electrical systems.
4. Understand and discuss the need for sustainable energy management.

Module 1: Energy Scenario: Classification of Energy, Indian energy scenario, Sectoral energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energy scenario, energy pricing, energy security, energy conservation and its importance, energy strategy for the future. Energy conservation Act 2001 and its features, Schemes of Bureau of Energy Efficiency (BEE) including Designated consumers, Integrated energy policy, National action plan on climate change.

8 Hours

SLE: ECBC code for Building Construction

Module 2: Energy Management & Audit: Definition, energy audit, need, types of energy audit, energy audit instruments and metering, Energy management (audit) approach - understanding energy costs, Benchmarking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, ECO assessment and Economic methods-specific energy analysis-Minimum energy paths.

8 Hours

SLE: Roles and responsibilities of a certified Energy Auditor

Module 3: Utilization of Electrical Energy: Introduction, Terms used in illumination, laws of illumination, Energy efficient light sources, effect of voltage variation on lamp efficiency, Domestic/commercial/industrial lighting schemes & Controls, Design of lighting schemes for different applications, Energy conservation in Lighting Schemes.

8 Hours

SLE: Luminaries

Module 4: Conservation of Energy: Electric loads of Air conditioning & Refrigeration, Energy conservation measures Cool storage Types, Electric water heating- Gysers- Solar

Water Heaters- Power Consumption in Compressors, Electrolytic Process, Energy conservation measures, Optimal operation of energy systems - case study.

8 Hours

SLE: Software tools for Energy Management Systems

Module 5: Energy and environment, air pollution, climate change: United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM Procedures case of CDM – Bachat Lamp Yojna and industry; Prototype Carbon Fund (PCF).

7 Hours

SLE: GoI initiatives for clean energy

Textbooks:

1. Dale R Patrick, Stephen W Fardo, "**Energy Conservation Guidebook"**, 2nd Edition, CRC Press.
2. Albert Thumann, "**Handbook of Energy Audits"**, 6th Edition, The Fairmont Press
3. "**Bureau of Energy Efficiency",** Reference book: No.1, 2, 3 4
4. W.C. Turner, "**Energy Management Handbook"**, John Wiley and Sons, A Wiley Interscience publication.
5. E J Wilson and D Gerard, "**Carbon Capture and Sequestration: Integrating Technology, Monitoring, and Regulation"**, Blackwell Publishing.