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, Cybersecurity 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: Cybermanufacturing Systems"by Sabina Jeschke

Engineering management and Entrepreneurship (3-0-0)

Sub Code: EE5C05 **CIE:50% Marks**
Hrs/week: 3+0+0 **SEE:50% Marks**
SEE Hrs: 3 **Max marks:100**

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

1. Understand the development of management thought and Concept of Entrepreneurs.
2. Evalute the human behaviour concepts and HRM.
3. Understand financial statements and concepts of Marketing.
4. Apply the project management tools to manage projects.
5. Remember the concepts of Quality and /Industrial management.

Module - 1

Entrepreneurship –Introduction, Management & Administration, Types of ownership and Organization structures. Concept of Entrepreneur, kind of Entrepreneurs, Entrepreneurship development and Govt.support in India. Role of Entrepreneurs in Economic Development.

7Hours

SLE: Barriers to Entrepreneurship

Module - 2

Human Resource Management: Functions of HRM, Recruitment and Selection, Interviewing Candidates. Human Resource Development, Training and Development, Performance Appraisal and Employee Compensation

Organizational Behaviour: Motivation, Content Theories: Maslow and Herzberg, Stress and Conflict, Management by Objectives, Job Enrichment, Job rotation.

8Hours

SLE: Individual and Group Behaviour. Negotiation

Module -3

Marketing Management: Introduction,5 Ps of Marketing,product life cycle,market Strategy **U**

Financial Management: Introduction, Types of Finance, Balance Sheet and Profit and Loss account statement, working capital, International Finance.

8 Hours

SLE: Types of Taxes

Module – 4

Project Management: Project/Program/Portfolio Management, Phases in Project life cycle, Top Down and Bottoms up Estimation, WBS, Stake Holder Management. Identification of new Ideas, Evaluation of Alternatives.

8 Hours

SLE: Make in India

Module – 5

Quality Management: Introduction, Contribution of Quality Gurus- Edward Deming (PDCA cycle), Joseph Juran (Quality trilogy), Quality Tools.

Industrial Management: Innovation in science, technology and industry: IOT, Big Data and Analytics. Lean and Six Sigma, 5S Techniques, Energy Management.

8 Hours

SLE: TQM, Industry 4.0 and Digital Manufacturing

Text Books :

1. Management and Entrepreneurship– (Sixth Edition) K R Phaneesh, Sudha Publication, Year 2013.

Reference Books:

1. Quality control and Total quality Management, (6^{th} Edition) Tata McGraw Hill, Year 2006.
2. Organizational Behavior- Stephen P. Robbins, Pearson Education India, 2009
3. Engineering economics-R. Panneerselvam(2^{nd} Edition), PHI Learning Pvt. Ltd., 2013
4. Marketing Management by Philip Kotler, Kevin Lane Keller, Pearsonpublication.
5. Project Planning, Analysis, Selection, Implementation and. Review- Prasanna Chandra, Tata McGraw Hill Publications, New Delhi, 2000
6. Energy Management Principles (2^{nd} Edition), Craig B. Smith Kelly Parmenter
7. Industrial Management, D K Bhattacharyya Vikas Publishing Financial Management- I.M. Pandey (9^{th} Edition) "Financial Management", Vikas publication, 2011

Management & Entrepreneurship (3-0-0)

Sub Code: EE0333 **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. Explain the characteristics and functions of management in the contemporary context
2. Discuss different behavioral patterns, various executive training programs and objectives.
3. Discuss various management functions, its relevance and the process of human resource management.
4. Explain the need for project planning, entrepreneurship and traits of an entrepreneur

UNIT 1: INTRODUCTION: Evolution of concept of scientific management, historical perspective, contribution of Taylor, Henry Fayal, Gilbreth and HL Gantt to scientific management: management as science/art: relevance of scientific management in Indian context.

06 Hours

SLE: Relevance of various schools of management thought in the present scenario

UNIT 2: MANAGEMENT AND BEHAVIOURAL APPROACH: Introduction to behavioural school of management thought, understanding past behaviour, predicting future behaviour, directing, changing and controlling present behaviour: Maslow's theory of hierarchical needs and Herzberg's two factor theory, McGregor's Theory X and Theory Y: Integration of organizational goals and needs of employees.

06 Hours

SLE: Relevance of different motivational theories in the present scenario

UNIT 3: MANAGEMENT FUNCTIONS: Planning, organizing, staffing, directing, controlling. Principles of management, managerial skills and skill mix required at different levels, leadership styles.

06 Hours

SLE: Necessity of leadership and management aspects in industry

UNIT 4: HUMAN RESOURCE MANAGEMENT: Selection and recruitment, training of personnel, employer employee relationship, causes and settlement of industrial disputes.

06 Hours

SLE: Necessity of personnel selection criteria

UNIT 5: ENTRENPRENEURSHIP: Definition, evolution of entrepreneurship, Qualities of entrepreneur; barriers to entrepreneurship, economic liberalization and development of entrepreneurship.

SMALL SCALE INDUSTRIES: Definition and objectives of SSI. Government policy and support through different state and central agencies; impact of economic liberalization on SSIs. Ancillary industry and tiny industries.

08 Hours

SLE: Study of women entrepreneurship and its relevance in the Indian context

UNIT 6: PROJECT PLANNING AND CONTROLLING: Definition of project, identification of project, feasibility study from technical, marketing, financial and social angles; preparation of project report, planning commission guidelines; project appraisal-factors to be considered, scheduling

SLE: Study of planning and controlling aspects involved in the recovery from disasters

08 Hours

SLE: Study of planning and controlling aspects involved in the recovery from disasters

Text Books:

1. P.C. Tripathi& P.N. Reddy, *"**Principles of Management''***, Tata Mcgraw Hill, 6th edition, 2017.
2. Poornima M Charanthimath, ***"Entrepreneurship Development"***,Pearson Education – 3rd edition 2018

Reference Books:

1. T. R. Banga, S. Sharma,***"Industrial Organization and Engineering Economics".***
2. S.S. Khanka, ***"Entrepreneurial Development",*** S. Chand & Co. Ltd. Ram Nagar, New Delhi.

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

Industrial Control and Automation (2-0-2)

Sub Code :EE6E105	**CIE: 50% Marks**
Hrs/week : 2+0+2	**SEE: 50% Marks**
SEE Hrs : 2	**Max marks : 50**

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

1. Describe the different Control Circuit components and schemes, starters and protection schemes for AC motors
2. Apply various static control methods for the control of industrial drives.
3. Apply the concept of ladder logic and its relationship PLC Programming.
4. Study and harness control circuit components for Industrial applications.

Module 1: **Control Circuit Components:** MCCB & MCB, Contactors, Relays. Timers, limit switches, pressure switches, thermostats, Solenoid Valves, control transformers, symbols for various components.

8 Hours

SLE: Fuses and fuse switch Modules.

Module 2: **Starters for 3-phase Squirrel Cage Motor:** Motor Current at Start and During Acceleration, DOL and star-delta starter, Reversing the direction of rotation of Induction Motors, Plug stopping of Motor.
Protection of AC Motors: Co-Ordination of Fuse, Overload, Relay and Contactor/Circuit Breaker operating Characteristics , Over-temperature Protection, under voltage protection

9 Hours

SLE: Dynamic Braking of three phase squirrel cage Induction Motor.

Module 3: **Industrial Control Circuits:** Introduction, Skip Hoist Control, Control of Electrical Oven, Air Compressor and Conveyor System.
Static Control of Machines: Introduction, advantages and disadvantages of static control over magnetic relay control, solid state timer, development of logic circuits, solenoid valve operated cylinder piston assembly, control of three stage air conditioning system. Introduction to PLC-I/O device, timers, counters, ladder and functional block programming, programming PLC.

9 Hours

SLE: Automatic Control for a Water Pump.

List of Experiments

1. Operation and functionality of contactors.
2. Operation and functionality of Thermal Overload Relay and MCCB.
3. Study of Electronic Overload Relay- different starting / tripping classes.
4. Study of DOL starter for Induction Motor.
5. Study of Y-Δ starter of Induction Motor.
6. Automatic reversal of direction of Induction Motor.
7. Building of control logic circuits.
8. Study and simulation of earth leakage protection.
9. Study of basic pilot devices.
10. Study of field devices and control components.
11. Introduction to programming using PLC.

Text Books:

1. S.K.Bhattacharya, Brijnder Singh, ***"Control of Machines",*** 2nd edition, New Age International Publisher, 2006.
2. W. Bolten, ***"Programming Logic Controllers",*** Elsevier Publication, Oxford UK.

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

Management dept specific (MOOC course)

1. PROJECT MANAGEMENT FOR MANAGERS -NOC21-MG66
   - https://nptel.ac.in/courses/110/107/110107081/

2. BIG DATA COMPUTING-NOC21-CS86
   - https://nptel.ac.in/courses/106/104/106104189/

Software Product Design & Development (2-0-0)

Sub Code: MCD2I01 **CIE: 50% Marks**
Hrs/week: 2+0+0 **SEE: 50%Marks**
SEE Hrs: 2 **Max marks: 50**

Course Outcomes

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

1. Apply the concepts of software design and development process in engineering to improve the competitiveness of product/service
2. Describe product quality assessment process and intellectual property rights
3. Select an appropriate technology for product development

MODULE 1: Product design and development: Introduction to Software Engineering – SDLC V-Model approach - Product inception – Identification of stakeholders - Infrastructure design - Detailed design – Product Planning - Development / Implementation - Verification and Validation

09Hours

SLE: Software Characteristics

MODULE 2: Software quality process overview: Introduction – Product Quality – Quality Process– CMMi Process – Mock Product Design - Copyright, Trademark, Trade secrets

09Hours

SLE: Intellectual Property in general

MODULE 3: Trending software technologies: Internet of things - Cloud Computing - Mobile app development – Artificial Intelligence - Data Analytics

08Hours

SLE: Real Time Operations

Text Books

1. Ian Sommerville, "***Software Engineering***", 10th Edition, Pearson Education, Addison-Wesley
2. Wendy Buskop J.D, "*Patents, Trademarks, Copyrights, and Trade Secrets*: What Automation Professionals, Manufacturers, and Business Owners Need to Know", ISA; 1 edition, June 9, 2008
3. Wolfgang Ertel, "*Introduction to Artificial Intelligence*", Springer, 18-Jan-2018
4. Nasreddine Bouhai, Imad Saleh, "*Internet of Things*" (Evolutions and Innovations), Wiley.

Design and Analysis of Industrial Power System Protection(2-0-0)

Pre-requisite: Course on power system protection(Sub Code:MPS1CXX)

Sub Code : MPS2I01 **CIE:50%Marks**
Hrs/week : 2+0+0 **SEE:50%Marks**
SEE Hrs : 2 **Max marks:50**

Course Outcomes

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

1. Familiar with Types of relays, protection schemes, computer applications, fault calculation used in an industrial power system
2. Apply the protection schemes to design and solve the industrial power system protection problem.
3. Familiar with special protection needs, disturbance file analysis, post-mortem analysis following a disturbance.

MODULE 1 : Typical industrial system SLD, Power flow and fault analysis of the industrial system to establish the base case, Stability study to compute the critical clearing time, Impact of large motor starting, Impact of loss of generation and loss of grid.

09 Hours

SLE: Electromagnetic transient analysis for the industrial system

MODULE 2: Understanding the protection diagram of the industrial system, Relay setting calculation for feeder protection, motor protection, generator protection, transformer protection, line protection, bus bar protection, Application of frequency based relays.

09 Hours

SLE: Grid islanding relay settings.

MODULE3: Protection system simulation, COMTRADE file format, Tripping analysis, Adaptive relaying.

08 Hours

SLE: Special protection scheme

Reference:

1. Lecture and tutorial notes by the Industry offering the course and Journal publications.