Department of Electrical and Electronics Engineering
Chaitanya Bharathi Institute of Technology (A)
Gandipet, Hyderabad-500075

VISION and MISSION of the Institute

Vision

To be a centre of excellence in technical education and research

Mission

To address the emerging needs through quality technical education and advanced research

Quality Policy

Chaitanya Bharathi Institute of Technology imparts value based technical education and training to meet the requirements of student, industry, trade/profession, research, and development organizations for self-sustained growth of society.

VISION and MISSION of the Department

Vision

To achieve Academic and Professional Excellence in Teaching and Research in the frontier areas of Electrical and Electronics Engineering Vis-a -Vis serve as a Valuable Resource for Industry and Society.

Mission

Empowering the Faculty and Student Rendezvous to Nurture Interest for Conceptual Keystone, Applied Multidisciplinary Research, Inspiring Leadership and Efficacious Entrepreneurship culture, Impeccable Innovation in frontier areas to be synergetic with Environmental, Societal and Technological Developments of the National and International community for Universal Intimacy.

M1: Emphasis on providing Strong Theoretical Foundation & Engineering Leadership Eminence, infusion of Creativity and Management skill while maintaining Ethics and Moral for Sustainable Development. **(Individual development)**

M2: Enable the Faculty and Student Interactions to trigger interest for Applied Multidisciplinary Research and Entrepreneurship Culture resulting in Significant Advancement of the field of Specialization with Involvement of Industries and Collaborative Educational Networks. **(Sense of Ownership, Networking and Eco system Development)**

M3: Extend the Conducive Neighborhoods for Innovation in frontier areas to keep pace with Environmental, Societal and Technological Developments of the National and International Community to Serve Humanity. **(Service to Society, Atmanirbhar Bharat)**

Program Educational Objectives (PEOs)

PEO 1- Graduates will Ennoble in offering Design solutions for Complex Engineering Problems using appropriate modern Software tools, with the specified need of the Industry and Protagonist in transforming the Society into a Knowledge Society.

PEO 2- Graduates will Elevate Engineering Leadership and will be recognized as Experts working in Government, Consulting firms, international organizations with their Creativity in Design of Experiments, Analysis and Interpretation of Data and Synthesis of Information.

PEO 3- Graduates will Exalt in their Professional career by Persistence in Teamwork, Ethical behavior, Proactive involvement, and Effective Communication.

PEO 4- Graduate will Excel by becoming Research, Professors and Entrepreneurs who will create and disseminate new knowledge in the frontier areas of Engineering, Technology and Management

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and Society**: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant tothe professional engineering practice.
7. **Environment and Sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. **Individual and Teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long Learning**: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1: Evaluate complex Engineering Problems to meet the distinct need of Industry & Society, by utilizing knowledge of Mathematics, Science, Emerging Technologies such as AI, Block chain & IT tools.

PSO 2: Exhibit Latent talent in understanding the Engineering and Administration standards at workplace as a team leader to manage Projects in the Multi-Disciplinary Environments.

PSO 3: Establish Engineering Expertise in Power system, Machines and Drives Systems and also Pursue Research in the Frontier areas such as Embedded systems, Renewable Energy, E- Mobility and Smart grid.

HONOURS ENGINEERING

The Electrical and Electronics Engineering department is offering "**Honours Engineering"** degree under the following rules and eligibility criteria.

Students, who have taken admission on or after 2018-19 academic years, will be eligible to get Undergraduate Degree with "Additional Minor Engineering", if he/she earns an **additional 20 credits** through **MOOCs/NPTEL/an**y other on-line courses apart from 160 academic credits.

INSTRUCTIONS FOR HONOURS ENGINEERING DEGREE:

1. For Honours Engineering, a student must earn at least twenty (20) Additional credits from professional courses.
2. A Student can choose the courses which were not studied earlier in the previous semester. Further the courses should not be present in the curriculum of the forthcoming semesters.
3. For "Honours Engineering", a student must earn additional credits from **their own branch/ discipline** of study only.
4. Credits for the 4-week course is-1, for 8 weeks course is-2, for 12 weeks course is-3.
5. A student must ensure that he/she earns these additional credits before the completion of the regular course.
6. It is the student's responsibility for registering for the courses ONLINE and the required registration fee shall be borne by the respective student.
7. Students must register for the courses with the **approval of the Head of the Department.**
8. A student is eligible to opt either for "Honours" or "Additional Minor Engineering", but not eligible for both.

With effect from AY 2023-24

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)
SCHEME OF INSTRUCTION AND EXAMINATION

B.E/B.Tech Honours Electrical Engineering under AICTE Model Curriculum

List of Courses

S. No	Course code	Title of the course	Credits	Weeks
1	22EEH01	Advances in UHV Transmission and Distribution	2	8
2	22EEH02	DC Microgrid and Control system	2	8
3	22EEH03	Design of Photovoltaic systems	3	12
4	22EEH04	An Introduction to Coding Theory	2	8
5	22EEH05	Applied Optimization for Wireless, Machine learning, Bigdata	3	12
6	22EEH06	Digital VLSI Testing	3	12
7	22EEH07	Linear System Theory	3	12
8	22EEH08	Computer aided Power System Analysis	3	12
9	22EEH09	Digital Image Processing	3	12
10	22EEH10	Electrical Equipment and Machines: Finite Element Analysis	2	8
11	22EEH11	A brief introduction of Micro-Sensors	1	4
12	22EEH12	Electric Vehicles - Part 1	1	4
13	22EEH13	Design and Simulation of Power conversion using open-source tools	1	4
14	22EEH14	Design, Technology, and Innovation	2	8
15	22EEH15	Introduction to Soft Computing	2	8
16	22EEH16	Deep Learning	3	12

17	22EEH17	Introduction to Blockchain Technology and Applications	2	8
18	22EEH18	Computer Aided Applied Single Objective Optimization	2	8
19	22EEH19	Waste to Energy Conversion	2	8
20	22EEH20	Electronic Waste Management - Issues and Challenges	1	4
21	22EEH21	Solar Photovoltaics Fundamentals, Technology and Applications	2	8
22	22EEH22	Numerical Methods and Simulation Techniques for Scientists and Engineers	2	8
23	22EEH23	Energy Economics and Policy	2	8
24	22EEH24	Artificial Intelligence Search Methods for Problem Solving	3	12
25	22EEH25	Machine Learning for Engineering and Science Applications	3	12
26	22EEH26	MATLAB Programming for Numerical Computation	2	8
27	22EEH27	Joy of computing using Python	3	12
28	22EEH28	Introduction to Robotics	3	12

22EEH01

ADVANCES IN UHV TRANSMISSION AND DISTRIBUTION

Course Duration	8 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	2

UNIT -I

Advantages of HV AC/DC Transmission, Introduction to Grid Management, Transmission system development, Important components of transmission system, Insulation coordination, over voltage in power systems, Design/selection of insulators, Importance of grading/cc rings, Non ceramic insulators performance-service experience, Failure of apparatus in the field, importance of reliability and testing, Pollution flashover phenomena, modeling, Planning of High Voltage laboratories

UNIT -II

Importance of High Voltage testing and techniques employed, Basic philosophy of HV testing, tests for various HV apparatus, HV testing techniques for various apparatus, HV testing on Composite Insulators, Surface degradation studies on composite insulators, Surface morphological techniques for composite insulators, Conductors used for EHV/UHV transmission

UNIT -III

Corona and interference on transmission lines, Introduction of HTLS conductors and their advantages, Mechanical considerations for HV conductors, Introduction to Towers and importance of foundations, Selection/Design of clearances for HV towers, Design Optimization for UHV towers, Introduction to 1100 kV HVDC, Introduction to HV Substations, Types of Substations, comparison, Insulation coordination, Components in a typical substation

UNIT -IV

Preventive maintenance of Substation, Electric and magnetic fields, mitigations techniques, Importance of Grounding, reducing Earthing resistance, Introduction to the use of Fiber optic cables, OPGW, Introduction to communication and SCADA, Precautions and safety measures in substation, Electrical hazards, minimum clearances in substation

UNIT -V

Importance of Generation of HVDC in the laboratory, Importance of Generation of HVAC, Impulse Voltage and Currents in the laboratory, Measurements of High Voltages, Introduction to digital recorders, measurement, Upgradation/uprating of transmission lines- advantages

Text Books:

1. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, New Age International(P) Ltd, New Delhi, 2000.
2. E Kuffel, W S Zaengl and J Kuffel, “High Voltage Engg. Fundamentals”, textbook published by Newness publishers, second edition, 2000.
3. CIGRE Working Group SC B.3-22 “Technical requirements for substations exceeding 800 kV”, Brochure No: 400, Dec 2009.
4. IEC-60826, International standard, “Design criteria of overhead transmission lines”, 2003.
5. Outdoor Insulators – Ravi gorur, Edward Cherney & Jeffery Burnham Textbook.

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Advances in UHV Transmission and Distribution https://nptel.ac.in/courses/108108099	Prof. Subba Reddy	IISC Bangalore

22EEH02

DC MICROGRID AND CONTROL SYSTEM

Course Duration	8 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	2

UNIT -I

Overview of Microgrids, Concept of Microgrids, Microgrid and distributed generation, Microgrid vs Conventional Power System, AC and DC Microgrid with Distributed Energy Resources, Power Electronics for Microgrid, Power Electronic Converters in Microgrid Applications, Power Electronic Converters in Microgrid Applications

UNIT -II

Modeling of converters in microgrid power system (AC /DC and DC/AC Converters Modeling), Modeling of Power Converters in Microgrid Power System (DC/DC Converter Modeling and Control), Modeling of Renewable Energy Resources (Modeling of Wind Energy System), Modeling of Renewable Energy Resources (Modeling of Photovoltaic System), Modeling of Energy Storage System

UNIT -III

Microgrid Dynamics and Modeling, Microgrid Dynamics and Modeling (continued), Microgrid Operation Modes and Standards, Microgrid Control Architectures, Intelligent Microgrid Operation and Control

UNIT -IV

Energy Management in Microgrid System, DC Microgrid System Architecture and AC Interface, DC Microgrid Dynamics and Modeling

UNIT -V

Control of DC Microgrid System, Applications of DC Microgrids, Stability in Microgrid, Stability Analysis of DC Microgrid, DC Microgrid stabilization strategies (passive damping method), DC Microgrid Stabilization Strategies (Impedance/Admittance stability criteria), DC microgrid stabilization using nonlinear Techniques

Text Books:

1. Fusheng Li, Ruisheng Li, Fengquan Zhou, Microgrid Technology and Engineering Application, Elsevier, 2015
2. S. Chowdhury, P. Crossley, Microgrids and Active Distribution Networks, Institution of Engineering and Technology, 2009
3. Nikos Hatziargyriou, Microgrids Architectures and Control John Wiley Sons, 2014
4. Manuela Sechilariu, Fabrice Locment, Urban DC Microgrid: Intelligent Control and Power Flow Optimization, Butterworth-Heinemann, 2016
5. Hassan Bevrani, Bruno François, Toshifumi Ise, Microgrid Dynamics and Control John Wiley Sons, 2017
6. Gevork B. Gharehpetian, S. Mohammad Mousavi Agah, Distributed Generation Systems: Design, Operation and Grid Integration, Butterworth Heinemann, 2017

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	DC Microgrid and Control https://nptel.ac.in/courses/108107143	Prof. Avik Bhattacharya	IIT Roorkee

22EEH03

DESIGN OF PHOTOVOLTAIC SYSTEMS

Course Duration	12 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	3

UNIT -I

PV cell characteristics and equivalent circuit, Model of PV cell, Short Circuit, Open Circuit and peak power parameters, Cell efficiency, Effect of temperature, Fill factor, Identical cells in series, Load line, Non-identical cells in series, Protecting cells in series, Interconnecting modules in series, Identical cells in parallel, Non-identical cells in parallel, Protecting cells in parallel, Interconnecting modules

UNIT -II

Insolation and irradiance, Insolation variation with time of day, Earth centric viewpoint and declination, Solar geometry, Insolation on a horizontal flat plate, Energy on a horizontal flat plate, Sunrise and sunset hour angles, Energy on a tilted flat plate, Atmospheric effects, Airmass, Energy with atmospheric effects, Clearness index, Sizing PV for applications without batteries, Introduction to Batteries, Battery capacity, Battery C-rate, Battery efficiency, Battery energy and power densities, Battery comparison, Battery selection

UNIT -III

PV system design - load profile, PV system design - days of autonomy, PV system design - battery sizing, PV system design - PV array sizing, MPPT concept, Input impedance of Boost converter, Input impedance of Buck converter, Input impedance of Buck-Boost converter, Impedance control methods, Reference cell - voltage scaling method, Reference cell - current scaling method, Sampling method, Power slope method, Hill climbing method, Practical points - MPPT for non-resistive loads

UNIT -IV

Direct PV-battery connection, Charge controller, Battery charger - Understanding current control, Battery charger - slope compensation, Battery charger - simulation of current control, Batteries in series - charge equalization, Batteries in parallel, Peltier device - principle, Peltier element - datasheet, Peltier cooling, Thermal aspects, Heat transfer by conduction, Heat transfer by convection, Radiation and mass transport

UNIT -V

Water pumping principle, Hydraulic energy and power, Total dynamic head, Centrifugal pump, Reciprocating pump, PV power, Pumped hydro application, Grid connection principle, PV to grid topologies, introduction to 3 phase d-q controlled grid connection, dq-axis theory, d-q theory : AC to DC and DC-AC transformations, 3 phase grid connection system, Single phase grid connection system

Text Books:

1. Chenming, H. and White, R.M., "Solar Cells from B to Advanced Systems", McGraw Hill Book Co, 1983
2. Ruschenbach, HS, "Solar Cell Array Design Hand Varmostrand", Reinhold, NY, 1980
3. Proceedings of IEEE "Photovoltaics Specialists Conferences", Solar Energy Journal.

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Design of photovoltaic systems https://nptel.ac.in/courses/117108141	Prof. L. Umanand	IISC Bangalore

22EEH04

AN INTRODUCTION TO CODING THEORY

Course Duration	8 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	2

UNIT -I

Introduction to error control coding, Introduction to linear block codes, generator matrix and parity check matrix, Properties of linear block codes: Syndrome, error detection, Decoding of linear block codes, Distance properties of linear block codes.

UNIT -II

Some simple linear block codes: Repetition codes, Single parity check codes, Hamming codes, Reed Muller codes, bounds on size of codes: Hamming bound, Singleton bound, Plotkin bound, Gilbert-Varshamov bound, Low density parity check codes, decoding of low-density parity check codes-I: Belief propagation algorithm on BEC, Decoding of low density parity check codes-I: Belief propagation algorithm on BSC and AWGN channels

UNIT -III

Introduction to convolutional codes-I: Encoding, state diagram, trellis diagram, Introduction to convolutional codes-II: Classification, realization, distance properties, Introduction to convolutional codes-II: Classification, realization, distance properties, Decoding of convolutional codes-I: Viterbi algorithm.

UNIT -IV

Decoding of convolutional codes-II: BCJR algorithm, Performance bounds for convolutional codes, Turbo codes, Turbo decoding

UNIT -V

Distance properties of turbo codes, Convergence of turbo codes, Applications of linear codes

Text Books:

1. Shu Lin and Daniel J. Costello. Jr., “Error Control Coding”, 2nd edition, Prentice Hall, 2004
2. F.J. MacWilliams, N.J.A. Sloane, “The Theory of Error-Correcting Codes”, North-Holland, Amsterdam, 1977
3. R.E. Blahut, “Algebraic Codes for Data Transmission”, 1st Edition, Cambridge University Press 2003
4. Todd K. Moon, “Error Correction Coding”, 1st Edition, Wiley-Interscience, 2006
5. Cary W. Huffman, Vera Pless, “Fundamentals of Error-Correction codes”, 1st Edition, Cambridge University Press, 2003

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	An Introduction to Coding Theory https://nptel.ac.in/courses/108104092	Prof. Adrish Banerjee	IIT Kanpur

22EEH05

APPLIED OPTIMIZATION FOR WIRELESS, MACHINE LEARNING, BIGDATA

Course Duration	12 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	3

UNIT -I
Introduction to properties of Vectors, Norms, Positive Semi-Definite matrices, Gaussian Random Vectors, Introduction to Convex Optimization – Convex sets, Hyperplanes/ Half-spaces etc. Application: Power constraints in Wireless Systems

UNIT -II
Convex/ Concave Functions, Examples, Conditions for Convexity. Application: Beamforming in Wireless Systems, Multi-User Wireless, Cognitive Radio Systems, Convex Optimization problems, Linear Program, Application: Power allocation in multi-cell cooperative OFDM, QCQP, SOCP Problems, Application: Channel shortening for Wireless Equalization, Robust Beamforming in Wireless Systems

UNIT -III
Duality Principle and KKT Framework for Optimization. Application: Water-filling power allocation, Optimization for MIMO Systems, OFDM Systems and MIMO-OFDM systems, Optimization for signal estimation, LS, WLS, Regularization. Application: Wireless channel estimation, Image Reconstruction-Deblurring

UNIT -IV
Application: Convex optimization for Machine Learning, Principal Component Analysis (PCA), Support Vector Machines, Application: Cooperative Communication, Optimal Power Allocation for cooperative Communication, Geometric Program, Application: Compressive Sensing, Sparse Signal Processing, OMP (Orthogonal Matching Pursuit), LASSO (Least Absolute Shrinkage and Selection Operator) for signal estimation

UNIT -V
Application: Radar for target detection, Array Processing, MUSIC, MIMO-Radar Schemes for Enhanced Target Detection, Application: Convex optimization for Big Data Analytics, Recommender systems, User Rating Prediction, Optimization for Finance

Text Books:

1. Stephen Boyd and Lieven Vandenberghe, “Convex Optimization”, Cambridge University Press

Suggested NPTEL Swayam Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Applied Optimization for Wireless, Machine learning, Bigdata. https://nptel.ac.in/courses/108104112	Prof. Aditya K. Jagannatham	IIT Kanpur

22EEH06

DIGITAL VLSI TESTING

Course Duration	12 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	3

UNIT -I

Introduction: Importance, Challenges, Levels of abstraction, Fault Models, Advanced issues, Design for Testability: Introduction, Testability Analysis, DFT Basics, Scan cell design, Scan Architecture, Design for Testability: Scan design rules, Scan design flow, Fault Simulation: Introduction, Simulation models

UNIT -II

Fault Simulation: Logic simulation, Fault simulation, test Generation: Introduction, Exhaustive testing, Boolean difference, Basic ATPG algorithms, test Generation: ATPG for non-stuck-at faults, other issues in test generation Built-In-Self-Test: Introduction, BIST design rules.

UNIT -III

Built-In-Self-Test: Test pattern generation, Output response analysis, Logic BIST architectures, test Compression: Introduction, Stimulus compression.

UNIT -IV

Test Compression: Stimulus compression, Response compression, memory Testing: Introduction, RAM fault models, RAM test generation

UNIT -V

Memory Testing: Memory BIST Power and Thermal Aware Test: Importance, Power models, Low power ATPG, Power and Thermal Aware Test: Low power BIST, Thermal aware techniques

Text Books:

1. Michael B Lee and Vishwani Agrawal, “Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits” Springer
2. Miron Abramovici, Melvin A. Breuer, Arthur D. Friedman, “Digital Systems Testing and Testable Design”, IEEE Press

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Digital VLSI Testing https://nptel.ac.in/courses/117105137	Prof. Santanu Chattopadhyay	IIT Kharagpur

22EEH07

LINEAR SYSTEM THEORY

Course Duration	12 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	3

UNIT -I

Introduction to Linear systems with Examples, math Preliminaries I - Vector Spaces, Bases, Coordinate Transformation, Invariant Subspaces, Inner product, Norms

UNIT -II

Math Preliminaries II - Rank, Types of Matrices, Eigen values, Eigen vectors, Diagonalization, Matrix Factorization, State Transition Matrix, Solutions to LTI Systems, Solutions to LTV Systems

UNIT -III

Equilibrium points, Linearization, Types of Linearization with Examples, Stability, Types of Stability, Lyapunov Equation, Controllability, Reachability, Stabilizability, Tests, Controllable and Reachable Subspaces, Grammians, Controllable Decomposition

UNIT -IV

Observability, Constructability, Detectability, Tests, Subspaces, Grammians, State Estimation, Observable Decomposition

UNIT -V

Kalman Decomposition, Pole Placement, Controller Design, Observer Design, Duality, Minimal Realization, Basics of Optimal Control, LQR, Ricatti Equation, LMIs in Control

Text Books:

1. Gilbert Strang, “Linear Algebra and its Applications”.
2. J.H.Hespanha, “Linear Systems Theory”.
3. C.T.Chen, “Linear System Theory and Design”.
4. D.G. Luenberger, “Introduction to Dynamic Systems”.
5. P. Antsaklis and Anthony N. Michel, “Linear Systems”.

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Linear System Theory https://nptel.ac.in/courses/108106150	Prof. Ramkrishna Pasumarthy	IIT Madras

22EEH08

COMPUTER AIDED POWER SYSTEM ANALYSIS

Course Duration	12 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	3

UNIT -I

Review of modeling of power system components and formulation of YBUS matrix, Basic power flow equations and Gauss-Seidel load flow method

UNIT -II

Newton-Raphson load flow in polar co-ordinate, Newton-Raphson load flow in rectangular co-ordinate and introduction to Fast Decoupled load flow method

UNIT -III

Fast Decoupled load flow method and AC-DC load flow method, Sparsity and optimal ordering methods, LU decomposition and contingence analysis

UNIT -IV

Line outage sensitivity factor and method of least square, Method of least square and Introduction to AC state estimation

UNIT -V

AC state estimation (contd..) and test for bad data detection, Formulation of YBUS matrix of three phase unbalanced system, Fault analysis in phase domain

Text Books:

1. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", Tata McGraw-Hill Education, 2003.
2. J. J. Grainger and W. D. Stevension, Jr., "Power System Analysis", McGraw-Hill International Edition, 1994.
3. T.K. Nagsarkar and M.S. Sukhija, "Power System Analysis", Oxford University Press, 2016

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Computer Aided Power System Analysis https://nptel.ac.in/courses/108107028	Prof. Biswarup Das	IIT Roorkee

22EEH09

DIGITAL IMAGE PROCESSING

Course Duration	12 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	3

UNIT -I
Introduction and signal digitization, Pixel relationship, Camera models & imaging geometry

UNIT -II
Image interpolation, Image transformation

UNIT -III
Image enhancement, Image restoration

UNIT -IV
Colour image processing, Image segmentation

UNIT -V
Morphological image processing, Object representation, description, and recognition

Text Books:

1. Rafael C Gonzalez & Richard E Woods, "Digital Image Processing",3rd Edition.
2. Anil K Jain, "Fundamentals of Digital Image Processing".
3. William K Pratt, "Digital Image Processing".

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Digital Image Processing https://nptel.ac.in/courses/117105135	Prof. Prabir Kr. Biswas	IIT Kharagpur

22EEH10

ELECTRICAL EQUIPMENT AND MACHINES: FINITE ELEMENT ANALYSIS

Course Duration	8 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	2

UNIT -I
Course Outline and Introduction, Analytical and Numerical Methods, Revisiting EM Concepts: Vector Algebra & Coordinate Systems, Revisiting EM Concepts: Vector Calculus and Electrostatics, Revisiting EM Concepts: Current Densities and Electric Fields in Materials

UNIT -II
Revisiting EM Concepts: Electrostatic Boundary Conditions and Shielding, Magnetostatics, Magnetic Forces and Materials, Time Varying Field, Theory of Eddy Currents

FEM: Variational Approach, Finding Functional for PDEs, Whole Domain Approximation, 1D FEM: Problem Definition and Shape Function, 1D FEM: Procedure

UNIT -III
1D FEM: Scilab Code, 2D FEM: Problem Definition and Shape Functions, 2D FEM: Procedure, 2D FEM Scilab Code: Manual Meshing, 2D FEM Code: Gmsh and Scilab. Computation of B and H Field and Method of Weighted Residuals, Galerkin Method Calculation of Leakage Inductance of a Transformer, Calculation of Inductance of an Induction Motor and a Gapped-Core Shunt Reactor, Insulation Design Using FE Analysis

UNIT -IV
Quadratic Finite Elements, Time Harmonic FE Analysis, Calculation of Eddy Current Losses, Eddy Losses in Transformer Windings, Torque Speed Characteristics of an Induction Motor and FE Analysis of Axisymmetric Problem, Permanent Magnets: Theory, Permanent Magnets: FEM Implementation, Periodic and Antiperiodic Boundary Conditions in Rotating Machines, FE Analysis of Rotating Machines

UNIT -V
Voltage Fed Coupled Circuit Field Analysis, Current Fed Coupled Circuit Field Analysis, Transient FE Analysis, Nonlinear FE Analysis, Computation of Forces using Maxwell Stress Tensor, Computation of Forces using Virtual Work Method

Text Books:

1. S. V. Kulkarni and S. A. Khaparde, “Transformer engineering: design, technology, and diagnostics”, Second Edition, Boca Raton: CRC Press (Taylor & Francis Group), 2012
2. S. J. Salon, “Finite element analysis of electrical machines”, Springer International Edition (1995), Indian Reprint (2007)
3. J. P. A. Bastos and N. Sadowski, “Electromagnetic modeling by finite element methods”, CRC Press, 2003
4. N. Bianchi, “Electrical machine analysis using finite elements”, CRC Press, 2005
5. M. N. O. Sadiku, “Numerical techniques in electromagnetics”, CRC Press, 2000
6. M.N.O. Sadiku and S.V. Kulkarni, “Principles of electromagnetics”, Sixth Edition, Oxford University Press, India, 2015 (Asian adaptation of 'M.N.O. Sadiku, Elements of electromagnetics, Sixth International Edition, Oxford University Press').

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Electrical Equipment and Machines: Finite Element Analysis https://nptel.ac.in/courses/108101167	Shrikrishna V. Kulkarni	IIT Bombay

22EEH11

A BRIEF INTRODUCTION OF MICRO-SENSORS

Course Duration	4 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	1

UNIT -I
Introduction to Microscale Sensors or MEMS , Scaling effect, Some Simple Mechanics, Basic Mechanics

UNIT -II
Electrostatics, Electrostatic force, Coupled electromechanics, Stiction

UNIT -III
Si crystal structure, Si etching, KOH etching, TMAH etching

UNIT -IV
Deposition and Lithography, Lithography

UNIT -V
Pressure Sensor, Accelerometer

Text Books:

1. G. K. Anantha Suresh, "Micro and Smart Systems".
2. Stephen D Senturia, "Microsystem Design" Springer US, 1st ed. 2000. Corr. 2nd printing 2004 edition

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	A Brief Introduction to Micro Sensors https://nptel.ac.in/courses/108106165	Prof. Santanu Talukder	IISER Bhopal

22EEH12

ELECTRIC VEHICLES - PART 1

Course Duration	4 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	1

UNIT -I

Introduction to EV Historical Background, Introduction to EV Benefits of Using Evs, Introduction to EV Overview of types of Evs and its Challenges

UNIT -II

Introduction to EV Motor Drive Technologies, Introduction to EV Energy Source Technologies, Introduction EV Battery Charging Technologies, Introduction EV Vehicle to Grid

UNIT -III

Introduction to EV Subsystems and Configurations, Introduction to HEV Subsystems and Configurations, Introduction to HEV Subsystems and Modes of Operation

UNIT -IV

Vehicle Dynamics intro and tractive effort, Vehicle Dynamics and dynamic equation

UNIT -V

Vehicle Dynamics simulation dynamic equation constant Fte, Vehicle Dynamics dynamic equation variable Fte, Vehicle Dynamics simulation dynamic equation variable Fte, Vehicle Dynamics Modelling and simulation in Simulink

Text Books:

1. Iqbal Husain, "ELECTRIC and HYBRIDVEHICLES, Design Fundamentals", CRC Press,2003.2.
2. M. Ehsani, Y. Gao, S. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", CRC Press, 2005.

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Electric Vehicles Part-1 https://nptel.ac.in/courses/108102121	Prof. Amit Jain	IIT Delhi

22EEH13

DESIGN AND SIMULATION OF POWER CONVERSION USING OPEN-SOURCE TOOLS

Course Duration	4 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	1

UNIT -I

Getting started with NgSpice, Refractoring the .cir, Sub-circuits, gschem and netlist generation, Setting up for simulation with Octave, Getting started with equation based simulation, Resuming a simulation in Octave, PV cell model - review, PV cell characteristic - review

UNIT -II

PV cell - symbol and subcircuit, Rectifier-capacitor filter - operation review, Rectifier-capacitor filter - NgSpice simulation, Rectifier-capacitor filter with non-idealities, 3 phase Rectifier-capacitor filter, Equation based simulation in Octave, Passive power factor improvement - review, Buck Converter - review, Boost converter - review, Buck-Boost converter - review, Buck converter - NgSpice, Boost converter - NgSpice, Buck-boost converter - NgSpice

UNIT -III

Passive Power Factor Improvement - NgSpice, Equation based simulation of converters, Forward Converter - review, Forward Converter simulation, Understanding Core flux reset, Core flux reset - simulation, Flyback converter - review, Flyback converter - simulation, Pushpull converter - review, Pushpull converter - simulation

UNIT -IV

Half bridge converter - review, Half bridge converter - simulation, Full bridge converter - review, Full bridge converter - simulation, Close loop operation, Close loop with feed forward control, NgSpice simulation of close loop control, Battery charging with current control, Slope compensation for current control, NgSpice simulation of battery charging, Single phase PWM for single phase inverter

UNIT -V

NgSpice simulation of single phase PWM, 2-axes theory for 3-phase systems, Transformations for 2 and 3 axes systems, Maximum power point tracking - NgSpice, Space vector PWM - digital, Space vector PWM - analog, SVPWM analog - NgSpice simulation, Induction motor model, Induction motor simulation in Octave, V/F control of induction motor - NgSpice.

Text Books:

1. NgSpice User Manual
2. Octave User Manual

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Design and Simulation of Power Conversion Tools using Open Source Softwares https://nptel.ac.in/courses/108108166	Prof. L. Umanand	IISC Banglore

22EEH14

DESIGN, TECHNOLOGY, AND INNOVATION

Course Duration	8 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	2

UNIT -I

Jaipur Foot - A classic innovation, User Centred Helmet Design, User Centred Helmet Design, Challenges of Reaching a Million Users

UNIT -II

Technology to Solution , Technology to Solution, A Collaborative Excellence, A Collaborative Excellence , Collaborative Innovation Methods, Collaborative Innovation Methods

UNIT -III

Collaborative Innovation Methods, Learnings from Grassroot Innovation, Learnings from Grassroot Innovation

UNIT -IV

Systemic Approach to Biomed Innovations, Systemic Approach to Biomed Innovations, Systemic Approach to Biomed Innovations

UNIT -V

Research to Innovation, Smartcane for the Blind- A Success Story, Smartcane for the Blind- A Success Story.

Text Books:

1. Helmut Traitler, Birgit Coleman, Karen Hofmann “Food Industry Design, Technology, and Innovation”, John Wiley & Sons, Inc

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Design Technology and Innovation https://nptel.ac.in/courses/107101088	Prof .B.K Chakravathy	IIT Bombay

22EEH15

INTRODUCTION TO SOFT COMPUTING

Course Duration	8 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	2

UNIT -I

Introduction to Soft Computing, Introduction to Fuzzy Logic, Fuzzy membership functions and Defining Membership functions, Fuzzy operations, Fuzzy relations, Fuzzy propositions

UNIT -II

Fuzzy implications, Fuzzy Inferences, Defuzzification techniques, Fuzzy logic controller, Concept of Genetic Algorithm and GA strategies

UNIT -III

GA Operator : Encoding schemes, GA Operator : Selection, GA Operator: Crossover techniques, GA Operator : Mutation and others

UNIT -IV

Multi-objective optimization problem solving, Concept of domination, Non-Pareto based approaches to solve MOOPs, Pareto-Based approaches to solve MOOPs

UNIT -V

Introduction to Artificial Neural Network, ANN Architectures, Training ANNs, Soft computing tools

Text Books:

1. Melanic Mitchell, "An Introduction to Genetic Algorithm", (MIT Press)
2. Collelo, Lament, Veldhnizer "Evolutionary Algorithm for Solving Multi-objective, Optimization Problems", (2nd Edition), (Springer)
3. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", (Wiley)
4. Simon Haykin, "Neural Networks and Learning Machines", (PHI)

Suggested NPTEL/SWAYAM Course:

S.No.	NPTEL Course Name	Instructor	Host Institute
1	Introduction to Soft Computing https://nptel.ac.in/courses/106105173	Prof. Debasis Samantha	IIT Kharagpur

22EEH16

DEEP LEARNING

Course Duration	12 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	3

UNIT -I

History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Feedforward, Neural Networks, Representation Power of Feedforward Neural Networks.

UNIT -II

Feed Forward Neural Networks, Backpropagation, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam, Eigenvalues and eigenvectors, Eigenvalue Decomposition, Basis, Principal Component Analysis and its interpretations, Singular Value Decomposition.

UNIT -III

Autoencoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders, Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout.

UNIT -IV

Greedy Layer wise Pre-training, Better activation functions, better weight initialization methods, Batch Normalization, Learning Vectorial Representations of Words Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks.

UNIT -V

Recurrent Neural Networks, Back propagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs, Encoder Decoder Models, Attention Mechanism, Attention over images.

Text Books:

1. Deep Learning, An MIT Press book, Ian Goodfellow and Yoshua Bengio and Aaron Courville http://www.deeplearningbook.org

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Deep Learning https://nptel.ac.in/courses/106105215	Prof. Prabir Kumar Biswas	IIT Kharagpur

22EEH17

INTRODUCTION TO BLOCKCHAIN TECHNOLOGY AND APPLICATIONS

Course Duration	8 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	2

UNIT -I
Introduction – basic ideas behind blockchain, how it is changing the landscape of digitalization, introduction to cryptographic concepts required, Hashing, public key cryptosystems, private vs public blockchain and use cases, Hash Puzzles, Introduction to Bitcoin Blockchain

UNIT -II
Bitcoin Blockchain and scripts, Use cases of Bitcoin Blockchain scripting language in micropayment, escrow etc Downside of Bitcoin – mining.

UNIT -III
Alternative coins – Ethereum and Smart contracts, Alternative coins – Ethereum continued, IOTA.

UNIT -IV
The real need for mining – consensus – Byzantine Generals Problem, and Consensus as a distributed coordination problem – Coming to private or permissioned blockchains – Introduction to Hyperledger

UNIT -V
Permissioned Blockchain and use cases – Hyperledger, Corda, Uses of Blockchain in E-Governance, Land Registration, Medical Information Systems, and others.

Text Books:

1. Keizer Söze, "Blockchain: Ultimate Step by Step Guide to Understanding Blockchain Technology, Bitcoin Creation, and the future of Money", CreateSpace Independent Publishing Platform, 2017
2. Rosario Girasa, "Regulation of Cryptocurrencies and Blockchain Technologies", Springer International Publishing; Palgrave Macmillan, 2018

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Introduction to Block Chain Technology and Applications https://nptel.ac.in/courses/106104220	Prof. Sandeep Shukla	IIT Kanpur

22EEH18

COMPUTER AIDED APPLIED SINGLE OBJECTIVE OPTIMIZATION

Course Duration	8 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	2

UNIT -I
Introduction to Optimization, Teaching Learning Based Optimization, Implementation of TLBO in MATLAB, Particle Swarm Optimization, Implementation of Particle Swarm Optimization using MATLAB

UNIT -II
Differential Evolution, Implementation of Differential Evolution using MATLAB, Binary Coded Genetic Algorithm, Real Coded Genetic Algorithm, Implementation of Real Coded Genetic Algorithm using MATLAB

UNIT -III
Artificial Bee Colony Algorithm, Working of Artificial Bee Colony Algorithm, Implementation of Artificial Bee Colony using MATLAB, Constraint-Handling in Metaheuristic Techniques, Preliminary Statistical Analysis for Metaheuristic Techniques, Preliminary Statistical Analysis - MATLAB implementation, Comparison of Variation Operators and Survival Strategies, Parallelization and Vectorization of Fitness Function, Black-Box Optimization Problems

UNIT -IV
Case Study: Production Planning, Case Study: Production Planning MATLAB Implementation, Simplex Method for LP, Branch & Bound Method for MILP, MILP formulation of Production Planning Problem, Constraint-Handling using Correction Approach, Linear Regression, Multiple, Polynomial and General Linear Least Square Regression, Nonlinear Regression, Regression : MATLAB Implementation

UNIT -V
MATLAB inbuilt functions: Linear & Mixed Integer Linear Programming, MATLAB inbuilt functions: Nonlinear & Mixed Integer Nonlinear Programming, MATLAB Optimization Tool: Options, Output Function, Vectorization, Parallelization, MATLAB inbuilt functions: Multi-objective Optimization, Generalized Algebraic Modelling System, Solution of Production Planning Problem using GAMS & NEOS, MIRO, IBM ILOG CPLEX Optimization Studio, Constraint Programming Applications in IBM ILOG CPLEX Optimization Studio

Text Books:

1. H. P. Williams, “Model building in mathematical programming”, Wiley
2. Hamdy A. Taha, “Operations Research | An Introduction to Research”, Pearson
3. Singiresu S. Rao, “Engineering Optimization: Theory and Practice”, New Age International publishers

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Computer Aided Applied Single Objective Optimization https://nptel.ac.in/courses/103103164	Prof. Prakash Kotecha	IIT Guwahati

22EEH19

WASTE TO ENERGY CONVERSION

Course Duration	8 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	2

UNIT -I

Introduction, Characterization of wastes, Notes: Updates in energy production in India, Tutorial on Characterization of wastes, Energy production from wastes through incineration Energy production from wastes through incineration, Tutorial on incineration, Energy production from wastes through gasification

UNIT -II

Syngas utilization, Energy production from wastes through pyrolysis, Tutorial on gasification, Tutorial on Pyrolysis, Densification of solids

UNIT -III

Efficiency improvement of power plant, Energy production from waste plastics, Gas clean up

UNIT -IV

Energy production from organic wastes through anaerobic digestion, Design of anaerobic digester, Introduction to Microbial fuel cells, Energy production from organic wastes through fermentation, Tutorial on anaerobic digestion

UNIT -V

Tutorial on fermentation, Energy production from wastes through transesterification, Tutorial on transesterification, Cultivation of algal biomass and treatment of waste water, Energy production from algal biomass

Text Books:

1. Rogoff, M.J. and Screve, F., "Waste-to-Energy: Technologies and Project Implementation", Elsevier Store.
2. Young G.C., "Municipal Solid Waste to Energy Conversion processes", John Wiley and Sons.
3. Harker, J.H. and Backhusrt, J.R., "Fuel and Energy", Academic Press Inc.
4. EL-Halwagi, M.M., "Biogas Technology- Transfer and Diffusion", Elsevier Applied Science.
5. Hall, D.O. and Overeed, R.P.," Biomass - Renewable Energy", John Willy and Sons.
6. Mondal, P. and Dalai, A.K. eds., 2017. Sustainable Utilization of Natural Resources. CRC Press.

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Waste to Energy Conversion https://nptel.ac.in/courses/103107125	Prof. P. Mondal	IIT Roorkee

22EEH20

ELECTRONIC WASTE MANAGEMENT - ISSUES AND CHALLENGES

Course Duration	4 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	1

UNIT -I
E-Waste Overview, E-Waste Management Overview

UNIT -II
Environmental and Public Health Issues, E-waste Health Risk Assessment

UNIT -III
Environmental and Public Health Issues, Recovery of Materials from E-Waste

UNIT -IV
Metal Recovery Process, Recovery of Metals from Electronic Waste, Recovery of Metals from Electronic Waste, Recovery of Metals from Electronic Waste

UNIT -V
E-waste Management, Electronics and LCA, LCA applications for Electronics, Tutorials

Text Books:

1. Electronic Waste Management Rules 2016, Govt. of India, available online at CPCB website.
2. MSW Management Rules 2016, Govt. of India, available online at CPCB website
3. Scientific literature uploaded by TAs.

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Electronic Waste Management-Issues and Challenges https://nptel.ac.in/courses/105105169	Prof. B.K Dubey	IIT Kharagpur

22EEH21

SOLAR PHOTOVOLTAICS FUNDAMENTALS, TECHNOLOGY AND APPLICATIONS

Course Duration	8 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	2

UNIT -I

Introduction to course, Review of Semiconductor Physics, Charge carrier generation and recombination, p-n junction model and depletion capacitance, Current voltage characteristics in dark and light, Device Physics of Solar Cells, Principle of solar energy conversion, Conversion efficiency, Single, tandem multi-junction solar cells, Numerical solar cell modeling

UNIT -II

Numerical solar cell modeling, Crystalline silicon and III-V solar cells, thin film solar cells: Amorphous silicon, Quantum Dot solar cells

UNIT -III

Introduction to Dye Sensitized Solar Cells, Fabrication of Dye Sensitized Solar Cells, Design of novel dyes, Design of solid electrolytes materials, Counter electrode engineering, Introduction to Organic Solar Cells, Physics of Bulk Heterojunction (BHJ) Solar Cells, Morphology and charge, separation in BHJ, Design of low bandgap polymers.

UNIT -IV

Perovskite Solar Cells, Fabrication of perovskite solar cells, Photophysics in perovskite solar cells, Stability in perovskite solar cells, Lead free perovskite solar cells, Photovoltaic system engineering, Thermo- Photovoltaic generation of electricity.

UNIT -V

Concentration and storage of electrical energy, Photovoltaics modules, system and application, green energy building, Nanomaterials for photovoltaics, PV panels with nanostructures, Band gap engineering and optical engineering, Photo thermal cells, Energy Economy and management

Text Books:

1. Jasprit Singh, “Semiconductor Devices, Basic Principles”. Wiley, 2001
2. Jenny Nelson, “The Physics of Solar Cells”, Imperial College Press, 2003
3. Stephen J.Fonash, “Solar Cell Device Physics”, 2nd edition, Academic Press, 2003
4. A. Luque and S.Hegedus, :Handbook of Photovoltaic Science &Engineering”., Wiley
5. Tsakalakos, L.; “Nanotechnology for Photovoltaics”, CRC

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Solar Photovoltaics Fundamentals, Technology and Applications https://nptel.ac.in/courses/115107116	Prof. Soumitra Satapathi	IIT Roorkee

22EEH22

NUMERICAL METHODS AND SIMULATION TECHNIQUES FOR SCIENTISTS AND ENGINEERS

Course Duration	8 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	2

UNIT -I

Introduction to Numerical analysis, Importance of error and their calculations, Examples, Root Finding Method of non-linear equations, Bisection Method, Newton Raphson Method, Secant method, Regula- Falsi method, Practical examples

UNIT -II

Curve fitting method, linear and non-linear fitting, Linear interpolation, Lagrange interpolation method, Newton Interpolation formula, Practical examples, Numerical differentiation, central difference methods, higher order derivatives, errors, practical examples

UNIT -III

Numerical integration, Simpson's 1/3 rd rule, Simpson's 3/8 th rule, local and global error analysis, practical examples

UNIT -IV

Eigenvalue problems, Heun's method, Euler's method, Runge Kutta Method, Gerschgorin disc theorem, Jacobi method, Practical examples

UNIT -V

Simulation Techniques, Random numbers, Monte Carlo Method, Importance Sampling, Metropolis Algorithm, Heat- bath algorithm, practical Examples, Molecular dynamics, interaction and forces in molecular systems, MD and Verlet algorithm, correlations, practical examples

Text Books:

1. R.H. Landau, M.J. Paez, and C.C. Bordeianu, "Computational Physics: Problem solving with Computers" Wiley VCH (2007)
2. S.C. Chopra and R.P. Canale, "Numerical Methods for Engineers", Tata Mcgraw Hill (2002)
3. M.K. Jain, S.R.K. Iyengar, and R.K. Jain, "Numerical Methods for Scientific and Engineering Computation", New Age Pvt. Pub, New Delhi.
4. M.E.J. Newman and G.T. Barkema, Monte Carlo, "Methods in Statistical Physics", Oxford University Press (2010)
5. J.M. Haile, "Molecular Dynamics Simulations: Elementary methods", Wiley Professional (1992)

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Numerical Methods and Simulation Techniques for Scientists and Engineers https://nptel.ac.in/courses/115103114	Prof. Saurabh Basu	IIT Guwahati

22EEH23

ENERGY ECONOMICS AND POLICY

Course Duration	8 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	2

UNIT -I

Energy as an Economic Resource - Introduction, Energy as an Economic Resource - Classification of Energy Resource, Energy as an Economic Resource - Measurement of Energy, Energy as an Economic Resource - Energy Accounting, Energy as an Economic Resource – Problem, Energy Demand: Basic concepts in Economics, Descriptive Analysis of Energy Demand, Decomposition Analysis and Parametric Approach

UNIT -II

Energy Demand: Demand Side Management, Load Management, Demand Side Management - Energy Efficiency, Rebound Effect

UNIT -III

Energy Supply - Supply Behaviour of a Producer, Energy Investment, Economics of Non-renewable Resources, Economics of Renewable Energy Supply Setting the context, Economics of Renewable Energy Supply, Economics of Electricity Supply

UNIT -IV

Energy Market - Prefect Competition as a Market Form, Energy Market - Why Energy Market is not Perfectly Competitive?, Energy Market - Market Failure and Monopoly

UNIT -V

Energy Market : Oil Market: Pre OPEC Era , Energy Market : Oil Market: OPEC, Special Topics on Energy - Energy Security, Special Topics on Energy - Energy Access, Special Topics on Energy - Energy, Environment and Climate Change

Text Books:

1. Bhattacharyya, Subhes. C. "Energy Economics: Concepts, Issues, Markets and Governance", Springer London, UK. (Selected chapters), 2011.
2. Stevens, P. "An Introduction to Energy Economics", In Stevens, P.(ed.) The Economics of Energy, Vol.1, Edward Elgar, Cheltenham, UK., 2000.
3. Selected contemporary journal articles.

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Energy Economy and Policy https://nptel.ac.in/courses/109106161	Prof. Shyamasree Dasgupta	IIT Mandi

22EEH24

ARTIFICIAL INTELLIGENCE SEARCH METHODS FOR PROBLEM SOLVING

Course Duration	12 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	3

UNIT -I

Introduction: History, Can Machines think? Turing Test, Winograd Schema Challenge, Language and Thought, Wheels & Gears, Introduction: Philosophy, Mind, Reasoning, Computation, Dartmouth Conference, The Chess Saga, Epiphenomena, State Space Search: Depth First Search, Breadth First Search, Depth First Iterative Deepening

UNIT -II

Heuristic Search: Best First Search, Hill Climbing, Solution Space, TSP, Escaping Local Optima, Stochastic Local Search, Population Based Methods: Genetic Algorithms, SAT, TSP, emergent Systems, Ant Colony Optimization, Finding Optimal Paths: Branch & Bound, A*, Admissibility of A*, Informed Heuristic Functions

UNIT -III

Space Saving Versions of A*: Weighted A*, IDA*, RBFS, Monotone Condition, Sequence Alignment, DCFS, SMGS, Beam Stack Search, Game Playing: Game Theory, Board Games and Game Trees, Algorithm Minimax, AlphaBeta and SSS

UNIT -IV

Automated Planning: Domain Independent Planning, Blocks World, Forward &Backward Search, Goal Stack Planning, Plan Space Planning, Problem Decomposition: Means Ends Analysis, Algorithm Graphplan, Algorithm AO, Rule Based Expert Systems: Production Systems, Inference Engine, Match-Resolve-Execute, Rete Net

UNIT -V

Deduction as Search: Logic, Soundness, Completeness, First Order Logic, Forward Chaining, Backward Chaining, Constraint Processing: CSPs, Consistency Based Diagnosis, Algorithm Backtracking, Arc Consistency, Algorithm Forward Checking

Text Books:

1. Deepak Khemani, “A First Course in Artificial Intelligence”, McGraw Hill Education (India), 2013
2. Stefan Edelkamp and Stefan Schroedl. “Heuristic Search: Theory and Applications”, Morgan Kaufmann, 2011
3. John Haugeland, “Artificial Intelligence: The Very Idea, A Bradford Book”, The MIT Press, 1985
4. Pamela McCorduck, “Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence”, A K Peters/CRC Press; 2 editions, 2004.
5. Zbigniew Michalewicz and David B. Fogel. “How to Solve It: Modern Heuristics”, 2nd edition, Springer, 2004

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Artificial Intelligence Search Methods for Problem Solving https://nptel.ac.in/courses/106106226	Prof. Deepak Khemani	IIT Madras

22EEH25

MACHINE LEARNING FOR ENGINEERING AND SCIENCE APPLICATIONS

Course Duration	12 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	3

UNIT -I
Mathematical Basics 1 – Introduction to Machine Learning, Linear Algebra, Mathematical Basics 2 – Probability, Computational Basics – Numerical computation and optimization, Introduction to Machine learning packages

UNIT -II
Linear and Logistic Regression – Bias/Variance Tradeoff, Regularization, Variants of Gradient Descent, MLE, MAP, Applications, Neural Networks – Multilayer Perceptron, Backpropagation, Applications

UNIT -III
Convolutional Neural Networks 1 – CNN Operations, CNN architectures, Convolutional Neural Networks 2 – Training, Transfer Learning, Applications, Recurrent Neural Networks RNN, LSTM, GRU, Applications

UNIT -IV
Classical Techniques 1 – Bayesian Regression, Binary Trees, Random Forests, SVM, Naïve Bayes, Applications, Classical Techniques 2 – k-Means, kNN, GMM, Expectation Maximization, Applications

UNIT -V
Advanced Techniques 1 – Structured Probabilistic Models, Monte Carlo Methods, Advanced Techniques 2 – Autoencoders, Generative Adversarial Network

Text Books:

1. Deep Learning, Goodfellow et al, MIT Press, 20172.
2. Pattern Recognition and Machine Learning, Christopher Bishop, Springer, 20093.

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Machine Learning for Engineering and Science Applications https://nptel.ac.in/courses/106106198	Prof. B Srinivasan and Prof. B Ganapathy	IIT Madras

22EEH26

MATLAB PROGRAMMING FOR NUMERICAL COMPUTATION

Course Duration	8 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	2

UNIT -I

Basics of MATLAB programming, Array operations in MATLAB, Loops and execution control, working with files: Scripts and Functions, Plotting and program output, Defining errors and precision in numerical methods, Truncation and round-off errors, Error propagation, Global and local truncation errors

UNIT -II

Numerical Differentiation in single variable, Numerical differentiation: Higher derivatives, Differentiation in multiple variables, Newton-Cotes integration formulae, multi-step application of Trapezoidal rule, MATLAB functions for integration

UNIT -III

Linear algebra in MATLAB, Gauss Elimination, LU decomposition and partial pivoting, Iterative methods: Gauss Siedel, Special Matrices: Tri-diagonal matrix algorithm, Nonlinear equations in single variable, MATLAB function fzero in single variable, Fixed-point iteration in single variable, Newton-Raphson in single variable, MATLAB function fsolve in single and multiple variables, Newton-Raphson in multiple variables

UNIT -IV

Linear least squares regression (including lsqcurvefit function), Functional and nonlinear regression (including lsqnonlin function), Interpolation in MATLAB using spline and pchip, Introduction to ODEs; Implicit and explicit Euler's methods, Second Order Runge-Kutta Methods, MATLAB ode45 algorithm in single variable, Higher order Runge-Kutta methods, Error analysis of Runge-Kutta method.

UNIT -V

MATLAB ode45 algorithm in multiple variables, Stiff ODEs and MATLAB ode15s algorithm, Practical example for ODE-IVP, solving transient PDE using Method of Lines

Text Books:

1. Fausett L.V. "Applied Numerical Analysis Using MATLAB", 2nd Ed., Pearson Education, 2007.
2. Chapra S.C. and Canale R.P, "Numerical Methods for Engineers", 5th Ed., McGraw Hill, 2006.

Suggested NPTEL/SWAYAM Course:

S .No.	NPTEL Course Name	Instructor	Host Institute
1	MATLAB Programming for Numerical Computation https://nptel.ac.in/courses/103106118	Prof. Niket Kaisare	IIT Madras

22EEH27

JOY OF COMPUTING USING PYTHON

Course Duration	12 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	3

UNIT -I

Introduction to Programming , Programming for Everybody, Introduction to Scratch, Introduction to Loops, More about Loops, Solution to Looping Problem, Introduction to Anaconda, Introduction to Spyder IDE, Printing statements in Python, Understanding Variables in Python, Executing a sequence of instructions in the Console, Writing your First Program, Motivation to if condition, Understanding if condition's working

UNIT -II

Realizing the importance of syntax and indentation, Introductions to loops, Loops: Sum of numbers, Loops: Multiplication Tables, Introduction to While Loop, Lists: Introduction, Manipulation, Operations, Slicing, Loops and Conditionals : Fizzbuzz 01, Loops and Conditionals : Fizzbuzz 02, Crowd Computing - Just estimate 01, Crowd Computing - Just estimate 02

UNIT -III

Magic Square: Hit and Trial, Let's program and play, Dobble Game - Spot the similarity, Birthday Paradox - Find your twin, Guess the Movie Name, Introduction to Dictionaries, Speech to Text : No need to write, Monte Hall : 3 doors and a twist, Rock, Paper and Scissor : Cheating not allowed

UNIT -IV

Sorting and Searching, Substitution Cipher -The science of secrecy, Tic Tac Toe - Down the memory Lane, Recursion, Snakes and Ladders - Not on the Board, Spiral Traversing - Let's Animate, GPS - Track the route

UNIT -V

Tuples- Python Data Structure, Lottery Simulation - Profit or Loss, Image Processing - Enhance your images, Anagrams, Facebook Sentiment Analysis, Natural Language Processing - Author Stylometry, Introduction to Networkx, Six Degrees of Separation : Meet your favourites, Area Calculation, FLAMES, Data Compression, Browser Automation Watsapp using Python, Fun with Calendar, Page Rank - How does Google Work ? , Collatz Conjecture

Text Books:

1. Prof. Sudharshan Iyengar, “The Joy of Computing using Python”.

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Joy of Computing Using Python https://nptel.ac.in/courses/106106182	Prof. S. Iyenger and Prof. Y Gupta	IIT Ropar

22EEH28

INTRODUCTION TO ROBOTICS

Course Duration	12 weeks
Duration of SEE	3 Hours
SEE	75 Marks
CIE	25 Marks
Credits	3

UNIT -I

Introduction to robotics- History, growth; Robot applications- Manufacturing industry, defense, rehabilitation, medical etc., Laws of Robotics, Robot mechanisms; Kinematics- coordinate transformations, DH parameters.

UNIT -II

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

UNIT -III

Sensors, sensor integration, Control – PWM, joint motion control, feedback control, Computed torque control

UNIT -IV

Perception, Localisation and mapping, Probabilistic robotics, Path planning, BFS; DFS; Dijkstra; A-star; D-star; Voronoi; Potential Field; Hybrid approaches

UNIT -V

Simultaneous Localization and Mapping, Introduction to Reinforcement Learning

Text Books:

1. Robert J Schilling, “Fundamentals of Robotics”, Prentice Hall India, 2003
2. John J Craig, “Introduction to Robotics”, Prentice Hall International, 2005

Suggested NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Introduction to Robotics https://nptel.ac.in/courses/107106090	Prof. T Asokan, Prof. B Ravindran and Prof. K Vasudevan	IIT Madras

Faculty Coordinator
Honours Degree

HoD
Department of EEE