Maratha Vidya Prasarak Samaj's

Karmaveer Adv. Baburao Ganpatrao Thakare College of Engineering

An Autonomous Institute affiliated to Savitribai Phule Pune University, Pune

Udoji Maratha Boarding Campus, Gangapur Road, Nashik - 422 013,

Maharashtra, India.

Syllabus of Under-Graduate Program

Third Year B.Tech. Electrical Engineering (2024 Pattern)

(As per NEP 2020)

Academic Year 2026-27

(Copy for Student Circulation Only)

V1.25.03.2026

Program Specific Outcomes (PSOs).

PSO1: Apply electrical engineering concepts and modern engineering tools for analysis and design of electrical systems.

PSO2: Develop solutions for power, energy, automation, and embedded system applications.

PSO3: Design reliable, sustainable, and innovative electrical engineering solutions for industrial and societal applications.

Program Educational Outcomes (PEOs).

PEO1: Establish successful careers in industry, public sector, research organizations, or entrepreneurship.

PEO2: Develop sustainable engineering solutions for industrial and societal challenges.

PEO3: Demonstrate professional ethics, effective communication, teamwork, leadership, and lifelong learning.

Program Outcomes (POs)

PO1: **Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 to develop to the solution of complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).

PO3: **Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).

PO4: **Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).

PO5: **Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6).

PO6: **The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5 and WK7).

PO7: **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9).

PO8: **Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: **Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) Independent and life-long learning, ii) Adaptability to new and emerging technologies and iii) Critical thinking in the broadest context of technological change. (WK8).

Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Third Year B.Tech. Electrical Engineering
Curriculum Structure (2024 Pattern) Semester – V

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks					Credits			
			TH	PR	TU	CCE	ESE	TW	PR + OR	TOT	TH	PR	TU	TOT
108501	**PCC-8**	Electrical Machines – II	3	2	-	40	60	25	25	**150**	3	1	-	**4**
108502	**PCC-9**	Power System Engineering	2	2	-	40	60	25	25	**150**	2	1	-	**3**
108503	**PCC-10**	Power Electronics	2	2	-	40	60	25	25	**150**	2	1	-	**3**
108504	**PEC-1**	Program Elective Course-1	3	2	-	40	60	25	-	**125**	3	1	-	**4**
170505	**MDM-3**	Multi-Disciplinary Minor-3	3	2	-	40	60	25	-	**125**	3	1	-	**4**
108506	**VSEC-4**	Simulation Tools for Electrical Engineering	-	4	-	-	-	50	-	**50**	-	2	-	**2**
Total			**13**	**14**	**0**	**200**	**300**	**175**	**75**	**750**	**13**	**7**	**0**	**20**

Course Code	PEC Course – 1
108504A	Design of Renewable Energy Systems
108504B	Microcontroller and Embedded Systems
108504C	Signals and Systems

Note: MDM-3 Courses are Listed on Page 6.

Third Year B.Tech. Electrical Engineering
Curriculum Structure (2024 Pattern) Semester – VI

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks					Credits			
			TH	PR	TU	CCE	ESE	TW	PR + OR	TOT	TH	PR	TU	TOT
108601	**PCC-11**	Control Systems	3	2	-	40	60	25	25	**150**	3	1	-	**4**
108602	**PCC-12**	Power System Operation and Control	3	2	-	40	60	25	25	**150**	3	1	-	**4**
108603	**PEC-2**	Program Elective Course-2	3	2	-	40	60	25	25	**150**	3	1	-	**4**
108604	**PEC-3**	Program Elective Course-3	3	2	-	40	60	25	25	**150**	3	1	-	**4**
170605	**MDM-4**	Multi-Disciplinary Minor-4	3	-	1	40	60	50	-	**150**	3	-	1	**4**
Total			**15**	**8**	**1**	**200**	**300**	**150**	**100**	**750**	**15**	**4**	**1**	**20**

Course Code	PEC Course – 2	Course Code	PEC Course – 3
108603A	Electrical Machine Design	**108604A**	Electric Mobility
108603B	Smart Grid Systems and Technologies	**108604B**	Condition Monitoring and Diagnostics
108603C	Embedded Systems Design using ARM	**108604C**	Digital Signal Processing

Note: MDM-4 Courses are Listed on Page 6.

Third Year B.Tech. Multi-Disciplinary Course – 3 and 4
List of Courses (2024 Pattern) Semester – V and VI

S #	Offered by Department	Streams (Choose One Stream Only)	Semester-V		Semester-VI		Semester-VIII		Eligible Student
			MDM – 3 Code	MDM – 3 Courses	MDM – 4 Code	MDM – 4 Courses	MDM – 5 Code	MDM – 5 Courses	
1.	Mechanical Engineering	Automobile Engineering	170505A	Systems in Mechanical Engineering	170605A	Automotive Technology	170805A	Computer-Aided Engineering	All, except Mech. Engg. Dept
2.	Computer Engineering	Software Development	170505B	Data Structures and Algorithms	170605B	Database Systems	170805B	Software System Design	All, except Computer Engg., Information Tech. and AI&DS Dept.
3.	Instru. & Control Engg.	Measurement and Control	170505C	Engineering Measurements	170605C	Industrial Control Components	170805C	Industrial Control Applications	All, except Instru. Control Engg. Dept.
4.	Electronics & Tele. Engg.	Internet of Things	170505D	Sensors and Actuators	170605D	Embedded System in IoT	170805D	Applications of IoT	All, except E&TC Department
5.	Civil Engineering	Infrastructure Planning	170505E	Infrastructure and Planning	170605E	Governing Policies	170805E	Transportation Systems	All, except Civil Engg. Department
6.	Information Technology	Web Technology	170505F	Web Development	170605F	Application Development	170805F	Digital Governance	All, except Info. Tech., Computer and AI&DS Dept.
7.	AI&DS	Data Analytics	170505G	Applied Data Science	170605G	Data Visualization	170805G	Business Analytics	All, except AI&DS, Computer and Information Tech. Dept.
8.	Electrical Engineering	Electrical Machines & Drives	170505H	Electrical Machines	170605H	Drives and Controls	170805H	Industrial Applications	All, except Electrical Engg. Dept

- **Summary of Credits and Total Marks:**

Semester	Credits	Marks
V	20	750
VI	20	750
Total	**40**	**1500**

- **Definition of Credit :**

The Under Graduate (U.G.) programmes will have credit system. The details of credit will be as follow.
1 Credit = 1 hour/week for lecture
= 2 hours/week for practical
= 1 hour/week for tutorial

- **Description of Various Courses:**

Type of Course	Description
PCC	Programme Core Course
PEC	Programme Elective Course
MDM	Multidisciplinary Minor Course
VSEC	Vocational and Skill Enhancement Course (Skill Courses)

Semester - V

Course Code: 108501	Course Name: Electrical Machines – II	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks **PR + OR** : 25 Marks

Prerequisite Courses:

- Basic Electrical Engineering, Electrical Measurement, Electrical Machines-I.

Course Objectives:

- To understand selection of machines for specific applications.
- To understand the construction, principle of operation of single phase and synchronous machines.
- To test and analyze the performance of synchronous machines.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Demonstrate the performance of synchronous generators under different loading and power factor conditions.

CO2: Apply methods to determine voltage regulation and load-sharing strategies for parallel operation.

CO3: Examine the effect of excitation on motor performance under constant load and interpret V-curves and inverted V-curves.

CO4: Compare the operating characteristics, performance, and applications of single-phase and three-phase induction motors.

CO5: Analyze the performance of specialized motors with applications under AC/DC operation.

Course Contents:

Unit-I: Three-Phase Synchronous Generator — 08 Hours

Construction, rotating-field type and rotating-armature type, salient-pole type and non-salient-pole type and their comparison, Excitation Methods,

Synchronous generator (cylindrical): Operation, emf equation and winding factors, generator on load and no load, armature reaction and effect under load power factors, armature resistance, leakage flux and synchronous reactance, per phase equivalent circuit and phasor diagram

Synchronous generator (salient pole): Armature reaction as per Blondel's two reaction theory for salient-pole machines, direct-axis and quadrature-axis synchronous reactance's and their determination by slip test, phasor diagram and calculation of voltage regulation.

Unit-II: Voltage regulation of Three phase Synchronous Generator 08 Hours

Performance of open circuit and short circuit test on synchronous generator, determination of voltage regulation by emf, mmf, and Potier triangle methods. Determination of voltage regulation by direct loading, short circuit ratio, parallel operation of 3-phase alternators: necessity, conditions, load sharing between two alternators in parallel, process of synchronizing alternator with infinite bus-bar by lamp methods and by use of synchroscope (one dark & two equally bright method). Synchronizing current, power and torque.

Unit-III: Three-Phase Synchronous Motors 08 Hours

Principle of operation, Methods of starting, Equivalent circuit, significance of torque angle, Losses, efficiency and Power flow chart, Operation of 3-phase Synchronous motor with constant load and variable excitation ('V' Curves and 'inverted V' curves), Phenomenon of hunting and its remedies, Applications of 3-phase synchronous motors, Comparison of 3 phases synchronous motor with 3-phase induction motor.

Unit-IV: Single-Phase Induction Motor 08 Hours

Construction of single-phase induction motor, double field revolving theory. Equivalent circuit and torque-slip characteristics on the basis of double revolving field theory, Tests to determine the parameters of equivalent circuit and calculation of performance characteristics of motor, Methods of self-starting, Types of single-phase induction motors: Split-phase motors (Resistor split-phase motor, Capacitor-start motor, Capacitor start and capacitor run motor and permanent capacitor motor). Comparison of 1-phase induction motor with 3-phase induction motor.

Unit-V: Special Purpose Motors 08 Hours

Construction, principle of working, characteristics, ratings, advantages, limitations and applications of special motors - Brush less D.C. motors (inner and outer rotor) with hall sensor, Stepper motors (permanent magnet and variable reluctance type only) and their control parameters, Permanent magnet synchronous motor (PMSM), AC and DC series motors (Universal motors), Switched reluctance motor, AC and DC Servomotors, basic control mechanism and industrial application for all these motors.

Learning Resources:

Text Books:

1. Edward Hughes, "Electrical Technology", ELBS, Pearson Education.
2. Ashfaq Husain, "Electrical Machines", Dhanpat Rai & Sons.
3. S. K. Bhattacharya, "Electrical Machine", Tata McGraw Hill publishing Co. Ltd, 2nd Edition.
4. Nagrath & Kothari, "Electrical Machines", Tata McGraw-Hill.
5. Bhag S Guru, Husein R. Hiziroglu, "Electrical Machines", Oxford University Press.
6. K Krishna Reddy, "Electrical Machines- I and II", SCITECH Publications (India) Pvt. Ltd., Chennai.

Reference Books:

1. I. J. Nagrath and D. P. Kothari, Electric Machines, Tata McGraw-Hill, New Delhi, 2005.
2. M. G. Say, The performance and design of alternating current machines, CBS Publishers and distributors, Delhi, 1983.
3. Fitzgerald, Kingsley and Umans, Electric Machinery, Tata McGraw-Hill, New Delhi, 2003
4. S. K. Sen, Electrical Machinery, Khanna Pub., Delhi, 2012.
5. Mukherjee and Chakravorty, Electrical Machines, Dhanpat Rai Pub., New Delhi, 2005.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc19_ee69/preview
2. https://archive.nptel.ac.in/courses/108/102/108102146/

List of Practicals: (Any 8)

1. Determination of direct-axis and quadrature-axis reactance of cylindrical/salient pole alternator by slip test.
2. Determination of voltage regulation of cylindrical/salient pole alternator by following methods a) EMF method b) MMF method.
3. Determination of the regulation of cylindrical/salient pole alternator by the Potier method.
4. Synchronization of three phase alternator by Lamp and Synchroscope/digital methods.
5. Determination of the regulation of the alternator by the direct loading method.
6. V and inverted V curve of synchronous motor at constant load.
7. Load test on three phase synchronous motor.

8. Simulation of three phase synchronous motor on MATLAB/Vlab to obtain its performance.
9. Load test on a single-phase induction motor to obtain its performance characteristics.
10. No load and blocked-rotor test on a single-phase squirrel cage induction motor and determination of its equivalent circuit parameters.
11. Load test on a single-phase series motor to obtain its performance characteristics.
12. Speed control of BLDC Motor by electronics controller with PWM techniques.
13. Industrial Visit.

Course Code: 108502	Course Name: Power System Engineering	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 2 Hours/Week **Practical :** 2 Hours/Week	2 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks **PR + OR** : 25 Marks

Prerequisite Courses:

- Basic Electrical Engineering, Power Generation Technologies, Electrical Networks, Power systems and Equipment, Electrical Machines-I.

Course Objectives:

- To impart knowledge of mechanical and electrical design aspects of overhead transmission lines, including sag calculation, conductor supports and insulator selection for reliable power delivery.
- To develop analytical skills for modeling and evaluating transmission line performance using RLC parameters, per-unit system, power-flow methods and ABCD constants for medium and long-distance networks.
- To enable students to perform symmetrical and unsymmetrical fault analysis for estimating fault currents and selecting appropriate protection equipment in power systems.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply overhead line and insulator design concepts to evaluate sag and string efficiency.

CO2: Analyze and model the short, medium, and long transmission lines.

CO3: Compute per-unit quantities and develop solution power flow equations in power transmission networks.

CO4: Analyze symmetrical faults to determine fault currents and voltages in a faulted Power system.

CO5: Calculate the currents and voltages in a faulted power system under unsymmetrical Faults.

Course Contents:

Unit-I: Mechanical Design of Overhead lines and Insulators — 06 Hours

Mechanical design of overhead lines: Main components of overhead lines, various types of line supports, conductor spacing, length of span, calculation of sag for equal and unequal supports and effect of ice and wind loading.

Overhead line insulators: Types of insulators, their construction, and their applications, such as pin type, suspension type, strain type, shackle type, post insulators and bushing. Potential distribution over suspension insulators, string efficiency (numerical on string efficiency and up to four discs only), and methods of improving string efficiency (descriptive treatment only).

Unit-II: Performance of Transmission Line — 06 Hours

Classification of lines based on length and voltage levels such as short, medium and long lines, Performance of short transmission lines with voltage current relationship and phasor diagram, Representation of medium lines as 'Nominal Π' and 'Nominal T' circuits using R,L and C parameters, Ferranti effect, Representation of 'T' and 'Π' models of lines as two port networks, Evaluation and estimation of generalized circuit constants (ABCD) for short and medium lines, Estimation of efficiency and regulation of short and medium lines. Surge Impedance Loading, Phenomenon of Corona.

Unit-III: Per Unit System and Power Flow Analysis — 06 Hours

Per unit system: Single line diagram, Impedance and reactance diagrams and their uses, per unit quantities, relationships, selection of base, change of base, reduction to common base, advantages and application of per unit system. Numerical based on per unit system.

Power flow analysis: Concept of System Matrices (Z-bus and Y-bus). Formulation of Z-bus and Y-bus matrix and their modification techniques. Power- flow equations generalization to n bus systems, classification of buses, Newton- Raphson method (polar method), Decoupled and Fast decoupled load flow.

Unit-IV: Symmetrical Fault Analysis — 06 Hours

3-phase short-circuit analysis of unloaded alternator, sub-transient, transient and steady state current and impedances, D.C. Offset, and effect of the instant of short-circuit on the waveforms, estimation of fault current without pre-fault current for simple power systems, selection of circuit-breakers and current limiting reactors and their location in power system (Descriptive treatment only). Numerical based on symmetrical fault analysis.

Unit-V: Unsymmetrical Fault Analysis — 06 Hours

Symmetrical components, transformation matrices, sequence components, power in terms of symmetrical components, sequence impedance of transmission line and zero sequence networks of transformer, solution of unbalances by symmetrical components, L-L, L-G, and L-L-G fault analysis of unloaded alternator and simple power systems with and without fault impedance. Numerical based on symmetrical components and unsymmetrical fault calculation.

Learning Resources:

Text Books:

1. J. B. Gupta, "Transmission and Distribution", S. K. Kataria and Sons, New Delhi.
2. I.J. Nagrath and D.P. Kothari – Modern Power System Analysis – Tata McGraw-Hill, New Delhi.
3. B. R. Gupta, “Power System Analysis and Design”, S. Chand.
4. Ashfaq Hussain, “Electrical Power Systems”, CBS Publication, 5th Edition.
5. J. B. Gupta. “A course in Power Systems,” S.K. Kataria Publications.
6. P.S.R. Murthy, “Power System Analysis”, B.S. Publications.

Reference Books:

1. Nagrath & Kothari, "Power System Engineering", Tata McGraw-Hill Publications
2. H. Hadi Sadat: Power System Analysis, Tata McGraw-Hill New Delhi.
3. G. W. Stagg and El- Abiad – Computer Methods in Power System Analysis – Tata McGraw-Hill, New Delhi.
4. M. E. El- Hawary, Electric Power Systems: Design and Analysis, IEEE Press, New York.
5. Rakash Das Begamudre, “Extra High voltage A.C. Transmission Engineering”, New age publication.
6. M. A. Pai, Computer Techniques in Power System Analysis, Tata McGraw-Hill Publication.
7. Stevenson W.D. Elements of Power System Analysis (4th Ed.) Tata McGraw-Hill, New Delhi.
8. K. R. Padiyar, HVDC Transmission Systems, New Age International Publishers Ltd, New Delhi.
9. Olle I. Elgard – Electric Energy Systems Theory – Tata McGraw-Hill, New Delhi.
10. V. K. Chandana, Power Systems, Cyber tech Publications.
11. P. Kundur, Power System Stability And Control, McGraw-Hill.

Web link for MOOC / NPTEL Links:

1. https://www.youtube.com/playlist?list=PLRWKj4sFG7-6gWwDMLI0Wy5DDRqyKP1uQ
2. NPTEL course on Power System Engineering, IIT Kharagpur

https://nptel.ac.in/courses/108/105/108105104/

3. NPTEL course on Power System Analysis, IIT Kharagpur
   https://nptel.ac.in/courses/108/105/108105067/
4. NPTEL Course on Power System Engineering by Debpriya Das
   https://nptel.ac.in/courses/108/105/108105104/
5. NPTEL Course on Power System Analysis by Dr. A.K. Sinha
   https://nptel.ac.in/courses/108/105/108105067/
6. NPTEL Course on Power System Analysis by Dr. Debpriya Das
   https://onlinecourses.nptel.ac.in/noc26_ee182/preview
7. https://nptel.ac.in/courses/108102047
8. https://nptel.ac.in/courses/108104051

List of Practicals: (Minimum 8)

1. Study of different types of insulators for overhead transmission lines.
2. Measurement of ABCD parameters of a medium transmission line with magnitude and angle.
3. Measurement of ABCD parameters of a long transmission line with magnitude and angle.
4. Formulation and calculation of the Y-bus matrix of a given system using software.
5. Static measurement of sub-transient reactance of a salient-pole alternator.
6. Measurement of sequence reactance of a synchronous machine (Negative and zero).
7. Plotting of the receiving end circle diagram to evaluate the performance of the medium transmission line.
8. Performance study of the effect of VAR compensation using a capacitor bank on the Transmission line.
9. Solution of a load flow problem using the Newton-Raphson method using software.
10. Simulation of a symmetrical fault of a single machine connected to an infinite bus.
11. Simulation of an unsymmetrical fault of a single machine connected to an infinite bus.
12. Simulation of HVDC system.
13. Compulsory industrial visit to Substation.

Course Code: 108503	Course Name: Power Electronics	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 2 Hours/Week **Practical** : 2 Hours/Week	2 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks **PR + OR** : 25 Marks

Expected Prerequisite Courses:

- Analog and Digital Electronics.

Course Objectives:

- To explain the fundamentals of power electronics and semiconductor power devices.
- To understand the operation of DC-DC converters and their applications.
- To analyze AC-DC converters and power factor correction techniques.
- To apply the operation of DC-AC converters and inverter systems in power electronics applications.
- To analyze feedback controllers and industrial applications of power electronics.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the characteristics and operation of power semiconductor devices used in power electronic circuits.

CO2: Analyze the operation of DC-DC converters (choppers) under various load conditions and switching techniques.

CO3: Analyze the performance of single-phase and three-phase controlled rectifiers with R and RL loads.

CO4: Apply PWM techniques in inverter operation for power conversion and motor drive applications.

CO5: Compare different types of AC-AC converters for industrial applications.

Course Contents:

Unit-I: Power Semiconductor Devices 06 Hours

Introduction to power electronics, applications and the role of power electronics and drives, structure of power electronics interface, the switch-mode load-side converter, VI characteristics and switching behavior of power diode, SCR, BJT, MOSFET, and IGBT.

Unit-II: Switch-Mode DC-DC Converters 06 Hours

DC-DC converters, common operating principles, buck converter switching analysis in DC steady state, boost converter switching analysis in DC steady state, buck-boost converter switching analysis in DC steady state, topology selection, worst-case design, synchronous-rectified buck converter for very low output voltages, bi-directional switching power-pole, feedback controllers in switch-mode DC power supplies.

Unit-III: AC-DC Converters and Power-Factor Correction 06 Hours

Distortion and power factor; diode-rectifier bridge "front-ends"; front-ends with bi-directional power flow; single-phase PFCs; control of PFCs; designing the inner average-current-control loop; designing the outer voltage loop; example of single-phase PFC systems; feed-forward of the input voltage; three-phase converter.

Unit-IV: Switch-Mode DC-AC Converters 06 Hours

Hard-switching in the switching power-poles, soft-switching in the switching power-poles, inverters for induction heating and compact fluorescent lamps, single-phase voltage source inverter: operation, output waveforms, and RMS/average analysis.

Unit-V: Designing Feedback Controllers and Utility Applications 06 Hours

Cascade control structure, steps in designing the feedback controller, system representation for small-signal analysis, controller design, distributed generation applications, power electronic loads, power quality solutions, transmission and distribution applications, and operation of single-phase to single-phase and three-phase to single-phase cycloconverters.

Learning Resources:

Text Books:

1. Ned Mohan, T.M. Undel and W.P. Robbins - Power Electronics, 3rd Edition, John Wiley and Sons.
2. M. H. Rashid - Power Electronics, 2nd Edition, Pearson publication.
3. B.W. Williams: Power Electronics, 2nd edition, John Wiley and Sons.
4. Ashfaq Ahmed- Power Electronics for Technology, LPE Pearson Edition.
5. Dr. P.S. Bimbhra, Power Electronics, Third Edition, Khanna Publication.

Reference Books:

1. Vedam Subramanyam - Power Electronics, New Age International, New Delhi.
2. M. D. Singh and K. B. Khand Chandani, Power Electronics, Tata McGraw-Hill.
3. L. Umanand, Power Electronics – Essentials and Applications, Wiley Publication.
4. V.R. Moorthi, Power Electronics Devices, circuits, and Industrial applications, Oxford University Press.

Web link for MOOC / NPTEL Links:

1. Power Electronics by Prof. D. Prasad, IIT, Kharagpur.
   https://nptel.ac.in/courses/108105066
2. Boost Converter Design and Simulation in MATLAB/Simulink
   https://www.youtube.com/watch?v=_1uPJhqo18Q
3. Design a Boost Converter for a Photovoltaic System
   https://www.youtube.com/watch?v=Ku50Fzwomv
4. Buck-Boost Converters in Electric Vehicles
   https://www.youtube.com/watch?v=Z2NE3i9Bzc0
5. Power Electronics Application on Wind Turbines.
   https://ijret.org/volumes/2013v02/i11/IJRET20130211056.pdf

List of Practicals: (Any 8)

1. Static VI characteristic of SCR / GTO.
2. Static VI characteristic of MOSFET / IGBT.
3. Single-Phase Half-Wave Controlled Rectifier with R and RL Load.
4. Single-Phase Full-Wave Controlled Rectifier with R and RL Load.
5. Operation of MOSFET-based chopper.
6. Single-Phase AC Voltage Controller Using SCR/TRIAC.
7. Single-Phase PWM Inverter Using MOSFET/IGBT.
8. Single-Phase Cycloconverter Using SCRs.
9. Simulation of Single-Phase Half-Controlled and Fully Controlled Rectifier.
10. Simulation of Buck, Boost / Buck-Boost Converters Using MATLAB/PSIM.
11. Harmonic Analysis of Inverter Output Using FFT in MATLAB/Simulink.
12. Design of a Battery Charging Circuit Using a Controlled Rectifier in MATLAB/Simulink.
13. Industrial visit.

Course Code: 108504A	**Course Name: Design of Renewable Energy Systems**	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Engineering Physics, Power Generation Technologies, Renewable Energy, Business Economics, Environmental Studies.

Course Objectives:

- To design solar PV and solar thermal systems for specified load and site conditions using standard engineering practices.
- To design wind energy conversion systems (WECS) for given wind speed and site conditions to meet specified power requirements.
- To design biomass, micro/mini hydro, ocean, and geothermal energy systems based on site-specific resource availability and demand.
- To design energy storage systems and hybrid renewable energy systems for grid-connected or standalone applications with defined reliability requirements.
- To analyze the economic feasibility of renewable energy systems using financial indicators and evaluate carbon credit mechanisms for sustainability assessment.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Design solar PV and solar thermal systems for specified load and site conditions using standard engineering practices.

CO2: Design wind energy conversion systems (WECS) for given wind speed and site conditions to meet specified power requirements

CO3: Design biomass, micro/mini hydro, ocean, and geothermal energy systems based on site-specific resource availability and demand.

CO4: Design energy storage systems and hybrid renewable energy systems for grid-connected or standalone applications with defined reliability requirements.

CO5: Analyze the economic feasibility of renewable energy systems using financial indicators and evaluate carbon credit mechanisms for sustainability assessment.

Course Contents:

Unit-I: Solar Energy System Design 08 Hours

Solar Resource Assessment and Site Survey: Solar resource assessment and site survey, Solar radiation data collection and analysis, Factors affecting solar energy system performance.

Solar Thermal System Design: Design of solar water heating systems, solar cookers, solar dryers, solar distillation systems and applications of solar thermal systems.

Solar Photovoltaic (PV) Component Design: Residential load estimation and energy assessment, PV module and array design, Maximum Power Point Tracking (MPPT) design concepts, DC–DC charge controller design, Battery sizing and selection, Inverter selection and design.

Solar PV System Design: PV system sizing methodology, Design of standalone solar PV systems and grid-connected solar PV systems, Grid integration issues and standards.

Solar PV Applications: Design of solar PV lanterns, solar street lighting systems, solar car parking systems, solar-based EV charging stations, solar trees, Vehicle-to-Grid (V2G) technology and applications.

Recent Trends in Solar Energy Systems: AI-based solar irradiance prediction, IoT-based PV monitoring and performance analytics.

Unit-II: Wind Energy Systems 08 Hours

Site Survey and Wind Resource Assessment: Site survey for wind energy projects, Wind resource assessment and wind data analysis, Wind speed distribution and energy estimation.

Wind Turbine Fundamentals and Aerodynamics: Principles of wind energy conversion, Aerodynamic calculations of wind turbines, Power coefficient, tip-speed ratio, and Betz limit.

Design of Wind Turbine Components: Rotor blade design, Hub and nacelle design, Tower design considerations, Design of gear mechanisms and transmission systems.

Wind Energy Conversion Systems (WECS): Selection and design of WECS, Selection and design of various electrical generators for WECS (SCIG, DFIG, PMSG, Synchronous generators etc.).

Control Strategies for WECS: Pitch control, Stall control, Yaw control, Maximum Power Point Tracking (MPPT), Supervisory control techniques.

Grid Integration and Power Quality: Grid integration through substations, Grid codes and interconnection requirements, Power quality issues in wind farms, Reactive power compensation and voltage regulation.

Wind Energy Applications: Design of wind-powered water pumping systems, Design small-scale wind turbines for residential or commercial applications, small-scale wind turbines for agricultural applications, Stand-alone and hybrid wind energy systems.

Advanced Monitoring and Smart Wind Farms: SCADA-based wind farm monitoring, IoT-based condition monitoring and performance analysis, AI-based wind speed forecasting and predictive maintenance.

Industrial Case Studies: Study of Suzlon Energy wind energy systems, Study of Enercon wind energy systems, Comparative analysis of other modern WECS technologies and wind farm installations.

Unit-III: Biomass and Other Renewables 08 Hours

Biomass Energy Systems: Biomass resource assessment and site survey, Selection of biomass conversion technology, Design of biomass gasifier systems, Design of biomass digester (biogas plant) systems, Performance evaluation and applications of biomass energy systems.

Micro/Mini Hydro Energy Systems: Site survey and hydro resource assessment, Selection and design of hydro turbines, Design of micro-hydro power systems, Design of mini-hydro power systems, Design of pumped-storage hydro power systems, Applications of hydro energy systems.

Ocean Energy Systems: Site survey and ocean energy resource assessment, Design of Ocean Thermal Energy Conversion (OTEC) systems, Design of tidal energy power plants, Design of wave energy power plants, Applications of ocean energy systems.

Geothermal Energy Systems: Site survey and geothermal resource assessment, Design of geothermal power plants, Applications of geothermal energy systems.

Hydrogen Energy Systems: Hydrogen production, storage and handling considerations, Design of hydrogen-based electricity generation systems, Design of hydrogen fuel-cell-based vehicle systems, Applications of hydrogen energy systems.

Unit-IV: Energy Storage and Hybrid Systems 08 Hours

Energy Storage Technologies: Sizing and selection of batteries (Lead-Acid Batteries, Lithium-Ion Batteries), Battery Management System (BMS), Battery Energy Storage System (BESS): Components, configuration and design, Sizing and application of Supercapacitors, Pumped Hydro Energy Storage (PHES): Concept and design considerations, Thermal Energy Storage (TES) using Phase Change Materials (PCM), AI-based Energy Management System (EMS) for storage-integrated renewable systems.

Hybrid Renewable Energy Systems: Concept of Hybrid Renewable Energy Systems, Design and optimization of Solar–Wind–Battery Hybrid Systems, Software tools for hybrid system design (HOMER Pro, PVsyst for Solar PV system design), Grid integration of hybrid renewable energy systems and associated challenges.

Microgrid Systems: Concept, need and architecture of Microgrids, AC Microgrid: Design and applications, DC Microgrid: Design and applications, Hybrid AC–DC Microgrid: Design and applications, Design of Integrated Renewable Energy-Based Microgrid Systems, Smart Microgrid: Features and architecture, Smart Microgrid Control Strategies, Design of Smart Renewable Energy Microgrids for residential, commercial and community applications.

Unit-V: System Economics and Modeling 08 Hours

Economic Analysis of Renewable Energy Systems: Cost components of renewable energy projects, life cycle cost analysis, payback period, net present value, return on investment, comparative economic assessment of renewable energy systems.

Carbon Credit Business and Environmental Assessment: Carbon footprints, greenhouse gas emission reduction, Kyoto Protocol, carbon credit mechanism, carbon credit market and trading, economic benefits of carbon credits.

Modeling and Simulation of Renewable Energy Systems: Developing mathematical models for renewable energy systems, system performance analysis and optimization, simulation studies and data analysis, modeling of solar, wind, biomass, hydro and hybrid energy systems, Various simulation tools/software for renewable energy system design and analysis (e.g., MATLAB/Simulink, HOMER Pro, PVsyst, RETScreen, ETAP).

Learning Resources:

Text Books:

1. R. K. Rajput, Power Plant Engineering, Laxmi Publications, New Delhi.
2. G. D. Rai, Energy Sources, Khanna Publications.

Reference Books:

1. B. H. Khan, Non-Conventional Energy Sources, Second Edition. Tata McGraw-Hill.
2. S P Sukhatme and J P Nayak, Solar Energy: Principles of Thermal Collection and Storage, McGraw-Hill Education, 2017.
3. G. N. Tiwari, Solar Energy: Fundamentals, Design, Modelling and Applications, Alpha Science, 2002.
4. J. F. Manwell, J. G. McGowan, and A. L. Rogers. Wind Energy Explained- Theory, Design and Application. John Wiley and Sons Ltd.
5. Prabir Basu, Biomass Gasification, Pyrolysis and Torrefaction, Academic Press, Elsevier, 2013.

Web link for MOOC / NPTEL Links:

1. https://nptel.ac.in/courses/103103206

2. https://nptel.ac.in/courses/103103207
3. https://nptel.ac.in/courses/108108078
4. International Energy Agency https://www.iea.org/energy-system/renewables
5. Ministry of New and Renewable Energy https://mnre.gov.in/en/
6. India 2020 Energy Policy https://iea.blob.core.windows.net/assets/2571ae38-c895-430e-8b62-bc19019c6807/India_2020_Energy_Policy_Review.pdf

List of Practicals: (Any 8: from 1 to 15 and 16 Compulsory)

1. Evaluate the thermal and electrical performance of a Concentrated Solar Thermal (CST) system under specified operating conditions.
2. Design a solar thermal system (solar water heater/solar cooker/solar dryer/solar distillation unit) for a specified application and climatic condition.
3. Design a standalone/grid-connected Solar PV system for a specified residential or commercial load using standard design procedures.
4. Analyze the effect of PV module tilt angle, orientation and shading on energy generation using experimental or simulation tools.
5. To simulate standalone solar PV system/solar PV grid connected system for residential/commercial load application.
6. Simulate and evaluate the performance of standalone/grid-connected Solar PV systems for residential/commercial load application using suitable software tools.
7. Design and validate an MPPT charge controller and inverter for a renewable energy system using analytical and simulation approaches.
8. Design a Wind Energy Conversion System (WECS) for a specified site using wind resource assessment and load requirements.
9. Design a biomass energy conversion system (biomass gasifier/biogas digester/biomass cook stove) for a specified energy demand.
10. Design a micro/mini hydroelectric power plant based on site survey data, hydraulic parameters, and load demand.
11. Analyze and design an ocean energy system (tidal/wave/OTEC) for a given resource potential and application.
12. Design a Battery Energy Storage System (BESS) and hybrid battery-supercapacitor energy management system for standalone or grid-connected renewable energy applications.
13. Design and optimize a solar-wind hybrid renewable energy system for a specified site considering reliability and economic constraints.
14. Prepare a detailed Bill of Materials (BOM), perform component selection, and conduct techno-economic analysis of a renewable energy project using current market data.

15. Mini Design Project: Design, model, simulate and present a complete renewable energy or hybrid renewable energy system for a real-world application, including technical and economic feasibility analysis.
16. A visit to any electrical power generation power plant is compulsory.

Course Code: 108504B	**Course Name: Microcontroller & Embedded Systems**	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Prerequisite Courses:

- Digital Electronics, Basic Programming.

Course Objectives:

- To understand architecture, features, and programming models of modern microcontrollers.
- To develop ability to interface sensors, actuators, and communication modules.
- To design embedded applications using ESP32.
- To develop basic IoT-enabled embedded solutions.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the ESP32 architecture, instruction set features, and programming environment for embedded system development.

CO2: Configure and program ESP32 on-chip peripherals such as GPIO, timers, interrupts, ADC, and PWM for embedded applications.

CO3: Develop Embedded C/MicroPython programs for real-time applications using ESP32.

CO4: Interface sensors and actuators with ESP32 to implement embedded system applications.

CO5: Implement IoT-based communication and data handling using ESP32 for connected applications.

Course Contents:

Unit-I: Embedded Systems & ESP32 Architecture **08 Hours**

Definition and components of embedded systems, Embedded system design flow, Microcontroller vs microprocessor, Overview of MCU families: PIC, AVR, ARM Cortex, ESP32 architecture: Xtensa dual-core processor, clocking system, memory organization (SRAM, Flash, RTC memory), boot process, GPIO structure, Development environments: Arduino IDE, ESP-IDF, MicroPython.

Unit-II: Programming of ESP32 (Embedded C / MicroPython) 08 Hours

Programming models for ESP32: Arduino C framework and overview of FreeRTOS concepts (introductory level), Embedded C fundamentals: data types, bitwise operations, use of volatile, basics of interrupt service routines, Digital I/O programming, Timers and non-blocking time-based event handling, External and timer interrupts, PWM generation and duty-cycle control, PWM-based analog signal generation (conceptual), ADC operation and limitations in ESP32, Interfacing external ADC devices using I2C / SPI (conceptual), MicroPython file system basics.

Unit-III: Interfacing Peripherals & Sensors 08 Hours

Communication protocols: UART, SPI, I2C, Sensor interfacing: Temperature sensors (LM35 / DS18B20), Ultrasonic sensor (HC-SR04), Light sensors (LDR / TSL2561). Actuator interfacing: Relay modules, Servo motors, DC motor using driver circuits (L293D / MOSFET-based drivers).

Unit-IV: ESP32 Communication Modules & IoT Basics 08 Hours

ESP32 Wi-Fi block diagram, Wi-Fi modes: STA, AP, AP+STA, Basics of IoT communication: HTTP, MQTT (Mosquitto broker installation, publish–subscribe model, QoS levels), Web server implementation on ESP32, IoT data formats: JSON, key–value encoding, CSV, lightweight encoding methods, Data upload to cloud platforms (ThingSpeak, MQTT broker), Basic security concepts: API keys and authentication. Limitations of simulation tools for IoT applications (Proteus constraints).

Unit-V: Embedded Application Design and Case Studies 08 Hours

System design approach: hardware–software co-design, Power considerations and battery interfacing, PCB design basics for ESP32-based systems, Application case studies: Smart greenhouse monitoring, Home automation node, Energy monitoring system, Industrial data logging, Introduction to FreeRTOS on ESP32 (overview), Best practices for debugging embedded systems.

Learning Resources:

Text Books:

1. J. Sathish, Getting Started with ESP32 and Arduino, Independently Published, 2021.
2. W. Wolf, Computers as Components: Principles of Embedded Computing System Design, 3rd ed. Burlington, MA, USA: Morgan Kaufmann (Elsevier), 2012.
3. J. K. Peckol, Embedded Systems: A Contemporary Design Tool, 2nd ed. New Delhi, India: Wiley India, 2014.

Reference Books:

1. V. O. Oner, Developing IoT Projects with ESP32, 1st ed. Birmingham, U.K.: Packt Publishing, 2019.
2. A. Kurniawan, Internet of Things Projects with ESP32, 1st ed. Birmingham, U.K.: Packt Publishing, 2019.
3. N. Kolban, Getting Started with ESP32. [Online]. Available: https://github.com/nkolban/ESP32
4. R. Barnett, Embedded C Programming and the Atmel AVR, 2nd ed. Upper Saddle River, NJ, USA: Pearson Education, 2011.

Web link for MOOC / NPTEL Links:

1. NPTEL Course: Embedded Systems
   https://onlinecourses.nptel.ac.in/noc26_cs22/preview
2. https://onlinecourses.nptel.ac.in/noc25_cs30/preview

List of Practicals: (Any 8)

1. Setting up ESP32 toolchain (IDE installation and board configuration).
2. GPIO programming on ESP32 (LED blinking).
3. Digital input/output interfacing using push-buttons and LEDs.
4. PWM-based brightness control using ESP32.
5. Interrupt handling using external input (push-button).
6. Interfacing the temperature sensor with the ESP32.
7. I2C-based LCD / OLED interfacing.
8. Servo motor control using ESP32.
9. DC motor control using driver circuits.
10. Development of a simple web server on ESP32.
11. IoT data upload to ThingSpeak or MQTT test broker.
12. Mini-project: Design of an IoT sensor node/automation system.
13. FreeRTOS demonstration on ESP32 (task creation and scheduling).
14. Serial communication using UART on ESP32.

Course Code: 108504C	Course Name: Signals and Systems	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Prerequisite Courses:

- Engineering Mathematics.

Course Objectives:

- To provide basic knowledge of theoretical structure, formal representation, computational methods, notation and vocabulary of linear time invariant models.
- To impact skills to perform signal analysis with reference to spectrum analysis of deterministic signals.
- To impart basic knowledge of signals and system analysis.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Classify and analyze basic signals and systems.

CO2: Evaluate system properties and representations.

CO3: Perform time-domain analysis using convolution and correlation.

CO4: Apply Fourier Series for periodic signal analysis.

CO5: Use Fourier Transform for frequency-domain analysis.

Course Contents:

Unit-I: Introduction to Signals and System — 08 Hours

Continuous and discrete: Introduction, mathematical representation, transformation of independent variables, periodic signals, even and odd signals, exponential signals, sinusoidal signals, unit impulse and unit step.

Unit-II: Properties of Signal and Systems — 08 Hours

Elementary operations on signals, basic properties and classification - system with and without

Memory, inevitability, inverse systems, causality, stability, time invariance and linearity. Nyquist sampling theorem, differential and difference equation representation, block diagram and state variable representation of the system, sampling and reconstruction of signals.

Unit-III: Time Domain Analysis of Continuous and Discrete Time — 08 Hours

Zero state and Zero input response of LTI system, Impulse response of LTI system, Convolution and its properties, Convolution integral, Properties of Convolution integral, Convolution sum, Properties of Convolution sum, graphical representation of convolution. Correlation - autocorrelation, cross-correlation, relationship between convolution and correlation.

Unit-IV: Fourier Series — 08 Hours

Introduction, Response of LTI Systems to Complex Exponentials, Fourier Series Representation of Continues Time Periodic Signal, Convergence of Fourier Series, Properties of Continues Time Fourier Series, Fourier Series Representation of Discrete Time Periodic Signal, Properties of Discrete Time Fourier Series, Fourier Series for LTI Systems.

Unit-V: Fourier Transform — 08 Hours

Introduction, Continues Time Fourier Transform - Fourier Transform representation of a periodic and periodic signals, Properties of Continues Time Fourier Transform, The Convolution Property, The Multiplication Property. Discrete Time Fourier Transform - Fourier Transform representation of a periodic and periodic signals, Properties of Discrete Time Fourier Transform, The Convolution Property, The Multiplication Property.

Learning Resources:

Text Books:

1. A. V. Oppenheim, A. S. Willsky, S. H. Nawab, “Signals and Systems”, Prentice Hall, 2nd Edition, 1998.
2. B. P. Lathi, “Principles of Linear systems and signals, Oxford University Press, 2nd Edition, 2005.

Reference Books:

1. J. Roberts, “Signals and Systems,” Tata McGraw-Hill, 3rd Edition, 2011.
2. Simon Haykin, Barry Van Veen, “Signals and Systems”, Wiley, 2nd Edition, 2007.

Web link for MOOC / NPTEL Links:

1. https://nptel.ac.in/content/storage2/courses/108105063/pdf/L-
2. https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-32.pdf
3. https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-34.pdf
4. https://nptel.ac.in/courses/112/107/112107143/

List of Practicals:

1. Basic Signal Generation and Plotting (Unit step, impulse, ramp, exponential, sinusoidal).

2. Time Domain Analysis of Signals (Shifting, Scaling, Reversal).
3. Signal Sampling and Reconstruction (Sampling Theorem).
4. Linear Convolution of Discrete Signals.
5. Circular Convolution using DFT/IDFT.
6. Fourier Series Analysis of Periodic Signals.
7. Fourier Transform and FFT Analysis.
8. Laplace Transform Applications for System Response.
9. Z-Transform, ROC and Pole-Zero Plot.
10. Time-Domain Analysis of LTI Systems (Impulse & Step Response).

Course Code: 170505A	**Course Name: Systems in Mechanical Engineering**	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Engineering Physics, Engineering Chemistry.

Course Objectives:

- To identify the sources of energy and their conversions.
- To explain the basic concept of engineering thermodynamics and its application.
- To introduce proper manufacturing process applicable to produce components.
- To understand the basic concepts of mechanical engineering.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply knowledge of thermodynamics concepts.

CO2: Explain basic laws of thermodynamics, heat transfer and their applications.

CO3: Select different materials for different applications.

CO4: Explain the basics of engineering components.

CO5: Describe and get exposure to the latest trends in manufacturing processes.

Course Contents:

Unit-I: Thermodynamic Concepts — 08 Hours

Introduction to thermodynamics, introduction to various thermodynamic properties, heat and work, thermodynamic laws. Power plant engineering and sources of energy : conventional thermal, nuclear, hydraulic power plant. Nonconventional- wind, solar, tidal, geothermal.

Unit-II: Heat Transfer — 08 Hours

Modes of heat transfer: conduction, convection and radiation. Fourier's law, Newton's law of cooling and Stefan-Boltzmann's law. Domestic appliances, viz., refrigerator, air-conditioner.

Unit-III: Material Science — 08 Hours

Classification of materials, their properties and applications, phase change material (PCM), composite material.

Unit-IV: Introduction to Transmission Devices 08 Hours

Study of shafts, belt drive, chain drive, gear and gear trains and clutches.

Unit-V: Manufacturing Processes 08 Hours

Metal casting, forging, sheet metal working, machining and machine tools, and metal joining processes.

Learning Resources:

Text Books:

1. Nag, P. K., "Engineering Thermodynamics" Tata McGraw-Hill Publisher Co. Ltd.
2. Chaudhari and Hajra, "Elements of Workshop Technology", Volume I and II, Media Promoters and Publishers, Mumbai.
3. Rajput, R.K., "Basic Mechanical Engineering", Laxmi Publications Pvt. Ltd.
4. Raghavan V.,"Materials Science And Engineering: A First Course",Hall of India.

Reference Books:

1. Khan, B. H., "Non-Conventional Energy Sources, Tata McGraw-Hill Publisher Co Ltd.
2. Khurmi, R.S, and Gupta, J. K., "A Textbook of Thermal Engineering", S. Chand & Sons.
3. Incropera, F. P.and Dewitt, D.P., "Fundamentals of Heat and Mass Transfer, John Wileyand Sons, USA.
4. Juvinal, R. C., Fundamentals of Machine Component Design, John Wiley & Sons, USA.
5. Kripal Sing, "Automobile Engineering", Vol.1 and Vol.2.

Web link for MOOC / NPTEL Links:

1. Energy resources. https://www.youtube.com/watch?v=Zgp86PVXXuQ
2. Thermodynamic Concepts. https://nptel.ac.in/courses/112103275
3. https://www.youtube.com/playlist?list=PLbRMhDVUMngeVrxtbBzn8HvP8KAWBpI5

List of Practicals: (Any 5)

1. Study of non-conventional or renewable sources of energy.
2. Study of laws of thermodynamics.
3. Study of laws of heat transfer.
4. Study of domestic appliances like the refrigerator and the air conditioner.
5. Study of materials used for different applications.
6. Study of power transmission devices.
7. Study of manufacturing processes.

Course Code: 170505B	Course Name: Data Structures and Algorithms	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Fundamentals of Programming, Programming and Problem Solving.

Course Objectives:

- To learn the fundamentals of data structures.
- To understand how data can be logically organized using data structures.
- To illustrate the types of data structures and their use in engineering.
- To choose suitable data structures for real engineering problems.
- To learn system efficiency, such as time and memory usage, without mathematics or programming.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand basic concepts of data structures.

CO2: Apply the concepts of stacks and queues.

CO3: Implement appropriate non-linear data structures.

CO4: Demonstrate searching and sorting techniques in engineering data handling.

CO5: Illustrate real-world engineering case studies using data structures.

Course Contents:

Unit-I: Introduction to Data Structures **08 Hours**

Need for data organization, Overview of Data structures: Types of data structures, **Abstract Data Types (ADT):** Concept and significance, **Arrays:** Characteristics and representation, types of arrays: 1D and 2D, Use in storing engineering measurements and parameters.

Case Study: Engineering Data Management in a Weather Monitoring System.

Unit-II: Linear Data Structures **08 Hours**

Introduction to linear data structures, **Stack**: Concept, operations, and behavior (LIFO), Applications: undo operations and automation systems. **Queue**: Concept, operations, and behavior (FIFO), Applications: scheduling, buffering, and resource management, Conceptual comparison between stack and queue, **Linked Lists:** Introduction, need, types and applications.

Case Study: Smart Office Management System.

Unit-III: Non-Linear Data Structures 08 Hours

Need for non-linear data representation, Trees: Terminology: root, node, parent, child, and level, Types of trees: Binary tree, Binary search tree, Tree traversal, Applications of Non-linear Data Structures, Graphs: Basic concepts, Concept of directed and undirected graphs, graph representation. Case Study: College Campus Management System.

Unit-IV: Searching and Sorting 08 Hours

Importance of searching and sorting, **Searching techniques:** Concept of linear and binary search, Use cases in engineering, **Sorting techniques:** Concept of ordering and prioritization, Examples such as sorting by size, cost and priority using bubble sort, selection sort, merge sort, Time and Space Complexity Concepts. **Case Study:** Engineering Inventory and Component Management System.

Unit-V: Engineering Case Studies 08 Hours

Data structures used in real time applications, Identification of case studies from Mechanical / Civil / Electrical systems etc., Selection of appropriate data structures for given engineering problems, and discussion on the benefits of proper data structuring.

Learning Resources:

Text Books:

1. Y. Kanetkar and A. Kanetkar, Let Us C++, New Delhi, India: BPB Publications.
2. E. Horowitz and S. Sahni, Fundamentals of Data Structures in C++, New York, NY, USA: W. H. Freeman, ISBN: 978-0716782926.

Reference Books:

1. M. A. Weiss, Data Structures and Algorithm Analysis in C++, 2nd ed., New Delhi, India: Pearson Education, ISBN: 81-7808-670-0.

Web link for MOOC / NPTEL Links:

1. Data Structures And Algorithms By Prof. Naveen Garg, IIT Delhi. https://nptel.ac.in/courses/106102064

List of Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications, and current trends related to the subject.
2. Preferably, there should be multiple sets of assignments and distributed among batches of students.

3. Giving assignments based on real-life problems can help the students with future projects.
4. Students should be encouraged to use free and open-source software.
5. Instructors can also include an additional assignment or mini-project that goes beyond the syllabus but aligns with the course.

List of Suggested Assignments:

1. Implementation of an array.
2. Implementation of stack.
3. Implementation of queue.
4. Implementation of trees.
5. Implementation of graphs.
6. Implementation of searching techniques.
7. Implementation of sorting techniques.
8. Mini project.

List of Suggested Activity-based Learning:

1. Flipped Classroom.
2. Gamification.
3. Online Interactive Tool.
4. Collaborative and Individual Problem-based learning.
5. Quizzes/Assignments.
6. VLab.

Course Code: 170505C	Course Name: Engineering Measurements	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Engineering Physics, Engineering Chemistry, Basic Electronics and Electrical Engineering.

Course Objectives:

- To explain the static/dynamic characteristics of measurement systems and the working principles of displacement, speed, vibration, and force/torque transducers.
- To impart knowledge on industrial pressure and vacuum measurement techniques along with standard calibration methods.
- To explain the construction, signal compensation, and operational characteristics of contact and non-contact temperature sensors.
- To introduce the mechanics, and selection criteria of various fluid level and flow monitoring instruments.
- To familiarize students with the principles of viscosity, density, humidity, and chemical sensors, alongside an introduction to intelligent SMART sensing systems.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Evaluate the performance of transducers used for mechanical parameters like displacement, speed, vibration, force, and torque.

CO2: Calibrate pressure and vacuum measuring devices using standard dead-weight or vacuum testing rigs.

CO3: Select appropriate temperature sensors for precise thermal monitoring.

CO4: Evaluate the operational dynamics of industrial fluid flow and level sensors based on principles.

CO5: Demonstrate miscellaneous sensors according to their working principles.

K B T C O E

Course Contents:

Unit-I: Fundamentals of Engineering Measurements 08 Hours

Measurement system elements, static and dynamic characteristics.

Need for sensors and transducers, definition and classification of transducers.

Displacement Measurement: Resistive-potentiometers, inductive-LVDT, capacitive, piezoelectric, ultrasonic, and proximity sensors.

Speed measurement, vibration measurement, force and torque measurement.

Unit-II: Pressure Measurement 08 Hours

Units and their relations, manometers, elastic sensors, piezoelectric secondary transducers, differential pressure sensors, capacitive (delta cell), vacuum gauges, dead weight tester.

Unit-III: Temperature Measurement 08 Hours

Temperature scales, units and their relations, classification of temperature sensors, bimetallic thermometer, Resistance temperature detectors (RTD), types of RTD, lead wire compensation,

thermistors, Thermocouples, thermopiles, thermos-well, cold junction compensation techniques, pyrometers, temperature IC sensor LM35.

Unit-IV: Flow Measurement 08 Hours

Bernoulli's equation for incompressible flow, head type flow meters (orifice, venture meter and pitot tube), variable area type (Rotameter), turbine, electromagnetic, ultrasonic, mass flow meter: Coriolis flow meter.

Unit-V: Level and Miscellaneous Measurement 08 Hours

Level Measurement: Float, DP cell, ultrasonic, capacitive.

Viscosity: Saybolt, Searle's rotating cylinder, rotameter. Density: Hydrometers. Humidity: Resistive and capacitive type sensors. PH sensors, conductivity sensors.

Learning Resources:

Text Books:

1. Instrumentation Measurement and Analysis – B.C. Nakra, K.K. Chaudhry, 4th Edition, McGraw Hill, 2010, ISBN: 978-0070709868
2. Principles of Industrial Instrumentation" — D. Patranabis, ISBN (latest editions): 978 0070605502 (approximate for recent editions)
3. Transducers and Instrumentation – D.V.S. Murty, 3rd Edition, PHI Learning, 2011, ISBN: 978-8120346876.

Reference Books:

1. Industrial Instrumentation – A.K. Sawhney, 4th Edition, Dhanpat Rai & Co., 2010, ISBN: 978-8177000311
2. Measurement Systems: Application and Design – Ernst O. Doebelin, 5th Edition, McGraw Hill, 2003, ISBN: 978-0071223122.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ee105
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ee32

List of Practicals (Any 8):

1. Measure linear displacement using a Linear Variable Differential Transformer (LVDT).
2. Determine the characteristics of different proximity sensors.
3. Calibrate a load cell and determine its sensitivity for weight measurement.
4. Measure angular displacement using a shaft angle encoder.
5. Calibrate a Bourdon tube pressure gauge using a dead-weight tester.
6. Calibrate a vacuum gauge using a vacuum gauge tester.
7. Calibrate a Resistance Temperature Detector (RTD) and determine the temperature of an unknown liquid.
8. Determine temperature using LM35.
9. Flow measurement using DP transmitter.
10. Measure pH sensor output and calibrate it using standard buffer solutions.
11. Flow measurement using Orifice / Venturi flowmeter.

Course Code: 170505D	**Course Name: Sensors and Actuators**	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Fundamentals of Electronic Engineering, Programming Language C.

Course Objectives:

- To enable students to apply IoT concepts, architectures (3-layer and 5-layer), and system components (sensors, actuators, devices) in designing basic IoT-based solutions for real-world applications.
- To analyse different types of sensors (such as temperature, pressure, proximity, and optical sensors) and their applications in real-world systems.
- To study various actuators (electrical, mechanical, hydraulic, and pneumatic) and understand their role in control systems.
- To develop the ability to interface sensors and actuators with microcontrollers and embedded systems for data acquisition and control.
- To apply knowledge of sensors and actuators in designing and implementing practical systems used in automation, robotics, and industrial applications.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply knowledge of IoT building blocks, architectures, and components to develop and implement simple IoT applications for real-world applications.

CO2: Analyze sensor/transducer performance, signal conditioning, and data acquisition to assess measurement accuracy and errors.

CO3: Apply principles of temperature, pressure, force, flow, and level sensors to select and use appropriate sensors for measurement applications.

CO4: Examine the operating principles and performance characteristics of position, proximity, and motion sensors to compare and select appropriate sensors for specific measurement and control applications.

CO5: Evaluate performance, working principles and control mechanisms of electrical, fluid power, and specialized actuators for various automation and control system applications.

Course Contents:

Unit-I: Introduction to IoT and Architecture 08 Hours

Definition, Need & Scope of IoT, Evolution of IoT, Industry 4.0, Basic Components of IoT: Sensors, Actuators, Devices, IoT System Building Blocks, IoT Architecture: 3-Layer, 5-Layer models (simple explanation), IoT Applications across various sectors, (healthcare, manufacturing, smart homes, agriculture, transport).

Unit-II: Introduction to Signal Conditioning 08 Hours

Concepts: Sensors vs. Transducers, Sensor Classification (Active/Passive, Digital/Analog), Performance Characteristics (Static and Dynamic: Sensitivity, Linearity, Hysteresis, Response Time). **Signal Conditioning:** Bridge circuits, Amplifiers (Op-Amp), Filtering (Low-pass, High-pass), Data Acquisition (ADC/DAC). **Error Analysis:** Calibration, Sensitivity Analysis, and Uncertainty.

Unit-III: Thermal and Mechanical Sensors 08 Hours

Temperature Sensors: Thermocouples (Seebeck effect), Resistance Temperature Detectors (RTDs), Thermistors (NTC/PTC), Bimetallic strips, Pyrometers.

Pressure Sensors: Manometer, Bourdon Tube, Diaphragm, Bellows, Piezoelectric and Strain Gauge.

Force & Weight Sensors: Strain Gauges (Bridge circuits, gauge factor), Load Cells.

Flow & Level Sensors: Ultrasonic, Capacitive, Float Sensors, Turbine Flowmeters, Venturi Tubes.

Unit-IV: Position, Proximity and Motion Sensors 08 Hours

Position and Displacement Sensors: Potentiometers (Linear/Rotary), Linear Variable Differential Transformers (LVDT), Eddy current probes.

Proximity Sensors: Inductive (metallic), Capacitive (non-metallic), Optical/Photoelectric, Magnetic (Reed switches), Light Dependent Resistors (LDR), Fiber-optic sensors.

Motion & Acceleration Sensors: Accelerometers (1-3 axis), Gyroscopes, MEMS inertial sensors, Velocity sensors.

Unit-V: Actuation Systems 08 Hours

Electric Actuators: DC Motors, AC Motors, Stepper Motors, Servo Motors, Solenoids, Relays.

Fluid Power Actuators: Hydraulic and Pneumatic Cylinders, Valves, Pumps.

Specialized Actuators: Piezoelectric actuators, Shape Memory Alloys.

Control Methods: PWM (Pulse Width Modulation) speed control.

Learning Resources:

Text Books:

1. Milan Milenkovic, "Internet of Things: Concepts and System Design", Springer, 2020.
2. D. V. S. Murthy, "Transducers and Instrumentation" Prentice Hall of India, 2nd Edition, 2012.
3. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", Wiley, 2014
4. Rolando Herrero, "Fundamentals of IoT Communication Technologies", Springer, 2022.

Reference Books:

1. Ian Sinclair & John Dunton, "Sensors and Transducers", Newnes (Elsevier) 3rd Edition, 2016.
2. Samayveer Singh, Manju, Aruna Malik, Pradeep Kumar Singh, "IoT-enabled Sensor Networks: Architecture, Methodologies, Security, and Futuristic Applications", Bentham Science Publishers, 2024.
3. C.S. Rangarajan, "Instrumentation Devices and Systems", Tata McGraw-Hill, 1st Edition, 2010.
4. Mohan Lal Kolhe, Kailash J. Karande, Sampat G. Deshmukh, "Artificial Intelligence, Internet of Things (IoT) and Smart Materials for Energy Applications", CRC Press (Taylor & Francis), 2023.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc25_ee76/preview
2. https://onlinecourses.nptel.ac.in/noc25_ee82/preview
3. https://onlinecourses.nptel.ac.in/noc26_ee41/preview

List of Practicals: (Any 8)

1. Interfacing of an LED with Arduino board.
2. Display real-time temperature & humidity values on serial monitor using DHT11.
3. IoT-Based Motion Detection / Security System (Interface PIR Motion Sensor. Send alert notification (app pop-up, buzzer or LED indicator).
4. IoT-Based Gas/Smoke Detection System. (Interface MQ-2 Gas sensor (or simulator). Trigger buzzer/alert message when gas level exceeds a threshold. Send alert notification to mobile using cloud app (Blynk/MQTT).
5. IoT-Controlled Servo Motor / Door Lock System. (Interface a servo motor. Control angle/position remotely using a cloud dashboard or mobile app.)
6. Heartbeat / Pulse Monitoring System (IoT-Based). (Interface pulse sensor or simulated heartbeat data. Send health parameters to cloud for real-time monitoring)

7. Water Level Monitoring & Alert System. (Use ultrasonic sensor to measure water tank level. Send water-level data to cloud and generate alerts when level is low or high.)
8. Fire Detection and Alert System. (Flame sensor or temperature sensor combination, Trigger instant alerts and send real-time fire detection signals to mobile/cloud.)
9. Voice-Controlled IoT Device (Google Assistant/Alexa Integration). Control LED/Fan simulation using voice commands through Google Assistant + IFTTT or Alexa IoT skills.
10. IoT-Based Smart Street Lighting System. Automatically control a street light (LED) using an LDR sensor and send status (ON/OFF) to an IoT dashboard.
11. Smart Energy Monitoring System. Measuring and visualizing electrical parameters (current/voltage simulation allowed) and uploading data to cloud.
12. IoT-Based Weather Station (Multi-Sensor System). Interfacing two or more sensors (temperature, humidity, light, pressure) and publishing combined data to cloud.

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Course Code: 170505E	Course Name: Infrastructure and Planning	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Fundamentals of Building Technology and Architectural Planning.

Course Objectives:

- To understand and analyze urban infrastructure systems, including their types, planning data, standards, and the roles of stakeholders in urban development.
- To apply concepts of water supply, sanitation, stormwater, solid waste, and transport planning to propose sustainable and efficient urban infrastructure solutions.
- To develop knowledge of rural planning principles and government schemes to improve village infrastructure, housing, livelihoods, and social services.
- To use modern planning tools and technologies (GIS, remote sensing, drones) for the implementation, monitoring, management of urban and rural infrastructure projects.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the role and types of urban infrastructure, key planning data and standards, and the planning process with stakeholder roles.

CO2: Apply concepts of water supply, sanitation, stormwater, and solid waste management to plan and propose basic urban infrastructure improvements.

CO3: Apply transport and land-use planning concepts to improve urban mobility, accessibility, and sustainability

CO4: Develop rural planning strategies using government schemes to improve village infrastructure, housing, and livelihoods.

CO5: Implement rural infrastructure and connectivity solutions using GIS and other planning tools.

Course Contents:

Unit-I: Introduction to Urban Planning and Infrastructure — 08 Hours

Role of infrastructure in urban development, Types of infrastructure: physical (water, power, transport), social (education, health), utilities Planning data, resource analysis, norms and standards Infrastructure planning process and stakeholder roles layouts.

Unit-II: Water, Sanitation and Stormwater Systems **08 Hours**

Water supply sources, treatment, storage, distribution, Water demand forecasting, leakage, reuse, rainwater harvesting, Sanitation systems: sewage generation, collection, treatment, greywater management, Stormwater drainage, natural drainage, stormwater harvesting Institutional and management issues, Municipal solid waste: generation, collection, treatment, recycling.

Unit-III: Transport and Mobility Planning **08 Hours**

Importance of transport infrastructure in urban form transport modes (public, private, non-motorized), and mobility demand land use–transport integration, accessibility, TOD (Transit-Oriented Development) transport modeling basics, pricing, congestion and sustainable mobility.

Unit-IV: Principles and Strategies of Rural Planning **08 Hours**

Introduction to rural planning: need, scope, and objectives, rural settlement patterns and typologies, planning strategies for rural development central and State government schemes: MGNREGA, PMAY-G, Swachh Bharat Mission, PMGSY, Jal Jeevan Mission, role of planning in livelihood, housing, and social infrastructure.

Unit-V: Rural Infrastructure Management **08 Hours**

Physical infrastructure: water supply, sanitation, drainage, roads, energy, solid waste management, social infrastructure: schools, healthcare, community centers, Transport and connectivity: rural road hierarchy, public transport, traffic management, Tools and technology: GIS, remote sensing, drones for rural planning, Implementation, monitoring, and governance of rural projects.

Learning Resources:

Text Books:

1. Town Planning, G. K. Hiraskar, Dhanpat Rai Publications.
2. Town Planning, S. C. Rangwala, Charotar Publishing House Pvt. Ltd.
3. Rural Development: Planning Strategy & Policy Imperatives - Vivek Saurath & Manoj Agarwal).

Reference Books:

1. Urban Planning by Chris Couch.
2. Urban Infrastructure and Governance by G. Ramesh, Vishnu Prasad Nagadevara, Gopal Naik, Anil Suraj.
3. Urban and Regional Planning Education: Learning for India (edited by Ashok Kumar, Diwakar S. Meshram, Krishne Gowda.

4. MRTP Act 1966 : The director, government printing, stationary and publications, Maharashtra state, Mumbai.
5. URDPFI & AMRUT Guidelines: Ministry of housing and urban affairs, Government of India.
6. Role of Edge Analytics on Sustainable Smart City Development: Challenges and Solutions by G. R. Kanagachidambaresan.
7. Sustainable Smart Cities in India: Challenges and Future Perspectives (The Urban Book Series) by Poonam Sharma and Swati Rajput.
8. Rural Development: Principles, Policies and Development by Katar Singh and Anil Shishodia. Atlantic Publications.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.swayam2.ac.in/cec20_ar01/preview
2. https://www.edx.org/certificates/professional-certificate/delftx-inclusive-and-sustainable-cities?index=product&queryId=2d5f1360201b4959787e19d485c4178e&position=3
3. https://www.coursera.org/learn/smart-cities
4. https://onlinecourses.nptel.ac.in/noc25_ar27/preview
5. https://onlinecourses.nptel.ac.in/noc26_ar08/preview
6. https://onlinecourses.nptel.ac.in/noc25_ar25/preview
7. https://onlinecourses.nptel.ac.in/noc26_ce48/preview

List of Practicals:

1. Prepare a case study for any infrastructure project of India and give presentation. (Group Activity).
2. Design a practical rainwater harvesting solution for any building. (Individual work).
3. Prepare a land-use map for a neighborhood with classification (residential, commercial, industrial, etc.) by calculation. (Group Activity)
4. Identify the major causes of congestion on any busy road in the city and suggest practical improvements to reduce traffic delays. Present your findings with brief observations and supporting photos or sketches. (Group work)
5. Draw a simple O–D diagram of your route from home to college, marking key points like home, major junctions, bus stops, and the college gate. Include the approximate distance and travel time with neat sketch map with brief travel details. (Individual work)
6. Select one rural development scheme (MGNREGA, PMAY-G, SBM, PMGSY, or JJM) and prepare a brief report covering its objectives, beneficiaries, key components, impact on rural livelihood or infrastructure, and a simple implementation flowchart (Individual work)

7. Prepare a village infrastructure improvement proposal for a hypothetical village of 1,000–1,500 people, listing existing issues, suggesting improvements in water supply, sanitation, housing, livelihood, and roads, and identifying relevant government schemes for implementation. (Group work)
8. Site visit to any urban infrastructure or rural infrastructure management project.

Course Code: 170505F	Course Name: Web Development	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Computer Networks.

Course Objectives:

- To familiarize students with Web Programming basic concepts.
- To learn and understand Web scripting languages.
- To introduce students to responsive web design frameworks and modern UI components.
- To provide knowledge of web page styling and layout design for effective user interfaces.
- To familiarize students with website development using no-code platforms.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand a basic of web application.

CO2: Develop structured web pages using HTML.

CO3: Apply styling and layout design principles to create visually appealing web interfaces.

CO4: Develop responsive and user-friendly web pages using modern design frameworks and layout approaches.

CO5: Create and publish functional websites using modern website development tools.

Course Contents:

Unit-I: Introduction to Web Applications — 08 Hours

Internet, Basic internet protocols, World Wide Web, HTTP Request message, HTTP response message, Client–Server Architecture, Frontend vs Backend, World Wide Web, Role of browsers and web servers, Introduction to W3C and web standards.

Unit-II: Web Essentials and Mark-up Language- HTML — 08 Hours

HTML: Introduction, history and versions. Tags, elements, and attributes, HTML elements: headings, paragraphs, line break, links, frames, lists, tables, images and forms, Input elements and basic validation, difference between HTML and HTML5.

Unit-III: CSS Styling and Layout Design **08 Hours**

CSS: Introduction to Style Sheet, CSS features, Types of CSS, CSS core: Properties, Classes, Child-Class (Nested CSS), Colors, Text, Background, Border, Margin, Padding, Positioning (flex, grid, inline, block), Animation, Transition.

Unit-IV: Bootstrap for Responsive Web **08 Hours**

Bootstrap vs plain CSS, Installing and using Bootstrap, Bootstrap grid system, Responsive design using Bootstrap, **Common Bootstrap Classes:** Buttons, Tables, Forms, Cards, Navigation bar, Alerts and Models.

Unit-V: Website Design Using No-Code Platforms **08 Hours**

Introduction to no-code and low-code web development and Advantages, Website design using **Wix Studio:** Page structure and layout, Responsive design tools, Customization of UI components, **Website design using WordPress:** Themes and templates, Page builders, Content management basics, Publishing and maintaining websites.

Learning Resources:

Text Books:

1. Jeffrey C. Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035.
2. Robert W. Sebesta, "Programming the World Wide Web", 4th Edition, Pearson Education.
3. Jon Duckett, HTML and CSS: Design and Build Websites, Wiley Publications.

Reference Books:

1. Marty Hall, Larry Brown, "Core Web Programming", Second Edition, Pearson Education, 2001, ISBN 978-0130897930.
2. HTML5 & CSS3 Complete Reference", McGraw-Hill.

Web link for MOOC / NPTEL Links:

3. https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr26_ed79

List of Practicals:

1. Create a simple HTML webpage that displays basic information about yourself including name, photo, educational details, hobbies, and contact information using headings, paragraphs, images, and hyperlinks, ordered and unordered list.
2. Develop a webpage that displays a student marksheet using HTML tables including subjects, marks, and total percentage.

3. Create an HTML form for student registration including fields such as name, email, gender, date of birth, course selection, and submit/reset buttons. Apply basic input validation.
4. Design a webpage using external CSS to demonstrate styling of text, background colors, borders, and fonts also make use CSS Flexbox to arrange elements such as header, navigation bar, content section, and footer.
5. Design a webpage demonstrating CSS animation and transition effects on buttons, images, or text elements.
6. Create a responsive webpage using Bootstrap that includes navigation bar, image banner, cards, alerts, buttons, and tables and content sections.
7. Design a responsive webpage using Bootstrap Grid System that adjusts layout for mobile, tablet, and desktop screens.
8. Develop and publish a basic website using a No-Code platform such as WordPress or Wix Studio that includes at least three pages (Home, About, Contact).
9. Mini Project: Design and develop a complete responsive website for a small business, institute, or portfolio using HTML, CSS, and Bootstrap or a No-Code platform. The website should include navigation, forms, images and a responsive layout.

Course Code: 170505G	**Course Name: Applied Data Science**	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Programming and Problem Solving.

Course Objectives:

- To introduce the fundamentals of Data Science.
- To apply Data Science in different domain.
- To do exploratory analysis on a given data.
- To understand the concept of regression models.
- To facilitate learning of data pre-processing using R Programming.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply statistics and probability methods to solve real-life problems.

CO2: Demonstrate the Data Science Process and how its components interact.

CO3: Apply basic tools (plots, graphs, summary statistics) to carry out EDA.

CO4: Solve real life problems using regression techniques.

CO5: Apply machine learning algorithms for real world applications.

Course Contents:

Unit-I: Probability and Statistics 08 Hours

Basics: sample space, outcomes, probability. Events: mutually exclusive, Conditional probability, Bayes' rule. Describing a Single Set of Data, Correlation and Causation Probability: Dependence and Independence, Conditional Probability, Random Variables, Continuous Distributions, The Normal Distribution. **Case Study:** Probability Analysis of Credit Card Fraud Detection.

Unit-II: Introduction to Data Science and Data Preprocessing 08 Hours

Defining data science and big data, Recognizing the different types of data, Machine Learning Definition and relation with Data Science, Data Science Process: Data collection; Data preparation; Training a model on the data, evaluation of the model performance, Data visualization techniques and inferences. **Case Study:** Data Preprocessing for Online

Shopping Recommendation System.

Unit-III: Exploratory Data Analysis (EDA) 08 Hours

Statistical measures, Basic tools (plots, graphs and summary statistics) of EDA, Data Analytics Lifecycle, Discovery Developing Initial Hypotheses, Identifying Potential Data Sources, EDA case study, testing hypotheses on means, proportions and variances. **Case Study:** Analysis of Food Delivery Trends.

Unit-IV: Regression models 08 Hours

Simple linear regression, least-squares principle, MLR, logistic regression, Multiple correlation, Partial correlation, Cross Validation, Overfitting, Under Fitting and Model Selection, Prediction by using Ridge Regression. **Case Study:** House Price Prediction Using Real Estate Data.

Unit-V: Introduction to Machine Learning & R Programming 08 Hours

Supervised learning, Unsupervised learning, Association Rule mining, Naive Bayes Classifier, k-means clustering, Introduction to R, R packages, Tidy data, Tabular data and data import, Strings and regular expressions. **Case Study:** Customer Segmentation in Retail Business.

Learning Resources:

Text Books:

1. Data Science from Scratch: Joel Grus, O'Reilly Media Inc. 2015, ISBN: 9781491901427.
2. R for data science: import, tidy, transform, visualize, and model data", Wickham, Hadley, and Garrett Grolemund. O'Reilly Media, Inc.", 2016.
3. Cathy O'Neil and Rachel Schutt, "Doing Data Science", O'Reilly, 2015, ISBN: 9781449358655.

Reference Books:

1. Introduction to Probability and Statistics for and Engineers and Scientists, S. Ross, 3rd Edition, Elsevier, 2004.
2. Software for Data Analysis: Programming with R (Statistics and Computing), John M. Chambers, Springer.
3. Hadley Wickham,Garrett Grolemund, " R for Data Science" , O'Reilly Media, 12 December 2016, ISBN:9781491910344, 1491910348.

K B T C O E

Web link for MOOC / NPTEL Links:

1. Python for Data Science
https://onlinecourses.nptel.ac.in/noc20_cs36/preview

List of Practicals:

1. Download any standard dataset from Kaggle. Using a programming language such as Python /R, perform statistical analysis to understand the structure, distribution, and relationships within the data.
2. Write python code that loads any standard dataset downloaded from Kaggle and plot the graph.
3. Perform some basic data cleaning operations on standard dataset using Python / R (Dataset should contain minimum 1000 records)
4. Perform data preprocessing, exploratory analysis on any standard dataset (dataset should contain minimum 1000 records) Using Python /R.
5. Perform correlation and regression analysis for any standard dataset downloaded from Kaggle, Government databases etc using Python / R.
6. Perform Simple Linear regression on for any standard data set downloaded from Kaggle, UCI, Government databases Using Python / R
7. Perform data analysis using Python / R / Weka for readily available data set using any one machine learning algorithm.

Course Code: 170505H	Course Name: Electrical Machines	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Basic Electrical Engineering.

Course Objectives:

- To understand selection of machines for specific applications.
- To understand the construction, principle of operation of various motors.
- To test & analyze the performance of single phase and three phase motors.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand the principles of electromechanical energy conversion, torque equation, and constructional features of electric motors.

CO2: Apply characteristics and speed control methods of DC motors to select suitable drives for applications.

CO3: Examine performance characteristics of three-phase induction motors for selection and control in mechanical loads.

CO4: Compare single-phase motors to select appropriate types for domestic and light-industrial use.

CO5: Apply operating principles and control methods of synchronous, BLDC, stepper, and servo motors in engineering applications.

Course Contents:

Unit-I: Fundamentals of Electric Motors — 08 Hours

Basic concepts of electromechanical energy conversion, Fleming's rules, torque and EMF equations. Constructional features: Stator, rotor, windings, bearings, cooling systems, Comparison of AC vs DC motors and their industrial relevance, Safety considerations & motor nameplate data interpretation.

Unit-II: DC Motors — 08 Hours

Construction: Lap and wave windings, commutator, field excitation, Working principle and back EMF, Types: shunt, series, compound motors, Torque-speed characteristics and performance curves, Speed control techniques (armature and field control), Applications in traction, lifts, rolling mills, robotics. Brushless DC motors: construction, electronic commutation, uses in EV and drones.

Unit-III: Three-Phase Induction Motors 08 Hours

Construction and working: squirrel cage vs slip-ring, Rotating magnetic field concept, slip, torque production, Torque-speed characteristics: starting torque, breakdown torque, Starting methods: DOL, star-delta, auto-transformer, Speed control: V/f control, rotor resistance, slip power recovery, Selection criteria for mechanical drives (load type, duty cycle), Use in pumps, compressors, crushers, conveyors, HVAC systems.

Unit-IV: Single-Phase Induction Motors & Auxiliary Motors 08 Hours

Limitations of single-phase supply, double-revolving field theory, Types: split-phase, capacitor-start, capacitor-run, shaded pole, Universal motor: working and uses, Applications in domestic & light-industrial mechanical equipment (fans, washing machines, small tools).

Unit-V: Synchronous & Special Motors 08 Hours

Synchronous Motors: excitation, torque-angle characteristics, Starting methods, V-curves, power factor improvement. **PMSM:** Construction, electronic controller, uses in EV. **Stepper Motors:** Variable reluctance & PM types, step angle, control, Servo motors for automatic control systems & CNC automation, Application focus in robotics, precision positioning and aerospace actuators.

Learning Resources:

Text Books:

1. Edward Hughes "Electrical Technology", ELBS, Pearson Education.
2. Ashfaq Husain, "Electrical Machines", Dhanpat Rai & Sons.
3. S. K. Bhattacharya, "Electrical Machine", Tata McGraw Hill publishing Co. Ltd, 2nd Edition.
4. Nagrath & Kothari, "Electrical Machines", Tata McGraw Hill.
5. Bhag S Guru, Husein R. Hiziroglu, "Electrical Machines", Oxford University Press. K Krishna Reddy, "Electrical Machines- I and II", SCITECH Publications (India) Pvt. Ltd. Chennai.

Reference Books:

1. I. J. Nagrath and D. P. Kothari, Electric Machines, Tata McGraw Hill, New Delhi, 2005.
2. M. G. Say, The performance and design of alternating current machines, CBS Publishers and distributors, Delhi, 1983.

3. Fitzgerald, Kingsley and Umans, Electric Machinery, Tata McGraw Hill, New Delhi, 2003
4. S. K. Sen, Electrical Machinery, Khanna Pub., Delhi, 2012.
5. Mukherjee and Chakravorty, Electrical Machines, Dhanpat Rai Pub., New Delhi, 2005.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc19_ee69/preview
2. https://archive.nptel.ac.in/courses/108/102/108102146/

List of Practicals (Any 8):

1. Load test on DC shunt motor to obtain torque-speed, efficiency and performance characteristics.
2. Speed control of DC motor using armature voltage and field control methods.
3. No-load and blocked-rotor tests on 3-phase induction motor to determine equivalent circuit parameters.
4. Load test on 3-phase induction motor to obtain performance characteristics.
5. Study and comparison of DOL, star-delta & auto-transformer starters for induction motor.
6. V/f (open-loop) speed control of induction motor using inverter (simulation or hardware).
7. Load test on synchronous motor to plot V-curves and study power-factor control.
8. Performance characterization of BLDC motor (simulation or hardware kit).
9. Stepper motor stepping and micro-stepping experiment to determine step angle and positioning accuracy.
10. Servo motor position control using PID controller and performance analysis.
11. Thermal/run-down and insulation resistance test (theoretical analysis for motor selection).
12. Motor selection and design mini-project based on given mechanical load (simulation/theoretical).

Course Code: 108506	Course Name: Simulation Tools for Electrical Engineering	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 4 Hours/Week	**2**	**TW** : 50 Marks

Expected Prerequisite Courses:

- Basic Electrical Engineering, Electrical Machines, Power Systems, Power Electronics, Electrical Installation and Maintenance.

Course Objectives:

- To develop professional competency in industry-standard electrical engineering software tools.
- To model, simulate, analyze, and design electrical engineering systems using professional engineering software.
- To prepare industrial electrical drawings, reports, and engineering documentation.
- To apply software tools for solving practical industrial electrical engineering problems.
- To develop industry-ready technical competencies and employability skills required for electrical system design, simulation, engineering documentation, commissioning, consultancy, and industrial automation applications.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Develop and simulate electrical and control system models using MATLAB/Simulink and analyze system performance.

CO2: Perform load flow, short-circuit, and protection coordination studies using ETAP software.

CO3: Prepare professional industrial electrical drawings and documentation using Electrical AutoCAD.

CO4: Design and analyze power electronic converters and motor drives using PSIM.

CO5: Develop professional electrical panel engineering documentation using EPLAN for industrial applications.

Course Contents:

This course provides hands-on training in professional engineering software widely used in

The electrical engineering profession, including MATLAB/Simulink, ETAP, AutoCAD

Electrical, PSIM, and EPLAN Electric.

Unit-I: MATLAB/Scilab & Simulink for Electrical Engineering 08 Hours

Introduction to MATLAB Environment, Simulink Basics, Simscape Electrical Library

Mathematical Modelling, DC Motor Modelling, Induction Motor Modelling, Speed Control

Renewable Energy System Simulation, Simulation Result Visualization and Performance Analysis.

Unit-II: ETAP for Power System Studies 08 Hours

ETAP Interface, Single Line Diagram Development, Load Flow Study, Short Circuit Analysis, Relay Coordination, Arc Flash Basics, Cable Sizing, Transformer Loading.

Unit-III: AutoCAD Professional Electrical Design 08 Hours

AutoCAD Electrical, IEC Standards and Symbols, Control Schematics, MCC Design, Terminal Plans, Cable Schedules, Bill of Materials, Engineering Documentation.

Unit-IV: Power Electronics Design using PSIM 08 Hours

Buck Converter, Boost Converter, Rectifiers, PWM Inverter, Motor Drive Simulation Harmonic Analysis, Efficiency Analysis.

Unit-V: Industrial Electrical Design using EPLAN 08 Hours

Industrial electrical control panel schematic (DOL starter/PLC-based control panel), assign devices, terminal connections, cable numbering, wire numbering, generate terminal plans, Bill of Materials (BOM), and prepare complete manufacturing documentation using EPLAN Electric.

Learning Resources:

Text Books:

1. Modeling and Simulation using MATLAB-Simulink, Jain & Kapshe (Wiley).
2. MATLAB and Simulink for Engineers, Agam Kumar Tyagi (OUP).
3. Power System Analysis Illustrated with MATLAB & ETAP, Shertukde (CRC Press).
4. Simulation of Power Electronics with MATLAB/Simulink, Farzin Asadi (Springer).
5. EPLAN Electric P8 Reference Handbook/User Guide.

Reference Books:

1. Power System Analysis, T.K. Nagsarkar& M.S. Sukhija.
2. Multiphysics Simulation for Electrical Machines & Drives, IEEE Press/Wiley.
3. AutoCAD Electrical Training Guide (Any Standard).
4. IEEE Standards Collection for Electrical Design and Documentation
5. IEC 60617 Electrical Symbols Standard.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc19_ee45/preview
2. https://onlinecourses.nptel.ac.in/noc25_ee167/preview
3. https://onlinecourses.nptel.ac.in/noc24_ee50/preview

List of Practicals: (Any 8 + Mini-Project)

1. DC Motor Modeling using MATLAB/Simulink

   Objective: To model and simulate a DC motor and analyze its speed–torque characteristics.

   Equipment/Software: MATLAB, Simulink, Simscape Electrical toolbox. Activity: Develop DC motor model in Simulink, apply load variations, plot speed and torque response, and analyze performance parameters.
2. Induction Motor Simulation in MATLAB/Simulink

   Objective: To simulate induction motor operation and obtain torque–speed characteristics.

   Equipment/Software: MATLAB, Simulink, Simscape Electrical library. Activity: Create induction motor model, vary load conditions, observe dynamic response, and record performance curves.
3. Load Flow Analysis using ETAP

   Objective: To perform load flow analysis on an industrial power system.

   Equipment/Software: ETAP software.

   Activity: Create single-line diagram, assign system parameters, run load flow study, and generate voltage profile report.
4. Short Circuit Analysis using ETAP

   Objective: To analyze different types of faults in a power system. Equipment/Software: ETAP software.

   Activity: Simulate three-phase and line-to-ground faults, calculate fault current levels, and verify breaker ratings.
5. Electrical Single-Line Diagram using AutoCAD Electrical

   Objective: To prepare a professional single-line diagram of an industrial power system.

   Equipment/Software: AutoCAD Electrical.

   Activity: Create SLD using standard symbols, label components, and generate drawing documentation.
6. Motor Control Circuit Design using AutoCAD Electrical

   Objective: To design and document a motor control circuit.

   Equipment/Software: AutoCAD Electrical.

Activity: Prepare wiring diagram for DOL starter, generate BOM, and export final drawing file.

7. Simulation of DC-DC Converter using PSIM

   Objective: To simulate and analyze performance of a DC-DC converter.

   Equipment/Software: PSIM software.

   Activity: Model buck/boost converter, observe output voltage variation with duty cycle, and analyze efficiency.

8. PWM Inverter Simulation using PSIM

   Objective: To simulate a PWM inverter and study harmonic performance.

   Equipment/Software: PSIM software.

   Activity: Design inverter circuit, generate PWM pulses, observe output waveform, and perform FFT analysis.

9. Industrial Electrical Control Panel Design using EPLAN Electric P8

   Objective**:** To prepare a professional industrial electrical control panel schematic and generate engineering documentation using EPLAN Electric P8.

   Equipment/Software**:** EPLAN Electric P8.

   Activity**:** Develop an industrial electrical control panel schematic (DOL starter/PLC-based control panel), assign devices, terminal connections, cable numbering, wire numbering, generate terminal plans, Bill of Materials (BOM), and prepare complete manufacturing documentation using EPLAN Electric P8.

Mini Project: Each student group shall complete one industry-oriented mini project using one or more software tools covered in the course.

- Industrial Distribution System Design.
- Solar PV Plant Electrical Design.
- EV Charging Station Design.
- Industrial Control Panel Design.
- Protection Coordination Study.
- Smart Distribution Network.
- Energy Management System.
- Motor Drive Design.
- Industrial Automation System.
- Digital Twin of Electrical System.

Semester - VI

Course Code: 108601	Course Name: Control Systems	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks **PR + OR** : 25 Marks

Expected Prerequisite Courses:

- Engineering Mathematics.

Course Objectives:

- To impart a basic understanding of control system engineering.
- To develop mathematical model of physical systems.
- To analyze behavior of system in time and frequency domain.
- To design controller to meet desired specifications.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Classify various types of control systems and to develop mathematical modeling of physical systems.

CO2: Determine the response of various control systems in the time domain.

CO3: Analyze the stability of control systems using a variety of methods.

CO4: Investigate the response and stability of control systems using frequency domain techniques.

CO5: Design PID controller for a given system to meet desired time domain specifications.

Course Contents:

Unit-I: Introduction to Control Systems **08 Hours**

Basic concepts of control systems, classification of control systems, Types of control systems, modeling and representations of control systems: Mechanical and Electrical systems, Transfer functions, Block diagram reduction, Signal flow graphs, Mason’s gain formula.

Unit-II: Time Domain Analysis **08 Hours**

Concept of transient and steady state response, standard test signals: step, ramp, parabolic and impulse signal, type and order of control system, time response of first and second order systems to unit impulse, unit step input, time domain specifications of second order systems, steady state error and static error coefficients.

Unit-III: Concepts of Stability 08 Hours

Introduction to stability, definition through impulse response function, asymptotic stability and relative stability, Routh-Hurwitz stability criterion. Basic Properties of Root Loci, Construction of Root Loci, Effects of Adding Poles and Zeros.

Unit-IV: Frequency Domain Analysis 08 Hours

Frequency domain specifications, relation between time and frequency domain specifications, Polar Plot, Bode plot, sketching of Bode plot, stability analysis using Bode plot and Polar plot, Introduction to Nyquist plot.

Unit-V: PID Controllers 08 Hours

Control System Components: Working principle and transfer function of Lag network, lead network, potentiometer, DC servo motors. Basic concept of P, PI, PID controller, design specifications in time domain and frequency domain, design of PID controller by Root Locus, tuning of PID controllers using Ziegler-Nichol Methods.

Learning Resources:

Text Books:

1. I. J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers, 6th edition, 2017.
2. Nise N. S. "Control Systems Engineering", John Wiley & Sons, Incorporated, 2011.

Reference Books:

1. Katsuhiko Ogata, Modern Control Engineering, Fifth Edition, Prentice-Hall, 2010.
2. Richard C Dorf and Robert H Bishop, "Modern control system", Pearson Education, 12th edition, 2011.
3. B. C. Kuo, "Automatic Control System", Wiley India, 8th Edition, 2003.

Web link for MOOC / NPTEL Links:

1. https://nptel.ac.in/courses/108102043.

List of Practicals:

Four experiments:

1. Experimental determination of DC servo motor parameters for mathematical modeling and transfer function
2. Experimental study of time response characteristics of the R-L-C second-order system. Validate the results using software simulation.
3. Experimental determination of the frequency response of the Lead compensator.
4. Experimental determination of the frequency response of the Lag compensator.
5. PID control of level/ Temperature/speed control system.

6. Experimental analysis of D.C. Motor Position Control System.

Four experiments using software:

7. Stability analysis using
   a. Bode plot, b. Root locus and c. Nyquist plot.
8. Effect of P, PI, and PID controllers on the time response of a second-order system.
9. Analysis of closed-loop DC position control system using PID controller.
10. Effect of the addition of a pole-zero on the root locus of a second-order system.
11. Effect of the addition of dominant and non-dominant poles on the step response of a second-order system.
12. PID controller for speed/position control of DC servomotor

Industrial visit:

13. Industrial visit to a process industry or control and automation industry.

Course Code: 108602	Course Name: Power System Operation and Control	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks **PR + OR** : 25 Marks

Expected Prerequisite Courses:

- Basic Electrical Engineering, Electrical Network, Power generation technology, Power System and Equipments, Power System Engineering, Electrical Machine-I.

Course Objectives:

- To evaluate the dynamic response and stability limits of synchronous machines using analytical and graphical methods.
- To model automatic generation control and formulate cost-effective generation scheduling under grid constraints.
- To study the mechanisms of power interchange and reactive power compensation for efficient grid regulation.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Develop ability to analyze and use various methods to improve stability of power systems.

CO2: Analyze load-frequency and voltage control strategies.

CO3: Optimize economic generation scheduling and unit commitment under grid constraints.

CO4: Evaluate power interchange and reactive power control strategies.

CO5: Analyze voltage stability using P-V and Q-V characteristics.

Course Contents:

Unit-I: Power System Stability — 08 Hours

Introduction to stability, dynamics of synchronous machine, swing equation, power angle equation and curve, types of power system stability (concepts of steady state, transient, dynamic stability), equal area criterion, methods to improve steady state and transient stability.

Unit-II: Automatic Generation Control — 08 Hours

Concept of Automatic Generation and Control (AGC), complete block diagram representation of load-frequency control of an isolated power system, steady state and dynamic response, control area concept, two area load frequency control. Schematic and block diagram of automatic voltage regulator scheme.

Unit-III: Economic Load Dispatch and Unit Commitment **08 Hours**

Economic operation of power system: Introduction, distribution of load between units within the plant. Optimum generation scheduling considering transmission losses. Representation of transmission loss using the loss formula coefficient. Derivation of loss formula coefficient.

Optimal unit commitment: Concept of unit commitment, constraints on unit commitment: spinning reserve, thermal and hydro constraints, methods of unit commitment: priority list and dynamic programming.

Unit-IV: Energy Control and Reactive Power Control **08 Hours**

Energy control: Interchange of power between interconnected utilities, economic interchange evaluation, interchange evaluation with unit commitment, types of interchange, capacity and diversity interchange, energy banking, emergency power interchange, inadvertent power exchange and power pools.

Reactive power control: The necessity of reactive power control, production and absorption of reactive power, reactive power requirements for power factor control and voltage regulation, types of FACTS controllers.

Unit-V: Voltage Stability **08 Hours**

Basic concepts related to voltage stability: transmission system characteristics (PV curve), generator characteristics (QV curve), and load characteristics. Voltage collapse, classification of voltage stability, static and dynamic stability, analysis techniques for dynamic voltage stability, and voltage stability indexing.

Learning Resources:

Text Books:

1. I. J. Nagrath, D. P. Kothari, "Modern Power System Analysis", 4th Edition, Tata McGraw-Hill Publishing Co. Ltd. (Edition 2)
2. T. J. E. Miller, "Reactive power control in electric systems," Wiley.
3. Hadi Saadat, "Power System Analysis," Tata McGraw's Hill
4. S. Sivanagaraju, G. Sreenivasan, "Power System Operation and Control," Pearson Education India, 2009.
5. P. S. R. Murthy, "Power System Operation and Control," Tata McGraw-Hill Publishing Co., Ltd.

6. Abhijit Chakrabarti, Sunita Halder, “Power System Analysis, Operation and Control,” Prentice Hall of India.
7. Narain G. Hingorani and Laszlo Gyugyi, “Understanding FACTs,” IEEE Press.
8. Dr. B.R. Gupta, “Power System-Analysis and Design”, S. Chand Publication.

Reference Books:

1. Allen J. Wood and Bruce F. Wollenberg, “Power Generation, Operation, and Control,” Wiley India Edition.
2. R. Mohan Mathur, Rajiv K. Varma, “Thyristor-based FACTS controller for electrical transmission systems”, by John Wiley and Sons, Inc.
3. Olle I. Elgerd, “Electrical Energy System Theory”, 2nd Edition, Tata McGraw-Hill Publishing Co. Ltd.
4. Dr. K. Uma Rao, “Power System Operation and Control,” Wiley India
5. Prabha Kundur, “Power System Stability and Control,” Tata McGraw’s Hill
6. “Electrical Power System Handbook”, IEEE Press
7. James Momoh, “Smart Grid: Fundamentals of design and analysis,” Wiley, IEEE Press.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc19_ee62/preview
2. http://nptel.ac.in/courses/108101040/
3. https://nptel.ac.in/courses/108101004
4. https://onlinecourses.nptel.ac.in/noc21_ee16/preview
5. https://onlinecourses.nptel.ac.in/noc26_ee158/preview
6. https://www.youtube.com/playlist?list=PL86E9AC8CFBA00ADB
7. https://www.youtube.com/watch?v=uy9lZCdkQIM&list=PLD4ED2FAF3C155625

List of Practicals:

1. To apply equal area criteria for stability analysis under a fault condition (three-phase fault at the middle point of a parallel transmission line).
2. To study the Lagrange multiplier technique for economic load dispatch (to find the optimal loading of generators).
3. To study load frequency control using an approximate and exact model.
4. To study reactive power compensation using STATCOM.
5. To solve the Unit Commitment problem by the priority list method/ dynamic programming (DP) approach
6. Plot a swing curve using the point-by-point/4th order Runge-Kutta method.
7. To apply equal area criteria for analysis stability under a sudden rise in mechanical power input.

8. To study load frequency control with proportional and integral control.
9. To study the two areas of load frequency control.
10. To study reactive power compensation using simulation of TCR or TCSC.
11. To study the optimum loading of generators considering transmission losses (penalty factor).
12. Industrial visit.

Course Code: 108603A	Course Name: Electrical Machine Design	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks **PR + OR** : 25 Marks

Expected Prerequisite Courses:

- Basic Electrical Engineering, Electrical Machines.

Course Objectives:

- To understand basic design principles, materials, and thermal considerations of electrical machines.
- To develop skills for designing and analyzing major electrical machines.
- To apply design methods for achieving efficient and reliable machine performance.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the basic design concepts, materials, thermal and magnetic loading involved in electrical machine design.

CO2: Design the main components of D.C. machines including armature, field system, and commutator while evaluating performance constraints.

CO3: Develop and analyze the design of core, windings, cooling systems, and mechanical structure of transformers for performance optimization.

CO4: Estimate and design key dimensions and winding configurations of three-phase induction motors considering torque, efficiency, and thermal limits.

CO5: Apply the design concepts to synchronous machines by determining rotor and stator parameters for improved performance and reliability.

Course Contents:

Unit-I: Introduction to Electrical Machine Design — 08 Hours

Basic concepts of machine design: design factors, rating, duty cycles, temperature rise, Magnetic, electric, and thermal loading, Standard specifications, materials used in electrical machines, Insulating materials and classes, cooling methods, Introduction to design process and performance parameters.

Unit-II: Design of DC Machines — 08 Hours

Constructional details and design considerations of yoke, pole, field winding & armature,

armature winding design, slot and conductor dimensions, design of commutator and brushes, magnetic circuit calculations and losses, performance evaluation and efficiency estimation.

Unit-III: Design of Transformers **08 Hours**

Core and winding design for core-type and shell-type transformers, Design of LV and HV windings, tank and cooling system, Estimation of equivalent circuit parameters and losses, Short-circuit strength and mechanical considerations, Temperature rise and cooling (ONAN, ONAF).

Unit-IV: Design of Three-Phase Induction Motors **08 Hours**

Design of stator core and winding: slots, conductors, air-gap, rotor design (squirrel-cage & wound rotor): bars, end rings, slip rings, starting torque, efficiency and power-factor considerations, performance characteristics and thermal aspects, estimation of main dimensions and output equation.

Unit-V: Design of Synchronous Machines **08 Hours**

Design of salient and non-salient pole rotors, stator design: slots, conductors, field winding design, cooling and ventilation requirements, short-circuit ratio, stability and voltage regulation considerations, estimation of performance and machine ratings.

Learning Resources:

Text Books:

1. A. K. Sawhney, “Electric Machine Design", Danpat Rai and Sons, 10th Edition, 2016
2. G. Upadhyay, “Design of Electrical Machines”, New Age International Publication, 2011
3. Deshpande. M. V., “A Course in Electrical Machine Design", Prentice Hall of India, 2011.
4. S. K. Sen “Principles Of Electrical Machine Design With Computer Programs", Oxford and IBH Publishing Company Pvt. Limited, 2nd Edition, 2006.

Reference Books:

1. A. E. Clayton, “Performance and Design of DC Machine", ELBS, ISAAC Pitman Sons, 3rd Edition, 2004.
2. S. V. Kulkarni, S. A. Khaparde , “Transformer Engineering: Design and Practice", Marcel Dekker Inc., 2004
3. M.G. Say, “Performance and Design of A.C. Machines”, ELBS and Pitman & Sons, 4th edition, 2013.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc23_ee140/preview

2. https://nptel.ac.in/courses/108102372

List of Practicals: (Any 8)

1. To study various materials used in electrical machine design and their properties.
2. To determine the output equation and main dimensions of a D.C. machine.
3. To design the core and winding dimensions of a transformer.
4. To design the stator core and slot configuration of a three-phase induction motor.
5. To calculate rotor dimensions and field winding parameters of a synchronous generator.
6. To create a 2D CAD/FEA drawing of a DC machine stator and rotor.
7. To model and analyze magnetic flux distribution in a transformer core using CAD/FEA software.
8. To design and simulate a 3-phase induction motor stator slot geometry in CAD/FEA environment.
9. To perform thermal analysis of an electrical machine using CAD/FEA tools.
10. To model a salient-pole synchronous rotor and evaluate magnetic loading using CAD/FEA simulation.
11. Industrial Visit.

Course Code: 108603B	Course Name: Smart Grid Systems & Technologies	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks **PR + OR** : 25 Marks

Expected Prerequisite Courses:

- Power systems.

Course Objectives:

- To explain the concept of smart grid, compare with conventional grid, and identify its opportunities and barriers.
- To describe the concept of smart meter, smart appliances, automatic meter reading, outage management system, plug in hybrid electric vehicles, vehicle to grid, smart sensors, home and building automation, phase shifting transformers.
- To elaborate the concept of substation automation, feeder automation. Intelligent electronic devices, smart storage like battery, pumped hydro, compressed air energy storage, wide area measurement system, phase measurement unit.
- To elaborate the concept of microgrid.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Differentiate between Conventional Grid and Smart Grid based on their features and applications.

CO2: Explain the importance of Supercapacitors in energy storage systems.

CO3: Identify the need and benefits of Smart Metering in modern power systems.

CO4: Apply communication technologies in Smart Grid systems.

CO5: Analyze the issues and challenges associated with Microgrids.

Course Contents:

Unit-I: Introduction to Smart Grid — 08 Hours

Concept of smart grid, need of smart grid, functions of smart grid, opportunities and barriers of smart grid, drivers of sg in India, functionalities and key components of smart grid, difference between conventional and smart grid, smart grid vision and roadmap for india, concept of resilient and self-healing grid, smart grid national policies, smart cities, pilot projects in India.

Case study: sustainability assessment of a smart grid pilot project in India.

Unit-II: Smart Grid Technologies 08 Hours

Intelligent Electronic Devices (IED), Phase Measurement Unit (PMU). Smart Substations, Substation and Feeder Automation, application for monitoring, protection and control, Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid (V2G), Energy Storage Technologies and applications – Battery (flow and advanced), SMES, Super Capacitors, Compressed Air Energy Storage (CAES) and its comparison.

Unit-III: Smart Meters and Advanced Metering Infrastructure 08 Hours

Introduction to Smart Meters, Prepaid meters, Net Metering, Advanced Metering Infrastructure (AMI), Real Time Pricing, Automatic Meter Reading (AMR), Outage Management System (OMS), Smart Substation, IEC 61850, Smart Sensors, Geographic Information System (GIS), IS 16444, LowPAN RF meter.

Unit-IV: Communication Technology for Smart Grids 08 Hours

Communication Architecture of SG, Wide Area Measurement Protection and Control (WAMPAC), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN)., ZigBee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing and Cyber Security for Smart Grid, LORaWAN (Long Range Wide Area Network), Narrowband Internet of things (NB-IoT), SigFox.

Unit-V: Microgrids 08 Hours

Concept of microgrid, need and applications of microgrid, microgrid architecture, DC microgrid, hybrid microgrid, formation of microgrid, issues of interconnection, protection and control of microgrid, integration of renewable energy sources, smart microgrid, microgrid and smart grid comparison, renewable energy-based microgrid system.

Learning Resources:

Text Books:

1. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press
2. Stuart Borlase, “Smart Grids-Infrastructure, Technology and Solutions”, CRC Press, Taylor and Francis group
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley Publications.
4. Nikos Ziargyriour, “Micro grid, Architecture and Control”, IEEE Press, Wiley Publications.

Reference Books:

1. Yang Xiao, "Communication and Networking in Smart Grids", CRC Press, Taylor and Francis group.

Web link for MOOC / NPTEL Links:

1. http://elearn.psgcas.ac.in/nptel/courses/video/108107113/L01.html
2. https://onlinecourses.nptel.ac.in/noc23_ee60/preview

List of Practicals: (Any 8)

1. To study power flow analysis in a simple electrical power system using simulation software.
2. To analyze fault current and relay coordination in a distribution network.
3. To study the operation of a smart meter, prepaid metering, and net metering concept.
4. To study the working of a Phasor Measurement Unit (PMU) and observe synchrophasor data.
5. To study substation automation and communication using IEC 61850 protocol.
6. To simulate microgrid operation under grid-connected and islanded modes.
7. To study charge and discharge characteristics of different energy storage systems.
8. To simulate Vehicle-to-Grid (V2G) operation and bidirectional power flow control.
9. To study communication networks used in smart grid (HAN, NAN, WAN).
10. To study cybersecurity concepts and demonstrate secure communication in smart grid.

Course Code: 108603C		Course Name: Embedded Systems Design using ARM
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks **PR + OR** : 25 Marks

Expected Prerequisite Courses:

- Microcontroller & Embedded Systems, C programming and basic understanding of microcontroller registers, Digital interfacing basics.

Course Objectives:

- To understand ARM processor architecture with reference to ARM7/LPC2148 and embedded memory systems.
- To develop embedded applications using Embedded C on ARM-based systems.
- To interface peripherals and communication modules in embedded platforms.
- To introduce RTOS concepts and real-time embedded system design.
- To design and implement medium-complexity embedded systems.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain ARM processor architecture with reference to ARM7/LPC2148.

CO2: Develop embedded C programs for ARM-based peripherals.

CO3: Interface sensors, actuators, and peripheral devices with ARM-based systems for embedded applications.

CO4: Implement communication using UART, SPI, and I2C protocols.

CO5: Implement multitasking embedded applications using RTOS concepts.

Course Contents:

Unit I: ARM7 Architecture & LPC2148 Overview — 08 Hours

ARM processor families: ARM7, ARM Cortex-M (overview), ARM7TDMI core architecture, Instruction pipeline and Thumb instruction set (basics), LPC2148 memory organization and on-chip peripherals (overview), GPIO structure and pin multiplexing (PINSEL concept), Logic levels and safe interfacing concepts: 5 V to 3.3 V interfacing, 1.8 V to 3.3 V level shifting, Use of level translators (conceptual), Embedded development tools: Keil µVision and Flash Magic.

Unit-II: Programming ARM7 in Embedded C **08 Hours**

Register-level programming concepts, Digital I/O programming, Timer configuration and time-based event handling, Interrupt handling and vectored interrupt controller (VIC) PWM generation for actuator control, PWM-based analog signal generation (conceptual approach), ADC interfacing fundamentals, Low-power modes and power-saving techniques.

Unit-III: Communication Interfaces **08 Hours**

UART communication, SPI communication, I2C communication, USB device fundamentals (introductory), Example applications: EEPROM interfacing, SPI-based sensor interfacing.

Unit-IV: RTOS Fundamentals & FreeRTOS on ARM7 **08 Hours**

Need for RTOS in embedded systems, Task creation and scheduling concepts, Inter-task communication mechanisms: queues, semaphores, mutexes, Introduction to FreeRTOS APIs, Demonstration applications: LED control task, Sensor acquisition task, Communication task, Multi-task embedded system design using FreeRTOS (introductory level).

Unit-V: Embedded Application Design **08 Hours**

Hardware–software co-design, Power management & clock configuration, PCB design considerations for ARM controllers, Case studies: Data logger, Motor control unit, Industrial sensor node, secure access control system.

Learning Resources:

Text Books:

1. A. Sloss, D. Symes, and C. Wright, ARM System Developer's Guide: Designing and Optimizing System Software. San Francisco, CA, USA: Morgan Kaufmann (Elsevier), 2004.
2. S. Furber, ARM System-on-Chip Architecture, 2nd ed. Boston, MA, USA: Addison-Wesley, 2000.
3. J. W. Valvano, Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers, 3rd ed. Lexington, KY, USA: CreateSpace Independent Publishing, 2017.

Reference Books:

1. NXP Semiconductors, LPC2148 User Manual. Eindhoven, The Netherlands: NXP, 2010. https://www.nxp.com
2. R. Barry, Mastering the FreeRTOS Real Time Kernel: A Hands-On Tutorial Guide. Real Time Engineers Ltd., 2016. https://www.freertos.org
3. ARM Ltd., ARM Architecture Reference Manual. Cambridge, U.K.: ARM Ltd. https://developer.arm.com

4. Keil, µVision IDE User's Guide. Arm Ltd. https://www.keil.com.

Web link for MOOC / NPTEL Links:

1. NPTEL: Embedded Systems Video Course
   https://nptel.ac.in/courses/108102045
   NPTEL: Embedded System Design with ARM (IIT Kharagpur) – https://onlinecourses.nptel.ac.in/noc26_cs40/preview
2. FreeRTOS Official Tutorials
3. https://www.freertos.org

List of Practicals: (Any 8)

Experiments may be carried out on LPC2148 or equivalent ARM Cortex-M development platforms such as STM32.

1. Study of ARM-based development board and toolchain (Keil µVision / equivalent IDE).
2. GPIO programming and digital I/O interfacing.
3. Timer configuration and time-based event generation.
4. Interrupt handling using external interrupt and timer interrupt.
5. ADC-based sensor interfacing and data acquisition.
6. PWM generation and duty-cycle control for actuator applications.
7. UART-based serial communication between ARM controller and PC.
8. I2C-based EEPROM interfacing and data transfer.
9. SPI-based sensor interfacing.
10. USB device demonstration (introductory level, if hardware supports).
11. Low-power mode configuration and power measurement analysis.
12. Multi-peripheral integration experiment (e.g., ADC + UART + LCD display).
13. FreeRTOS task creation and scheduling demonstration.
14. Inter-task communication using queues or semaphores in FreeRTOS.
15. Mini-project: Design of a multitasking embedded system (e.g., data logger / motor control / sensor monitoring unit).

Course Code: 108604A	**Course Name: Electric Mobility**	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks **PR + OR** : 25 Marks

Expected Prerequisite Courses:

- Basic Electrical Engineering, Basic Electronics Engineering, Engineering Chemistry, Electrical Machines-I and II.

Course Objectives:

- To understand the design and operation of electric vehicles and their power train components.
- To explore energy storage systems, including batteries, management systems, and alternative solutions.
- To examine trends and challenges in EV adoption and energy storage integration.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand the evolution, configurations, and environmental benefits of electric vehicles, and compare their performance with conventional internal combustion engine vehicles.

CO2: Explain the working principles and functionalities of EV power train components, including electric motors, power electronics, and regenerative braking systems.

CO3: Describe the various EV charging technologies, infrastructure requirements, and government policies to identify solutions for enhanced EV adoption.

CO4: Demonstrate knowledge of battery technologies, performance characteristics, and the role of battery management systems (BMS) in ensuring safety and efficiency in EV applications.

CO5: Analyze alternative energy storage systems like supercapacitors, fuel cells, and emerging technologies, highlighting their applications in EVs and hybrid systems.

Course Contents:

Unit I: Basics of Electric Vehicles — 08 Hours

Evolution of Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs), Comparison of EVs with ICE Vehicles, Environmental impact and benefits of EVs, EV configurations and types (BEVs, HEVs, PHEVs, FCEVs), Basics of vehicle dynamics.

Unit-II: EV Architecture and Components **08 Hours**

Electric vehicle powertrain architecture: 2W & 4W Components and design considerations, Electric motors for EVs: Types (BLDC, PMSM, Induction Motors, SRM), characteristics, and selection criteria, Power electronics in EVs: inverters, converters, and controllers; regenerative braking and energy recovery mechanisms; IOT and thermal management in EV systems.

Unit-III: Battery Technologies for EVs **08 Hours**

Types of batteries for EVs, Battery performance parameters: energy density, power density, cycle life, and thermal stability. Battery Management Systems (BMS): Functions, architecture, and safety features, battery recycling.

Unit-IV: Charging Systems for EVs **08 Hours**

EV battery charging technologies: Levels of charging (AC/DC fast charging), wireless charging, and battery swapping. The charging standards and protocols include CHAdeMO, CCS, and GB/T. Smart charging and grid integration: Vehicle-to-grid (V2G) technology, Government policies, incentives, and challenges for EV adoption; case studies of successful EV deployments.

Unit-V: Alternative Energy Storage for EVs **08 Hours**

Super capacitors: Principles, advantages, and applications in EVs, Fuel cells: Types, working principles, and integration in hybrid systems. Hydrogen storage and its role in FCEVs, Emerging technologies: Solid-state batteries, flow batteries, and hybrid storage systems, Future trends and challenges in energy storage systems.

Learning Resources:

Text Books:

1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", 2nd Ed, CRC Press.
3. Pillai S. K., "A First Course on Electrical Drives", New Age International (P) Ltd
4. C. C. Chand and K. T. Chau, "Modern Electric Vehicle Technology", Oxford University Press.

Reference Books:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley.
2. Dhameja Sandeep, "Electric Vehicle Battery Systems".

3. R. Krishnan, Permanent Magnet Synchronous & Brushless DC Motor Drives, CRC Press.
4. Mehrdad Ehsani, Ali Emadi, Modern Electric & Hybrid Electric: Fundamentals theory & design, CRC Press.

Web link for MOOC / NPTEL Links:

1. https://archive.nptel.ac.in/courses/108/106/108106182/
2. https://archive.nptel.ac.in/courses/108/103/108103009/

List of Practicals: (Any 8)

1. Study of electric vehicle start-ups, EV subsidies, and EV policies in India
2. Analysis of longitudinal vehicle dynamics and tractive effort calculation for electric vehicles using MATLAB
3. Demonstration of EV powertrain for two-wheelers
4. Speed control & performance characteristics of BLDC motor for EV applications
5. Speed control & performance characteristics of PMS motor for EV applications
6. Study of different batteries and battery pack design for electric vehicles
7. Experimental evaluation of battery performance parameters and State of Charge (SOC) estimation
8. Study of Harmonic Issues of EV Charging using Power Quality Analyzer
9. Study of battery recycling methods and second-life applications
10. Simulation of an electric vehicle using MATLAB
11. Industrial visit to electric vehicle manufacturing facility / EV charging infrastructure.

Course Code: 108604B	Course Name: Condition Monitoring & Diagnostics	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks **PR + OR** : 25 Marks

Expected Prerequisite Courses:

- Basic Electrical Engineering, Electrical Machines-I & II, Power System Equipment, Power System Engineering.

Course Objectives:

- To provide knowledge of condition monitoring principles, maintenance philosophies, reliability engineering, asset management concepts, and applicable standards for electrical equipment.
- To develop the ability to perform and interpret offline diagnostic tests for transformers, insulation systems, instrument transformers, and associated electrical assets.
- To impart knowledge of online condition monitoring techniques for rotating electrical machines and industrial monitoring architectures.
- To develop skills in diagnostics of switchgear, cables, and power equipment using modern signal processing and software-based diagnostic tools.
- To introduce smart diagnostics, artificial intelligence, IoT-based monitoring, and asset health management techniques for predictive maintenance of electrical assets.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the principles of condition monitoring, maintenance strategies, reliability assessment, asset management concepts, monitoring infrastructure, and relevant international standards for electrical equipment.

CO2: Apply offline diagnostic techniques to assess the condition of transformers, insulation systems, bushings, CTs, and PTs using standard testing procedures and diagnostic indicators.

CO3: Analyze online monitoring data of rotating electrical machines using current, vibration, thermal, and condition monitoring techniques to identify machine faults.

CO4: Analyze the condition of switchgear, cables, and associated power equipment using diagnostic measurements, signal processing techniques, and software tools.

CO5: Evaluate the health, reliability, and remaining useful life of electrical assets using AI-enabled diagnostics, IoT-based monitoring systems, and asset health management techniques.

Course Contents:

Unit I: Fundamentals of Condition Monitoring and Asset Management 08 Hours

Introduction: Need for condition monitoring and diagnostics, Failure mechanisms of electrical equipment, Equipment life cycle and Bathtub Curve.

Maintenance Philosophies: Breakdown Maintenance, Preventive Maintenance, Predictive Maintenance, Condition-Based Maintenance (CBM), Reliability-Centered Maintenance (RCM), Risk-Based Maintenance (RBM).

Reliability and Asset Management: Asset Management Concepts, Asset Health Index (AHI), Reliability Assessment, Failure Modes and Effects Analysis (FMEA).

Monitoring Infrastructure: Sensors and Transducers**,** Data Acquisition Systems**,** Communication Interfaces.

Standards: IEC Standards, IEEE Standards, ISO 55000 Asset Management Framework, Relevant Indian Standards (IS).

Unit-II: Offline Diagnostic Testing of Electrical Equipment 08 Hours

Transformer Diagnostics: Transformer failure modes, Insulation ageing mechanisms.

Failure Modes and Insulation Ageing in: Power Transformers, Bushings, CTs and PTs.

Diagnostic Oil Analysis: Dissolved Gas Analysis (DGA), Furan Analysis, Oil Quality Assessment, Moisture Measurement.

Electrical Insulation Diagnostics: Polarization Index (PI), Recovery Voltage Measurement (RVM), Dissipation factor (Tan δ) Measurement, Dielectric Frequency Response (DFR), Frequency Domain Spectroscopy (FDS), Time Domain Dielectric Response (TDDR).

Advanced Diagnostic Methods: Sweep Frequency Response Analysis (SFRA), Partial Discharge Testing, Chemical Analysis, Transformer Health Index Calculation, IEEE C57.104 Interpretation of DGA.

Emerging Techniques: Image Processing for Defect Detection.

Unit-III: Online Condition Monitoring of Rotating Electrical Machines 08 Hours

Failure Mechanisms: Induction Motor Faults, Synchronous Machine Faults, Bearing Defects, Rotor and Stator Faults.

Online Monitoring Techniques: Motor Current Signature Analysis (MCSA), Vibration

Monitoring, Spectrum Analysis, Bearing Condition Monitoring, Air-gap Monitoring, Thermal Imaging and Infrared Thermography.

Stator and Rotor Diagnostics: Stator Winding Monitoring, Rotor Fault Detection, Generator Condition Monitoring.

Integrated Monitoring Systems: Online Monitoring Architectures, SCADA-Based Monitoring, Case Studies from Industry.

Unit-IV: Diagnostics of Switchgear, Cables and Signal Processing 08 Hours

Switchgear Diagnostics: Circuit Breaker Condition Monitoring, Contact Resistance Measurement, Dynamic Resistance Measurement, SF6 Gas Diagnostics, Thermal Monitoring.

Cable Diagnostics: Cable Failure Mechanisms, Tan δ Measurement, Dielectric Response Analysis, Partial Discharge Diagnostics, Cable Health Assessment.

Other Power Equipment: Surge Arresters Monitoring, Insulator Diagnostics.

Signal Processing for Diagnostics: Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT), Wavelet Transform, Time-Frequency Analysis, Envelope Analysis, Cepstrum Analysis.

Software Applications: MATLAB/Simulink Applications, LabVIEW-Based Diagnostic Systems.

Unit-V: Smart Diagnostics, IoT and AI-Based Asset Health Management 08 Hours

Industry 4.0 for Electrical Asset Management: Smart Maintenance Concepts, Digital Substations, IEC 61850-Based Monitoring Architecture, Industry 4.0 applications in electrical maintenance.

IoT-Based Monitoring: Wireless Sensor Networks (WSN), IoT Architecture for Asset Monitoring, Edge Computing, Cloud-Based Monitoring Systems

Advanced Analytics: Artificial Intelligence in Diagnostics, Machine Learning for Fault Classification and diagnosis, Data-Driven Predictive Maintenance,Digital Twins Technology, AI-based predictive maintenance.

Reliability and Asset Health Assessment: Weibull Analysis, Remaining Useful Life (RUL) Estimation, Equipment Health Index (EHI), Asset Criticality Ranking, Reliability-Centered Asset Management, Asset health indexing and risk assessment.

Industrial Applications: Utility Case Studies, Smart Grid Asset Monitoring, Predictive Maintenance Applications.

Learning Resources:

Text Books:

1. P. Vas, Parameter estimation, condition monitoring and diagnosis of electrical machines, Clarendon Press, Oxford, 1993.
2. P. Tavner, Li Ran, J. Penman and H. Sedding, Condition monitoring of rotating electrical machines, IET Press, 2008.

Reference Books:

1. Xose M Lo´pez, Ferna´ndez, H Bu¨lentErtan, J Turowski, Transformers analysis, design, and measurement, CRC Press, 2012.
2. S.V. Kulkarni and S. A. Khaparde, Transformer Engineering: Design, Technology and Diagnostics, Second edition, CRC Press, 2013.
3. R. Billinton and R. N. Allan, Reliability Evaluation of Power Systems, 2nd ed. New York, NY, USA: Plenum, 1996.
4. Rao, Testing Commissioning Operation and Maintenance of Electrical Equipment, Khanna Publishers.
5. B.K.N. Rao, Handbook of Condition Monitoring, Elsevier.
6. S.L. Uppal, Electrical Power, Khanna Publishers.
7. S.K. Shastri, Preventive Maintenance of Electrical Apparatus, Katson Publication House.
8. B.V.S. Rao, Operation and Maintenance of Electrical Equipment, Asia Publication.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_ec05
2. https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_ge32
3. https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_me05

List of Practicals: (Any 8: from 1 to 16; 17 Compulsory)

1. Study of maintenance philosophies (BM, PM, CBM, RCM, RBM) and preparation of FMEA for electrical equipment.
2. Reliability assessment and Asset Health Index (AHI) calculation for transformer/motor using any simulation software like Excel/MATLAB.
3. Study and interfacing of sensors and DAQ systems for condition monitoring applications.
4. Transformer oil diagnostic analysis using Dissolved Gas Analysis (DGA) data and IEEE C57.104 interpretation.
5. Determination of Polarization Index (PI) and Insulation Resistance of transformer/motor insulation.
6. Transformer Health Index calculation using multi-parameter diagnostic data.

7. Image processing-based defect detection in insulators/bushings using any simulation software like MATLAB/Python.
8. Motor Current Signature Analysis (MCSA) for rotor fault detection using FFT in any simulation software like MATLAB.
9. Vibration analysis of rotating machine using accelerometer and FFT spectrum analysis.
10. Thermal condition monitoring of electrical machines using infrared thermography.
11. Circuit breaker condition assessment using contact resistance and thermal monitoring data.
12. Cable insulation diagnostics using Tan δ and Partial Discharge datasets.
13. Signal processing for fault diagnosis using FFT, Wavelet Transform and Envelope Analysis in any simulation software like MATLAB.
14. Development of IoT-based condition monitoring system using ESP32/Arduino and cloud dashboard.
15. Machine Learning based fault classification and Remaining Useful Life (RUL) estimation using any simulation software like MATLAB/Python.
16. IoT-Based Asset Health Monitoring and AI-Based Fault Classification Mini Project.
17. A visit to any industry/power plant/power system/substation regarding the work of testing/repair/ maintenance/condition monitoring/diagnostics of electrical equipment is compulsory.

Course Code: 108604C	Course Name: Digital Signal Processing	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks **PR + OR** : 25 Marks

Expected Prerequisite Courses:

- Engineering Mathematics.

Course Objectives:

- To summarize and analyze the concepts of signals, systems in time and frequency domain with corresponding transformations.
- To understand the digital signal processing, and various operations on signals.
- To use and understand the implementation of digital filters.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand basic concepts of DSP, signal classification, sampling theorem, and advantages of digital signal processing.

CO2: Analyze continuous-time and discrete-time LTI systems using time-domain methods such as impulse response and convolution.

CO3: Apply Laplace and Z-transform techniques to study system behavior, stability, ROC, and relationships among different transforms.

CO4: Design and evaluate IIR filters using analog-to-digital transformation methods and analyze their characteristics.

CO5: Design linear-phase FIR filters using windowing and frequency sampling techniques and analyze their frequency response.

Course Contents:

Unit I: Introduction to DSP — 08 Hours

Signals, systems and signal processing, classification of signals, elements of digital signal processing systems, properties of systems, sampling theorem, concept of frequency in continuous and discrete time signals, periodic sampling, frequency domain representation of sampling, basic elements of DSP and its requirements, advantages of digital over analog signal processing.

Unit-II: Linear Time Invariant Systems 08 Hours

Time domain representations of continuous and discrete time linear time invariant (LTI) systems, properties of LTI systems, impulse response, convolution, differential equation representation for continuous time LTI systems, linear constant-coefficient differential equation representation for discrete time LTI systems.

Unit-III: Laplace Transform and Z Transform 08 Hours

Need for transform, Introduction to Laplace transform, analysis of network systems using Laplace transform, relation between Laplace transform and Z transform, relation between Fourier transform and Z transform, Properties of ROC, properties of Z transform, Relation between pole locations and time domain behavior, causality and stability considerations for LTI systems.

Unit-IV: Digital IIR filters 08 Hours

Concept of analog filter design, IIR filter design by approximation of derivatives, Bilinear transformation method, warping effect. Butterworth filter design, Characteristics of Butterworth filters, Chebyshev filters and elliptic filters, IIR filter realization using direct form, Finite word length effect in IIR filter design.

Unit-V: Digital FIR filters 08 Hours

Ideal filter requirements, Gibbs phenomenon, windowing techniques, characteristics and comparison of different window functions, Design of linear phase FIR filter using windows and frequency sampling method. Magnitude and Phase response of Digital filters, Frequency response of Linear phase FIR filters.

Learning Resources:

Text Books:

1. Digital Signal Processing: Principles, Algorithms & Applications", 4th edition, Proakis,
2. Manolakis, Pearson.
3. S. Salivahanan, C. Gnanpriya, Digital Signal processing‖, McGraw-Hill.
4. Digital Signal Processors, Architecture, Programming, and Applications by B. Venkatramani, M Bhaskar, McGraw-Hill.

Reference Books:

1. Signals and Systems by Simon Haykin and Barry Van Veen, 2nd Ed., John Wiley and Sons, 2005.
2. Shaila Apte, Digital Signal Processing, Wiley India Publication, second edition.

3. Digital Signal Processing, A Computer-Based Approach, S. K. Mitra, Tata McGraw-Hill, 3rd edition, 2006.
4. Linear Systems and Signals by B. P. Lathi, 2nd Ed., Oxford University Press.

Web link for MOOC / NPTEL Links:

1. https://nptel.ac.in/courses/117102060?utm_source

List of Practicals: (Any 8)

1. Design an FIR filter with side lobe attenuation of 40 dB using a Kaiser Window of 200 points.
2. Design a high-pass elliptical filter with the given specification using the impulse invariance method.
3. Design a second-order digital bandpass Butterworth filter with the following specifications: fu=2.6 kHz, fL = 2.4 kHz , fs = 8000 Hz. Plot the magnitude and phase response.
4. Design a linear phase FIR filter for the given specifications.
5. Design a Butterworth filter for the given specifications.
6. Design-based Problems (DP)/Open-Ended Problem: (Any 1)
7. Apply Digital Signal Processing technique to any one specific area like Speech processing, Image processing, Audio processing, Bio-Medical Instrumentation, Encoding of signals, Signal Compression, etc. Develop a program for the same using MATLAB / OCTAVE software.
8. Realization of FIR and IIR Filters (Direct Form I, II, Cascade, Parallel)
9. Study of Finite Word Length Effects in Digital Filters
10. Spectrum Analysis Using FFT
11. Multi-rate Signal Processing (Upsampling, Downsampling, Interpolation, Decimation)

Course Code: 170605A		Course Name: Automotive Technology
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial** : 1 Hour/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 50 Marks

Expected Prerequisite Courses:

- Engineering Physics, Engineering Mechanics.

Course Objectives:

- To provide fundamental understanding of construction and working of automobile subsystems.
- To equip students with tools and methods to measure and analyze performance of automobiles.
- To acquaint students with contemporary automotive technologies.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Compare the various chassis and drive-trains of an automobile.

CO2: Analyze axles, wheels, tyres and the steering system of an automobile.

CO3: Select suspension and braking systems of an automobile.

CO4: Measure and analyze the performance of an automobile and describe the safety aspects.

CO5: Discuss electrical systems and assess modern propulsion technologies of an automobile.

Course Contents:

Unit-I: Introduction to Chassis and Drive Train **08 Hours**

Introduction: Current scenario in Indian auto/ancillary industries, vehicle specifications and classification.

Chassis and Frames: Types of chassis layout with reference to power plant locations and drive, various types of frames and constructional details.

Drive Trains: Necessity and selection of clutch, necessity of gearbox and different types, overdrive, torque convertor, continuous variable transmission, dual clutch transmission, automated manual transmission, propeller shaft, final drive, and differential.

Unit-II: Axles, Wheels, Tyres and Steering System **08 Hours**

Axles: Purpose, requirement and types of front and rear axle, loads acting on rear axles.

Wheels and Tyres: Wheel construction, alloy wheel, wheel balancing and rotation, type of tyres, tyre construction, tyre materials, factors affecting tyre life.

Steering System: Steering mechanism, steering geometry, cornering force, slip angle, scrub radius, steering characteristics, steering linkages and gearbox, power steering, collapsible steering, reversibility of steering, four-wheel steering, wheel alignment.

Unit-III: Suspension and Brake Systems 08 Hours

Suspension: Types of suspension linkages, types of suspension springs- leaf, coil, air springs, hydrogas, interconnected suspension, self-leveling suspension (active suspension), shock absorbers (hydraulic and air). **Brake Systems:** Drum, disc, mechanical, hydraulic, air brakes, power-assisted brakes, hand brake, ABS, EBD, BA.

Unit-IV: Vehicle Performance and Safety 08 Hours

Vehicle performance: parameters; vehicle resistances; traction and tractive effort; power requirements for propulsion; road performance curves (numerical examples); vehicle stability; vehicle testing on a chassis dynamometer; NVH in automobiles. **Vehicle safety:** Types of active and passive safety, vehicle interior and ergonomics.

Unit-V: Electrical Systems and Modern Propulsion Technologies 08 Hours

Batteries: Principles and construction of lead-acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on battery condition, charging methods, introduction to lithium batteries.

Electrical System and Accessories: Basic electric layout of the vehicle, automotive sensors and actuators, electronic control unit/module.

Modern Propulsion Technologies: Concept and environmental importance of EVs and HEVs, Layout, construction and working, Challenges and future scope of EVs and HEV.

Learning Resources:

Text Books:

1. William H. Crouse., "Automotive Mechanics", Tata McGraw Hill Publishing House.
2. Narang G. B. S, "Automobile Engineering", S. Chand and Company Ltd.

Reference Books:

1. Kirpal Singh, "Automobile Engineering", Volume 1, Standard Publishers distributors.
2. R. K. Rajput, "Automobile Engineering", Laxmi Publications.

Web link for MOOC / NPTEL Links:

1. Fundamentals of Automotive Systems:
   https://onlinecourses.nptel.ac.in/noc20_de06/preview
2. Autotronics: https://onlinecourses.nptel.ac.in/noc26_me101/preview

3. Vocational: Automotive Services Technician (Four-Wheeler): https://onlinecourses.swayam2.ac.in/nos24_ge28/preview
4. Automotive Industrial Engineering:

   https://www.coursera.org/learn/automotive-industrial-engineering
5. Automotive Engineering: Automobile Fundamentals: https://www.udemy.com/course/automotive-engineering-automobile-fundamentals-and-advanced/

List of Practicals: (Any 6)

1. Identify four vehicles having different chassis layout and compare their performance.
2. Identify four vehicles equipped with different types of automatic transmission and compare their performance.
3. Visit an automobile service centre for demonstration of wheel alignment and write a detailed report on axle, wheels, tyres and wheel alignment of one car.
4. Experimental study of shock absorber.
5. Measurement of noise and vibration in an automobile.
6. Study of requirements of BNCAP test.
7. Demonstration on basic maintenance and checks of an automobile such as doors etting, consumable checking and replacing, brake pad checking &replacing, checking tyre wear etc.

Course Code: 170605B	Course Name: Database Systems	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial** : 1 Hour/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 50 Marks

Expected Prerequisite Courses:

- Fundamentals of Programming.

Course Objectives:

- To understand the fundamental concepts of database management.
- To identify and classify entities, attributes, and relationships in real-world problem domains.
- To understand the principles and structure of the relational data model.
- To demonstrate the use of SQL for secure and efficient database querying and management.
- To understand the basic concepts of transaction processing and concurrency control.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the basic concepts, architecture, and components of database systems.

CO2: Convert ER diagrams into equivalent relational database schemas.

CO3: Normalize relational schemas using functional dependencies.

CO4: Explain the purpose and components of SQL in relational database systems.

CO5: Identify various transaction states and common transaction operations.

Course Contents:

Unit-I: Introduction to Database Systems — 08 Hours

Need of database system, Types of Data, Database System Applications, Database System VS File System, View of Data, Data Abstraction, data independence, Data Models, Structure of Database Management Systems. **Case Study:** Study of Architecture of any Database Management System (DBMS) like Oracle or MySQL.

Unit-II: Entity Relationship Modeling — 08 Hours

Conceptual data modeling: entities, entity types, attributes and its types, relationships, cardinalities on relationship, Entity Relationship diagram extended Features: Specialisation and Generalization on the ER Model. **Case Study:** ER Diagram conversion into Tables for

College Management Systems.

Unit-III: Relational Data Model **08 Hours**

Concept of relations, schema-instance distinction, keys and their types, Codd's Rules, Concept of Anomalies, Normalization, functional dependencies and Normal forms, 1NF, 2NF, 3NF and BCNF decompositions and desirable properties of them. **Case Study:** Library management system to identify different types of keys.

Unit-IV: Structured Query Language (SQL) **08 Hours**

Querying in SQL, DDL to create database and tables, table constraints, update database-update behaviors, DML, aggregation functions group by and having clauses, retrieve data from the database, generate and query views. Different types of Joins. **Case Study:** Design and implementation of Student Course Management System using SQL for effective management of students, courses, and faculty members.

Unit-V: Overview of Transaction Management **08 Hours**

The ACID Properties, Transactions and Schedules, Concurrency Control–The Need for Concurrency Control, Serializability, Locking Methods, Deadlock, Time Stamping Methods, Concurrency Control Protocols. Database Recovery: Need for Recovery, Recovery Techniques. **Case Study:** Design Online Shopping Cart Transaction Management In an e-commerce platform, multiple users simultaneously add, update, and purchase products.

Learning Resources:

Text Books:

1. Silberschatz A., Korth H., Sudarshan S., "Database System Concepts", McGraw Hill Publishers, ISBN 0-07-120413-X, 6th edition
2. S. K. Singh, "Database Systems: Concepts, Design and Application", Pearson Education, ISBN 978-81-317-6092-5
3. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Sixth Edition, ISBN-13: 978-0-136-08620-8.

Reference Books:

1. Shio Kumar Singh, Database Systems Concepts Design and Applications, Pearson
2. Mario Piattini, Oscar Diaz - Advanced Database Technology and Design- online book.

Web link for MOOC / NPTEL Links:

1. Introduction to Database Systems By Prof. Sreenivasa Kumar, IIT Madras. https://onlinecourses.nptel.ac.in/noc20_cs03/preview

List of Practicals:

1. Study of installation of various database software like MySQL, MariaDB & Oracle, etc.
2. Draw an ER diagram for any database system with various entities and their attributes on ERWin/ERDPLUS Software.
3. Implement SQL queries to provide students with hands-on experience for studying various commands of DDL.
4. Implement SQL queries to provide students with hands-on experience for studying various commands of DML.
5. Implement SQL queries to provide students with hands-on experience for studying various Logical Operators of SQL.
6. Implement SQL queries to provide students with hands-on experience in implementing various data constraints using SQL commands in MySQL/MariaDB.
7. Write at least 10 SQL queries for suitable database applications using SQL DML statements by implementing all types of joins.
8. Write at least 10 SQL queries for suitable database applications using SQL DML statements by implementing sub-queries and views.
9. Write at least 10 SQL queries for suitable database applications using SQL DML statements for studying various aggregation functions.
10. ER Modeling and Normalization: a. Consider case studies and formulate.
    a. Problem statement for any application to be developed.
    b. Propose a conceptual design using ER.
    c. Convert ER diagram into relational tables and normalize relational data model.
11. Mini- Project.

Course Code: 170605C	Course Name: Industrial Control Components	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial** : 1 Hour/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 50 Marks

Expected Prerequisite Courses:

- Fundamentals Electronics Engineering.

Course Objectives:

- To understand the basics of process control, including variables, system types, and real-world applications of control loops.
- To learn about transmitters, signal standardization, communication protocols, and converters used for accurate measurement in process control.
- To explore control actions and tuning methods to optimize controller performance and prevent issues like reset windup.
- To understand control valve design, terminology, types, and sizing using Cv calculations in line with industry standards.
- To learn about valve accessories and actuators, focusing on their design and function for optimal control system performance.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Analyze process variables, control system types, and process characteristics, and evaluate examples of process control loops in industry.

CO2: Apply knowledge of transmitters, signal standards, protocols, and converters to evaluate their role in process control systems.

CO3: Design and apply control actions and tuning methods to optimize controller performance and system stability.

CO4: Evaluate control valve selection, sizing, and design based on key characteristics and industry standards.

CO5: Analyze and evaluate valve accessories and actuators for optimal performance in process control systems.

Course Contents:

Unit-I: Introduction to Process Control 08 Hours

Key Concepts in Process Control: Process Variables: Definition and differentiation of manipulated, disturbance, and output variables.

Control System Types: Understanding Open-Loop vs. Closed-Loop systems.

Block Diagram Representation: Structure and components of control loops. Examples of Process Control Loops: Application examples of control loops in industries—temperature, flow, level, and pressure.

Unit-II: Transmitters and Converters 08 Hours

Transmitters and Signal Standardization: Importance of transmitters in process control systems. Standardization of signals: current (4-20 mA), voltage (0-10 V), and pressure signal standards. **Types of Transmitters:** Live zero vs. dead zero, and concept of two-wire. SMART Transmitters. **Differential Pressure Transmitters (DPT):** Types, installation, and calibration of DPTs. Application in level and flow measurement. Zero elevation, suppression.

Converters: Understanding the difference between converters and transmitters. Types: Current-to-pressure and pressure-to-current converters.

Unit-III: Control Actions and Tuning Techniques 08 Hours

Discontinuous Control: On-Off, multi-position, floating control modes. **Continuous Control:** Proportional (P), Integral (I), Derivative (D), PI, PD, and PID control modes.

Reset Windup: Techniques to prevent reset windup, rate before reset, and bumpless transfer.

Controller Tuning Methods: Introduction to process reaction curve. Tuning techniques: Ziegler-Nichols.

Unit-IV: Control Valve: Design, Sizing, and Selection 08 Hours

Control Valve Fundamentals: Key terminology: Rangeability, turndown ratio, cavitation, flashing, noise, viscosity index, valve capacity, AO, AC, and fail-safe actions. **Valve Characteristics:** Linear, equal percentage, and quick-opening characteristics.

Valve Types and Applications: Overview of different valve types: Globe, Ball, Butterfly, Diaphragm, and specialty valves for high-temperature and high-pressure applications.

Valve Sizing and Selection: Cv Calculation.

Unit-V: Control Valve Accessories and Actuator Design 08 Hours

Valve Accessories: Detailed discussion on accessories such as positioners (pneumatic, electro-pneumatic, and digital), I/P converters, volume boosters, air lock, limit switches, solenoid valves, and hand wheels.

Actuator Types and Design: Understanding different actuator types: Spring and diaphragm, piston cylinder, and smart actuator.

Learning Resources:

Text Books:

1. C. D. Johnson, Process Control and Instrument Technology, Tata McGraw Hill, Publications, 8th Edition.
2. N. A. Anderson, Instrumentation for Process Measurement and Control, CRC Press.

Reference Books:

1. G. Liptak, "Process Control", Instrument Engineering Handbook CRC Press,

Web link for MOOC / NPTEL Links:

1. Industrial Automation and Control, By Prof. Siddhartha Mukhopadhyay, IIT Kharagpur.
   https://nptel.ac.in/courses/108105062
2. Process Control and Instrumentation, by Dr. P.K. Saha, IIT Guwahati.
   https://nptel.ac.in/courses/103103037

List of Practicals: (Any 8)

1. Identification of industrial control components.
2. Block diagram of an industrial automation system.
3. Comparison of open-loop and closed-loop systems.
4. Direction control valve applications.
5. Control valve sizing basics.
6. Actuator selection.
7. Valve characteristic comparison.
8. PID control exercises.
9. Tuning of PID controller for level/flow control loop.
10. Controller tuning problems.
11. Process reaction curve analysis.
12. Study of the control valve & plot the installed characteristics of the control valve.

Course Code: 170605D	Course Name: Embedded System in IoT	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial** : 1 Hour/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 50 Marks

Expected Prerequisite Courses:

- Basic Electronics Fundamentals, Sensors and Actuators, Basic C Programming.

Course Objectives:

- To understand the fundamentals of embedded systems, IoT architecture, and the role of hardware–software co-design in connected devices.
- To develop the ability to interface sensors, actuators, and communication modules with microcontrollers for IoT applications.
- To analyze and implement embedded programming concepts using platforms such as Arduino, Raspberry Pi, or ARM-based controllers.
- To design and develop IoT-based systems using networking protocols (e.g., MQTT, HTTP) and cloud integration techniques.
- To evaluate security, power management, and real-time constraints in embedded IoT systems for efficient and reliable performance.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain fundamentals of embedded systems, including components, classifications, design metrics, and the role of microcontrollers.

CO2: Apply IoT hardware design concepts using microcontroller platforms, interfaces, and communication modules with effective power management.

CO3: Apply IoT communication models, protocols, data transmission, and basic cloud integration concepts.

CO4: Analyze Embedded C programming, real-time processing, RTOS concepts, and low-power design techniques in IoT-based embedded systems.

CO5: Evaluate end-to-end IoT system design, security mechanisms, and real-world IoT applications across domains.

K B T C O E

Course Contents:

Unit-I: Introduction to Embedded Systems 08 Hours

Definition, characteristics, and requirements of embedded systems, Embedded system components: hardware, software, processors, peripherals, Classification of embedded systems, Embedded system design metrics: cost, power, performance, memory, reliability, Applications of embedded systems in various domains, Overview of microprocessors vs microcontrollers, Role of 8-bit microcontrollers in embedded development.

Unit-II: IoT Hardware Platforms and Interfacing 08 Hours

Design Considerations for IoT Hardware, Microcontroller Platforms: Arduino, ESP32, NodeMCU, Nucleo (STM32 Overview), ADC, DAC, GPIO Programming, Communication Interfaces: UART, SPI, I2C, Wireless Communication Modules (Wi-Fi, BLE, GSM, LoRa – Basics), Power Management in IoT Devices.

Unit-III: IoT Communication Protocols and Networking 08 Hours

IoT Communication Models, IP Addressing Basics, Application Layer Protocols: MQTT, HTTP, CoAP (Overview), Client-Server vs Publish-Subscribe Model, Data Acquisition and Transmission, Introduction to Cloud Platforms (ThingsBoard / AWS IoT – Conceptual), REST API Basics.

Unit-IV: Embedded Software and Real-Time Concepts for IoT 08 Hours

Embedded C for IoT Applications, Interrupt Handling and Timer-Based Programming, Real-Time Data Monitoring, Introduction to RTOS for IoT Devices, Task Scheduling Basics, Data Logging and Local Storage, Edge Computing Concept, Low Power IoT Design Techniques.

Unit-V: IoT System Design, Security and Applications 08 Hours

End-to-End IoT System Design Methodology, IoT Security: Authentication, Encryption Basics, Secure Communication (TLS Concept), Data Analytics Basics for IoT, Industrial IoT (IIoT) Overview, Smart City Applications, Smart Energy Monitoring System, IoT-Based Environmental Monitoring, Smart Irrigation System, Remote Health Monitoring System.

Learning Resources:

Text Books:

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi & Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Pearson Education.
2. Zdravko Karakehayov, "Embedded Systems Design with 8051 Microcontrollers: Hardware and Software", CRC Press / Taylor & Francis.
3. Raj Kamal, "Embedded Systems: Architecture, Programming & Design", Tata McGraw-Hill.

4. David E. Simon, “An Embedded Software Primer”, Pearson Education.

Reference Books:

1. Daniel D. Gajski, Samar Abdi, “Embedded System Design: Modeling, Synthesis and Verification”, Springer, 2021.
2. Peter Marwedel, “Embedded System Design: Foundations of Cyber-Physical Systems and the Internet of Things”, Springer
3. Qing Li & Caroline Yao, “Real-Time Concepts for Embedded Systems”, CRC Press (Taylor & Francis)
4. Marilyn Wolf, “Computers as Components: Principles of Embedded Computing System Design”, Elsevier
5. Catherine H. Gebotys, “Security in Embedded Devices”, Springer.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc24_ee68/preview
2. https://onlinecourses-archive.nptel.ac.in/noc19_cs32/course
3. https://www.coursera.org/learn/iot

List of Practicals: (Any 8)

1. Draw and explain 3-layer and 5-layer IoT architecture. Map real-world application to architecture layers.
2. Comparison of IoT Development Boards. Compare Arduino, ESP32, Raspberry Pi based on: Processing speed, Memory, Connectivity, Power consumption, Application suitability.
3. Sensor & Actuator Selection. Select appropriate sensors for:
    a. Smart irrigation system
    b. Health monitoring system
    c. Smart energy meter

    Justify selection with technical reasoning.
4. Protocol Comparison. Compare MQTT, HTTP, CoAP. Identify best protocol for given IoT scenario.
5. IoT Communication Model Analysis. Device-to-Device. Device-to-Cloud. Device-to-Gateway. Draw block diagrams and explain.
6. Embedded C Programming Problems. Write logic for:
    a. Sensor threshold detection
    b. PWM-based motor control
    c. Interrupt-based event detection.
7. IoT Security Case Study. Identify security threats in smart home system. Suggest countermeasures.

8. Design complete IoT solution for Smart parking.
9. Design complete IoT solution for Weather monitoring.
10. Industrial IIoT Monitoring Plan. Design a predictive maintenance node with: Vibration analysis, Data transmission, Dashboard planning.
11. Smart Campus IoT Design. Complete architecture including: Sensors, Networking, Cloud, Security, Cost estimation.
12. Sensor Signal Conditioning Design. Design amplifier gain for low-voltage sensor. Select filter type for noise removal.

Course Code: 170605E	Course Name: Governing Policies	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial** : 1 Hour/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 50 Marks

Expected Prerequisite Courses:

- Business Economics.

Course Objectives:

- To explain the principles of infrastructure systems, governance frameworks, and policy implementation in urban and rural contexts.
- To examine economic evaluation tools, including demand forecasting, cost–benefit analysis, financing options, and PPP models.
- To interpret national infrastructure programs, policies, and regulations for effective development planning.
- To apply sustainable, inclusive, and technology-driven approaches to plan and manage urban and rural infrastructure.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand infrastructure, governance, and policy implementation in urban and rural development.

CO2: Analyze economic aspects of infrastructure, apply demand forecasting, cost–benefit analysis, financing mechanisms, and PPP models.

CO3: Apply national infrastructure programs, policies, and regulations to plan and assess urban and rural development projects.

CO4: Implement planning and management tools for urban and rural infrastructure projects.

CO5: Apply concepts of sustainable and inclusive infrastructure by integrating climate resilience, risk reduction, resource efficiency, digital governance, and global case insights.

Course Contents:

Unit-I: Infrastructure Governance — 08 Hours

Concept, scope, and components of urban & rural infrastructure, Infrastructure lifecycle and asset management, Principles of good governance, Role of central, state, and local governments, Urban Local Bodies (ULBs), Panchayati Raj Institutions (PRIs), National policies on housing, transport, water, sanitation, energy, rural development, Policy formulation, implementation, monitoring.

Unit-II: Economics of Urban and Rural Infrastructure 08 Hours

Economic characteristics of infrastructure (public goods, externalities, natural monopoly), Demand forecasting & cost–benefit analysis (CBA), Budgetary allocations, grants, and intergovernmental transfers, Municipal finance and rural development financing, PPP models, Case studies, Life-cycle costing, Economic impact assessment, social cost–benefit analysis.

Unit-III: Policies, Acts and Regulatory Frameworks 08 Hours

AMRUT, Smart Cities Mission, Swachh Bharat Mission, National Urban Housing Policy, PMAY, National Transport Policies, PMGSY, NRLM, MGNREGA, Rural drinking water, sanitation, electrification programs, Environmental regulations (EIA, Water/Air Acts, Waste Management Rules), Land acquisition and R&R policies, Infrastructure concession frameworks.

Unit-IV: Planning, Implementation and Monitoring of Infra. Projects 08 Hours

Master planning, regional planning, Integrated urban/rural planning approaches, GIS-based infrastructure planning, DPR preparation, feasibility studies, Procurement methods, contract management, Risk management, KPIs for urban and rural services, Service level benchmarks (SLBs), Digital governance & monitoring systems.

Unit-V: Sustainable, Inclusive and Resilient Infrastructure Governance 08 Hours

Green and climate-resilient infrastructure, Disaster risk reduction, Energy efficiency, circular economy, Infrastructure for marginalized groups, Rural–urban linkages for balanced development, E-governance tools IoT, AI, and data analytics, UN SDGs and infrastructure governance, international case studies.

Learning Resources:

Text Books:

1. Town Planning, G. K. Hiraskar, Dhanpat Rai Publications
2. Town Planning, S. C. Rangwala, Charotar Publishing House Pvt. Ltd.
3. Rural Development: Planning Strategy & Policy Imperatives — Vivek Saurath & Manoj Agarwal.

Reference Books:

1. Urban Planning by Chris Couch.
2. Urban Infrastructure and Governance by G. Ramesh, Vishnu Prasad Nagadevara, Gopal Naik, Anil Suraj.

3. Urban and Regional Planning Education: Learning for India (edited by Ashok Kumar, Diwakar S. Meshram, Krishne Gowda.
4. Swachh Bharat Mission Guidelines.
5. MRTP Act 1966: The director, government printing, stationary and publications, Maharashtra state, Mumbai
6. URDPFI & AMRUT Guidelines: Ministry of housing and urban affairs, Government of India.
7. Natural Infrastructure and Resilient Cities: Role of Green Infrastructure in Urban Planning for Adaptation to Climate Change in India (2025, by National Institute of Disaster Management, Delhi).
8. Role of Edge Analytics on Sustainable Smart City Development: Challenges and Solutions by G. R. Kanagachidambaresan.
9. Sustainable Smart Cities in India: Challenges and Future Perspectives (The Urban Book Series) by Poonam Sharma and Swati Rajput.
10. Rural Development: Principles, Policies and Development by Katar Singh and Anil Shishodia. Atlantic Publications.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.swayam2.ac.in/imb21_mg02/preview
2. https://onlinecourses.swayam2.ac.in/ugc23_ge04/preview
3. https://onl inecourses.nptel.ac.in/noc23_ce52/preview
4. https://onlinecourses.swayam2.ac.in/cec20_ar01/preview
5. https://www.coursera.org/learn/smart-cities
6. https://onlinecourses.nptel.ac.in/noc25_ar27/preview
7. https://onlinecourses.nptel.ac.in/noc26_ar08/preview
8. https://onlinecourses.nptel.ac.in/noc25_ar25/preview
9. https://onlinecourses.nptel.ac.in/noc26_ce48/preview

List of Practicals (Any 8):

1. Presentation on any national policy for housing and transport. (Group Activity)
2. Analyze the latest central/state government budget allocations for infrastructure sectors. (Individual Activity)
3. Comparison of Public-Private Partnership (PPP) models in infrastructure project (Individual Activity)
4. Conduct a sanitation or waste management study under Swachh Bharat guidelines with case study. (Individual Activity)

5. Prepare a compliance checklist for industries under Water Act, Air Act, and Waste Management Rules. (Group Activity)
6. Prepare a land use map and zoning proposal for a neighborhood. (Group work)
7. Conduct a basic energy audit of a building (college, hostel, home) and propose energy-saving measures. (Group Activity)
8. Suggest a small-scale circular economy project for rural or urban ward. (Group Activity)
9. Map how infrastructure projects (roads, water supply, housing, digital systems) contribute to SDGs 6, 7, 9, 11, and 13. (Individual Activity)
10. Identify and explain components of a tender document by referring to any online tender document related to infrastructure project.

Course Code: 170605F	Course Name: Application Development	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial** : 1 Hour/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 50 Marks

Expected Prerequisite Courses:

- Web Development, Database Management Systems.

Course Objectives:

- To familiarize students with client-side scripting concepts.
- To provide knowledge of server-side development and backend processing in web applications.
- To enable students to understand basic database concepts.
- To understand and learn Web application deployment.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply the client-side technologies for web development.

CO2: Develop user interfaces using component-based design approaches.

CO3: Apply the server-side technologies for web development.

CO4: Create effective web applications for business functionalities using the latest web development platforms.

CO5: Deploy web applications in collaborative environments.

Course Contents:

Unit-I: Basics of Web Application Interactivity 08 Hours

Introduction to JavaScript, JS Variables and Constants, JS Variable Scopes, JS Data Types, JS Functions, JS Array, JS Object, JS Events.

Unit-II: ReactJS 08 Hours

Introduction to ReactJS, ReactJS Components Styling, Routing, Redux- Architecture, Hooks- Basic hooks, useState() hook, useEffect() hook, useContext() hook.

Unit-III: Backend Development Using NodeJS 08 Hours

Role of backend in web applications, Introduction to NodeJS, Environment Setup, Node.JS Events, Node.JS Functions, Node.JS Built-in Modules, File System, Handling Data I/O in

Node.JS, Create HTTP Server, Create Socket Server.

Unit-IV: Database Integration Using MongoDB **08 Hours**

Introduction to databases, Need for databases in web applications, Types of databases: SQL vs NoSQL, MongoDB fundamentals, Data models and schemas, Basic CRUD operations.

Unit-V: Managing and Deploying Web Applications: GitHub **08 Hours**

Deployment strategies, Overview of Git, Git Repositories: Public vs private repositories, Basic Git Workflow & commands, collaboration using GitHub.

Learning Resources:

Text Books:

1. Jeffrey C.Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035.
2. Kogent Learning Solutions Inc, Web Technologies: HTML, JAVASCRIPT, PHP, JAVA, JSP, XML and AJAX, Blackbook, Dreamtech Press, ISBN: 9788177228496.

Reference Books:

1. Shama Hoque, Full-Stack React Projects: Learn MERN Stack Development by Building Modern Web Apps, Packt Publishing.
2. Dr. Hiren Joshi, Web Technology and Application Development, DreamTech, 1st Ed.

Web link for MOOC / NPTEL Links:

1. https://www.coursera.org/learn/programming-with-javascript
2. https://www.coursera.org/specializations/build-dynamic-website

List of Practicals:

1. Design responsive user registration and login which will do the following actions: Register user, login user functionality.
2. Create a To-Do List application where users can add tasks, mark tasks as completed, and delete tasks.
3. Develop a frontend using React JS which includes forms and navigation.
4. Create a Node.JS Application which serves a static website.
5. Develop a Node.js application with MongoDB to perform CRUD Operations.
6. Create version control account on GitHub and implement basic git commands and repository handling.
7. Mini Project: Develop a web application using front end and backend technologies in any of the domains: Social Media, E-commerce, Finance, Education, Any other.

Course Code: 170605G		Course Name: Data Visualization
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 50 Marks

Expected Prerequisite Courses:

- Programming and Problem Solving.

Course Objectives:

- To introduce the fundamental concepts and importance of data visualization.
- To develop the ability to create basic graphical representations such as bar charts, line charts, etc.
- To enable students to explore and summarize datasets using filtering, aggregation, and basic statistical measures.
- To apply visualization techniques to analyze time-series and geospatial data commonly used in engineering applications.
- To develop skills for creating dashboards and communicating insights through visual storytelling and business analytics tools.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the importance, principles, and techniques of data visualization and perform basic data exploration using filtering and aggregation methods.

CO2: Apply appropriate visualization techniques to create basic and advanced charts.

CO3: Analyze time-series datasets to identify trends, seasonality, and noise using suitable visualization techniques.

CO4: Analyze geospatial data using mapping techniques to derive meaningful insights.

CO5: Develop interactive dashboards and visual reports using visualization tools to communicate data insights effectively.

Course Contents:

Unit-I: Overview of Data Visualization 08 Hours

Importance and benefits of good data visualization– Design principles. Visualization ethics, misleading visualizations, accessibility considerations, and best practices for effective visual communication. Statistical Measures, Introduction to Python libraries for visualization, Exploring Data – Reduce Items and Attributes: Filter and Aggregate.

Unit-II: Creation of Basic Visualization **08 Hours**

Histogram, Bar (Vertical and Horizontal) and Line Chart, Box plot, Scatter plot (Examples and Exercises to be given for practice). Color palettes – Creation of 3D Charts. Creation of Advanced Visualization: Heat Map– Facet Grid – Interaction Techniques: Manipulate View – Creation of interactive Network topologies and Trees.

Unit-III: Visualization of Time Series Data **08 Hours**

Summary statistics and plotting aggregated views - Visualization of seasonality, trends and noise– working with multiple time series data such as Power load variation, Machine temperature monitoring, Rainfall and water level data, Signal variation in electronics.

Unit-IV: Visualization of Geospatial Data **08 Hours**

Spatial join - overlapping geospatial data to maps and adding special cues – Case Study- Visualization of multimodal data and analysis-case study sensor data and health care, genome and biomedical data.

Unit-V: Business Analytics and Visualization Tools **08 Hours**

Creation of interactive dashboards, charts, and visual reports using data visualization tools, applying visualization principles and data storytelling techniques.

Learning Resources:

Text Books:

1. Python Data Visualization: An Easy Introduction to Data Visualization in Python, ISBN: 9780070087705, Tata McGraw-Hill Education, 2009.
2. Tamara Munzner, Visualization Analysis and Design, A K Peters Visualization Series, CRC Press, 2014.

Reference Books:

1. Hands-On Data Visualization: Interactive Storytelling from Spreadsheets to Code Jack Dougherty and Ilya Ilyankou 1st Edition, O'Reilly Media, 2021.
2. Alberto Cairo, The Functional Art: An Introduction to Information Graphics and Visualization, New Riders, 2012.

Web link for MOOC / NPTEL Links:

1. https://www.coursera.org/learn/advanced-data-visualization-with-tableau-public

List of Practicals:

1. Load a dataset and perform basic data exploration by identifying attributes, data types, and displaying summary statistics.
2. Using a dataset, compute statistical measures (mean, median, standard deviation) and perform filtering and aggregation
3. Create Histogram, Bar Chart (vertical and horizontal), and Line Chart using a suitable dataset.
4. Using a dataset, create Box Plot and Scatter Plot to analyze data distribution and relationships between variables.
5. Using a dataset, generate advanced visualizations such as Heat Map and Facet Grid with appropriate color palettes.
6. Using a time-series dataset, create visualizations to identify trends, seasonality, and patterns.
7. Using a geospatial dataset, plot location-based data on a map and analyze spatial distribution.
8. Create an interactive dashboard using data visualization tools and present insights using data storytelling.

Course Code: 170605H		Course Name: Drives and Controls
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	3 1	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 50 Marks

Expected Prerequisite Courses:

- Power Electronics, Electric Machines.

Course Objectives:

- To understand the fundamentals, components, and control principles of electric drive systems.
- To analyze thermal models and select appropriate motor power ratings for different duty cycles.
- To study performance, speed control, and braking methods of DC motor drives.
- To understand operation, control techniques, and speed control methods of induction motor drives
- To understand the types, operation, and control of synchronous and special motor drives for fixed and variable speed applications.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the fundamentals, components, selection criteria, and control techniques of electric drives, including closed-loop and PLL control.

CO2: Analyze the thermal characteristics of motors to determine suitable motor power ratings under different duty cycles and load conditions.

CO3: Analyze performance, speed control, multi-quadrant operation, and closed-loop control of DC motor drives.

CO4: Explain starting, speed control methods, slip power recovery techniques, and closed-loop control of induction motor drives.

CO5: Analyze the operation and control of synchronous, Permanent Magnet Synchronous Motor, BLDC, stepper, and switched reluctance motor drives.

Course Contents:

Unit-I: Basics of Electric Drives and Control **08 Hours**

Definition, Advantages of electrical drives, Components of Electric drive system, Selection

Factors, status of Electrical Drives (DC & AC), speed control and drive classifications, close loop control of drives, phase locked loop (PLL) control.

Unit-II: Selection of Motor Power Rating **08 Hours**

Thermal model of motor for heating and cooling-Relationship between temperature rise and time, Heating time constant, Cooling time constant. classes of motor duty- continuous duty, short time duty, intermittent periodic duty, intermittent periodic duty with starting, intermittent periodic duty with starting & braking, continuous duty with intermittent periodic loading, continuous duty with starting & braking, Continuous duty with periodic speed changes. Determination of motor ratings, Selection of power ratings of motor -continuous duty and constant load, continuous duty and variable load, Short time rating of motor.

Unit-III: DC Motor Drives **08 Hours**

DC motors and their performance starting, transient analysis, speed control, Controlled rectifier fed drives, full controlled 3 phase rectifier control of dc separately excited motor, Multi quadrant operation, Chopper controlled drives closed loop speed control of DC motor.

Unit-IV: Induction Motor Drives **08 Hours**

Induction motor analysis, starting and speed control methods- voltage and frequency control, current control, closed loop control of induction motor drives, rotor resistance control, Slip power recovery: Static Kramer and Scherbius Drive, Single phase induction motor starting, braking and speed control.

Unit-V: Special Purpose Motor Drives **08 Hours**

Synchronous motor types, operation with fixed frequency, variable speed drives, Permanent Magnet Synchronous Motor and BLDC motor drives, Stepper motor drives, switch reluctance motor drives.

Learning Resources:

Text Books:

1. G. K. Dubey, Fundamentals of Electrical Drives, 2nd Edition (sixth reprint), Narosa Publishing House, 2001.
2. M. L. Soni, P.V. Gupta, U. S. Bhatnagar, "A course in Electrical Power", 1999, Dhanpat Rai & Sons.

Reference Books:

1. M. H. Rashid, Power Electronics -Circuits, devices and Applications, 3rd Edition, PHI Pub. 2004.
2. B. K. Bose, Modern Power Electronics and AC Drives, Pearson Education, Asia, 2003.

Web link for MOOC / NPTEL Links:

1. http://nptel.ac.in/courses/108104140

List of Practicals:

1. Based on Basics of Electric Drives and Control.
2. Based on Selection of Motor Power Rating.
3. Based on DC Motor Drives.
4. Based on Induction Motor Drives.
5. Based on Special Purpose Motor Drives.
6. Mini project/case study on Electrical drives.
7. Seminar on Electrical drives.
8. Industrial Visit to electrical drive and control industry and prepare report.

Curriculum Design and Development Chairman - Board of Studies and Advisors	
Dr. Y. P. Patil	Dr. A. G. Thosar
Dr. R. N. Awale	Dr. S. S. Khule
Dr. Manoj Rathi	Mr. Purushottam Kulkarni
Dr. R. V. Sarwadnya	

Course Design Team Members	
Mrs. V. V. Ahire	Mr. S. T. Datir
Dr. A. K. Patil	Ms. S. A. Dhumne
Mr. P. D. Aher	Ms. M. C. Deore
Ms. P. P. Boraste	Mr. Y. S. Bhavsar
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