SR UNIVERSITY
Department of Electrical and Electronics Engineering
R25 Course Structure and Syllabus - Ph.D. EEE

I SEM						
S.No.	**Course Code**	**Course**	**Hours / Week**			
			L	**R**	**P**	**C**
1	25EE410PC702	RESEARCH METHODOLOGY IN ELECTRICAL AND ELECTRONICS ENGINEERING	4	1	0	5
2	25EE400PC701	ADVANCED POWER ELECTRONICS FOR RENEWABLE SOURCES	4	0	0	4
3	25EE400PC703	SMART GRID AND ACTIVE DISTRIBUTION NETWORK	4	0	0	4

<table>
<tr><td colspan="3" rowspan="2">(25EE410PC702)
RESEARCH METHODOLOGY IN ELECTRICAL AND ELECTRONICS ENGINEERING</td><td>L</td><td>R</td><td>P</td><td>C</td></tr>
<tr><td>4</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Course type</td><td>-</td><td>Pre-requisite</td><td colspan="4">-</td></tr>
</table>

Unit I: Objectives and Types of Research

1. Motivation and objectives of research
2. Scope and significance of research in Electrical and Electronics Engineering
3. Research methods vs research methodology
4. Classification of research – descriptive, analytical, applied, and fundamental
5. Quantitative vs qualitative research approaches
6. Conceptual vs empirical research in engineering contexts
7. Characteristics of good research and identifying valid problems
8. Steps in the research process – from idea generation to implementation
9. Case studies of research types in renewable energy and automation

Unit II: Research Formulation

10. Defining and formulating the research problem
11. Selecting a research problem – feasibility and relevance
12. Necessity of defining the research problem precisely
13. Role and importance of literature review in research formulation
14. Primary and secondary sources of literature
15. Use of monographs, patents, and research databases in engineering research
16. Web-based literature search and online research tools
17. Conducting a critical literature review and identifying research gaps
18. Developing working hypotheses and theoretical frameworks
19. Examples of hypothesis formulation in Electrical and Electronics Engineering

Unit III: Research Design and Methods

20. Basic principles and objectives of research design
21. Features of a good research design and its necessity
22. Important concepts – variables, control, reliability, and validity
23. Observation, experimentation, and simulation in engineering research
24. Laws, theories, prediction, and explanation in engineering sciences
25. Development of analytical and simulation models in research
26. Planning and structuring a research investigation
27. Exploration, description, diagnosis, and experimentation in EEE studies
28. Application of MATLAB, Simulink, and statistical tools in data analysis
29. Case study: Developing a research design for renewable system optimization

Unit IV: Time Series Analysis and Data Handling

30. Methods of observation and data collection in engineering research
31. Sampling techniques – random, stratified, and systematic
32. Methods of data processing and cleaning
33. Data analysis and validation using statistical methods
34. Use of software tools – SigmaSTAT, SPSS, MATLAB statistics toolbox
35. Hypothesis testing using t-test and ANOVA
36. Generalization and interpretation of research results
37. Time series analysis for electrical load forecasting
38. Curve fitting techniques for analyzing electrical datasets
39. Application of interpolation and regression in EEE data modeling

Unit V: Reporting and Thesis Writing

40. Structure and components of scientific reports and theses
41. Planning and layout of research reports – title, abstract, introduction, and methodology
42. Presentation of results – tables, graphs, and illustrations
43. Formatting, referencing, and citation styles (IEEE, APA, MLA)
44. Use of software tools – Word processors, LaTeX, Mendeley, and Zotero
45. Writing the discussion, conclusion, and future work sections
46. Preparing technical reports and seminar presentations
47. Oral presentation skills and effective use of visual aids
48. Best practices in academic writing and communication in research

Textbooks:

1. W. C. Booth, G. G. Colomb, J. M. Williams, J. Bizup, and W. T. FitzGerald, *The Craft of Research,* 5th ed. Chicago, IL, USA: Univ. of Chicago Press, 2024.
2. C.R. Kothari and Gaurav Garg, *Research Methodology: Methods and Techniques*, New Age International, 2023.

Reference Books:

1. M. Hammond and J. Wellington, *Research Methods: The Key Concepts*, Routledge Publication, 2021.

(25EE400PC701) ADVANCED POWER ELECTRONICS FOR RENEWABLE SOURCES			L	R	P	C
			4	0	0	4
Course type	-	**Pre-requisite**	-			

Unit I: Introduction to Renewable Sources

1. World energy scenario and the need for renewable energy
2. Global and Indian renewable energy potential – solar, wind, hydro, geothermal
3. Comparative assessment of conventional and renewable energy resources
4. Fundamentals of solar radiation and its measurement
5. Photovoltaic effect and basics of solar power generation
6. P–V and I–V characteristics of solar cells
7. Effects of insolation, temperature, and shading on PV performance
8. Solar module interconnections, configurations, and ratings
9. Maximum Power Point (MPP) and MPPT fundamentals
10. Common MPPT algorithms – Perturb & Observe, Incremental Conductance
11. Standalone PV systems – design, components, and operation
12. Grid-connected PV systems – structure, storage, and AC/DC load interfaces

Unit II: Power Electronics Converters for Renewables

13. Introduction to DC–DC converters and their role in renewable systems
14. Buck converter – operation and renewable energy applications
15. Boost and buck–boost converters – principles and characteristics
16. Isolated converter topologies – flyback, forward, and Ćuk converters
17. Bidirectional converters for hybrid systems and battery charging
18. Interleaved and multi-input converter configurations
19. Single-phase inverter operation and control
20. Three-phase inverter operation and control
21. Multilevel inverter topologies – Neutral Point Clamped (NPC) and Modular Multilevel Converter (MMC)
22. Current Source Inverter (CSI) – structure and operation
23. Control strategies – PWM, voltage, and current control
24. Grid connection issues – islanding, leakage current, harmonics, and reactive power control

Unit III: Wind Energy Systems

25. Fundamentals of wind energy and wind turbine power extraction
26. Wind turbine aerodynamics and power coefficient characteristics
27. Mechanical control methods – pitch and yaw control mechanisms
28. Power regulation and Maximum Power Point Tracking (MPPT) in wind systems
29. Generators used in wind systems – overview and classification
30. Permanent Magnet Synchronous Generator (PMSG) – working and advantages
31. Induction generator (IG) – operation with and without converter interface
32. Doubly Fed Induction Generator (DFIG) – principle and control methods
33. Converter topologies for DFIG – rotor and grid side configurations

34. Hybrid wind–solar systems – integration challenges and control schemes

Unit IV: Storage Devices and Grid Integration

35. Role and importance of energy storage in renewable systems
36. Overview of storage technologies – batteries, flywheels, supercapacitors
37. Battery types and characteristics – lead-acid, lithium-ion, sodium-sulfur, flow
38. Battery charging and discharging mechanisms and control strategies
39. Fuel cells – working principle, types, and integration with renewables
40. Grid integration of renewable energy systems – technical challenges
41. AC and DC microgrids – structure, operation, and control
42. Grid stability, synchronization, and power quality issues
43. Building-to-grid (B2G) and distributed generation concepts

Unit V: Interfacing of Electric Vehicles into Active Distribution Networks

44. Introduction to Electric Vehicles (EVs) and their grid impact
45. Types of power sources in EVs – batteries, hybrid storage, and fuel cells
46. EV charging infrastructure – Type-1, Type-2, and Type-3 setups
47. Solar PV-based EV charging stations – design and operation
48. Vehicle-to-Grid (V2G) technology – bidirectional power flow and control

TEXT BOOKS:

1. Sudipta Chakraborty, Marcelo G. Simes, and William E. Kramer. Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control and Integration (Green Energy and Technology), Springer Science & Business, 2023.
2. Nicola Femia, Giovanni Petrone, Giovanni Spagnuolo, Massimo Vitelli, Power Electronics and control for maximum Energy Harvesting in Photovoltaic Systems, CRC Press, 2024.
3. Chetan Singh Solanki, Solar Photovoltaics: fundamentals, Technologies and Applications, Prentice Hall of India, 2021.

REFERENCE BOOKS:

1. Muhammad H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education India, 2024
2. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley and Sons, Ltd., 2021.
3. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, Wiley-IEEE Press, 2022.

<table>
<tr><td colspan="3" rowspan="2">(25EE400PC703)
SMART GRID AND ACTIVE DISTRIBUTION NETWORK</td><td>L</td><td>R</td><td>P</td><td>C</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>Course type</td><td>-</td><td>Pre-requisite</td><td colspan="4">-</td></tr>
</table>

Unit I: Introduction to Smart Grids and Active Distribution Network

10. Introduction to traditional power systems and their limitations
11. Definition and concept of Smart Grids and Active Distribution Networks
12. Justification and need for smart grids in modern power systems
13. Functional differences between conventional and smart grids
14. Smart grid conceptual model – layers, domains, and interactions
15. Smart grid architecture – logical and physical views
16. Communication technologies used in smart grids – overview
17. Interoperability in smart grids – concepts and frameworks
18. Role of smart grid standards – IEEE, IEC, and NIST standards
19. Intelligent grid initiatives around the world – case examples
20. National Smart Grid Mission (NSGM), Govt. of India – objectives and programs

Unit II: Smart Transmission Technologies

21. Overview of transmission automation and its importance
22. Concept and functions of substation automation systems
23. Supervisory Control and Data Acquisition (SCADA) – architecture and components
24. SCADA applications in transmission and renewable integration
25. Energy Management System (EMS) – functions and components
26. Load forecasting, generation scheduling, and economic dispatch in EMS
27. Phasor Measurement Units (PMUs) – working principle and data acquisition
28. Synchrophasor technology and real-time monitoring applications
29. Wide Area Measurement Systems (WAMS) – architecture and data communication
30. Applications of WAMS in stability enhancement and fault detection
31. Integration of SCADA, EMS, and WAMS for intelligent transmission systems
32. Challenges and cybersecurity aspects in smart transmission networks

Unit III: Smart Distribution Technologies

35. Evolution of distribution networks and need for automation
36. Distribution Automation (DA) – architecture and operational objectives
37. Outage Management Systems (OMS) – functionality and benefits
38. Automated Meter Reading (AMR) – technology and applications
39. Automated Metering Infrastructure (AMI) – structure and communication protocols
40. Fault Location, Isolation, and Service Restoration (FLISR) – working principle
41. Integration of FLISR with SCADA and AMI for self-healing grids
42. Energy Storage Systems (ESS) in smart distribution – roles and benefits
43. Renewable energy integration in active distribution networks

Unit IV: Smart Consumption over Active Distribution Network

44. Smart appliances and their role in energy efficiency
45. Low Voltage DC (LVDC) distribution in homes and commercial buildings
46. Home Energy Management Systems (HEMS) – architecture and functionality
47. Smart meters and Net Metering mechanisms
48. Building-to-Grid (B2G) concept and energy flow management
49. Vehicle-to-Grid (V2G) technology – operation and bidirectional power exchange
50. Solar-to-Grid (S2G) systems – integration and control strategies
51. Distributed Energy Resources (DERs) – concept and classification
52. Microgrids – structure, operation, and control hierarchy
53. Demand response strategies for peak load management and emission reduction

Unit V: Regulations and Market Models for Smart Grid

43. Overview of smart grid regulations and policy frameworks
44. Demand Response (DR) – types, mechanisms, and benefits
45. Tariff design for smart grids – Time-of-Day (TOD) and Time-of-Use (TOU) pricing
46. Consumer engagement, privacy, and data protection in smart grid operation
47. Cost-benefit analysis of smart grid implementation projects
48. Market models and regulatory mechanisms for smart grid development

TEXT BOOKS:

1. Clark W Gellings, “The Smart Grid, Enabling Energy Efficiency and Demand Side Response”- CRC Press, 2020.
2. Smart Grid Fundamentals: Energy Generation, Transmission and Distribution by Radian Belu (2022).

REFERENCES:

1. Smart Grids — Fundamentals and Technologies in Electric Power Systems (2nd Edition, 2020) by Bernd M. Buchholz & Zbigniew A. Styczynski

Assistant Dean, Ph.D.
EEE, SR University

HoD
EEE, SR University