Course Code EPE- 909	Credit Hours (Th-Pr) 3-0	**Smart Grid Architecture (core)**	Contact Hrs/Week (Th-Pr) 3-0	Total Contact Hrs (Th-Pr) 45-0

Course Outline:

1. Topics include smart grid architectural design, Smart Grid Measurement and Communication Technologies including Wide Area Monitoring Systems, Phasor Measurement Units ,Phasor Data Concentrators, Advance Metering Infrastructure, Smart Meters and Appliances, Performance Analysis Tools for Smart Grid Design ,Weakness of the present load flow methods, Congestion management effect, Load flow for smart grid design, Contingencies and their Classification, Computational Tools for Smart Grid Design, Pathway for Designing Smart Grid, Barriers and Solution to Smart Grid Development ,General Level Automation, Bulk Power system automation of the smart grid at transmission level, Distribution System Automation for Smart Grids, Integration of renewable energy and its storage

Eligibility Criteria:

2. B.E (Electrical Engineering)

Recommended Books:

S. No.	Title	Author(s)	Assigned Code	Remarks
1	**Smart Grid: Fundamentals of Design and Analysis**	James Momoh	A	Text
2	**Smart Grids: Infrastructure, Technology and Solutions**	Borlase	B	Reference
3	**Electric Power Distribution Engineering(Third Edition)**	Turan Gonen	C	Reference

3. **Course Objectives:**

a. To identify the architectural design of smart grids.
b. To discuss the need of implementing Smart Grids in Pakistan.
c. To discuss smart metering infrastructure and demand side management concepts for overcoming energy crisis.
d. To discuss the issues of renewable integration in smart grids
e. To identify the role of distribution companies in increasing the energy efficiency.
f. To discuss the energy storage systems for smart grids.
g. To discuss the concepts and topology of microgrids

Learning outcome:

4. After completing the course, the student shall
   a. Understand the background for Smart Grid, and the differences between the future Smart Grid and todays power system, as well as have knowledge about important terminology.
   b. Have knowledge about challenges faced by the Pakistani energy sector in the years ahead, such as challenges regarding the deployment of smart meters.
   c. Know the electric power engineering basis for Smart Grid.
   d. Have knowledge about technology for micro grids and the integration of renewable energy such as wind power, solar power, including the characteristics of these sources, in the power system, and technology related to charging of electric vehicles

5. **Topics Covered:**

No.	Topics	Text Book	Contact Hours
a.	**Smart Grid Architectural Design** (1) To days grid VS The Smart Grid (2) Smart Grid Global Initiatives (3) Power System Enhancement (4) Function of Smart Grid Components (5) Concept of Micro grid and its Topology	A	6
b.	**Smart Grid Measurement and Communication**	A	4

	Technology (1) Wide Area Monitoring Systems (2) Phasor Measurement Units (3) Advance Metering Infrastructure (4) Smart Meters and Appliances (5. GIS and Google Mapping Tools		
c.	**Performance Analysis Tools for Smart Grid Design** (1) Introduction to Load Flow Studies (2) Challenges to Load flow in Smart Grid (3) Weakness of the present load flow methods (4) Congestion management effect (5) Load flow for smart grid design (6) Contingencies and their Classification	A	8
d.	**Stability Analysis Tools for Smart Grids Design** (1) Introduction to Stability (2) Voltage Stability Assessment (3) Voltage Stability Assessment Techniques (4) Voltage Stability Indexing (5) Angle Stability Assessment (6) State Estimation	B	4
e.	**Computational Tools for Smart Grid Desig** (1) Introduction to Computation Tools (2) Optimization Techniques for Smart Grids (3) Classical Optimization Methods (4) Heursistic Optimization Methods (5) Computational Challenges	A	8
f.	**Pathway for Designing Smart Grid** (1) Barriers and Solution to Smart Grid Development General Level Automation (2) Bulk Power system automation of the smart grid at transmission level (3) Distribution System Automation for Smart Grids	C	8
g.	**Renewable Energy and Storage** (1) Renewable Energy Resources		4

	(2) Sustainable Energy option for Smart Grids (3) Penetration and Variability issues for sustainable energy technology (4) Demand Response Issues (5) Electric Vehicle and Plug ins Hybrids (6) Environmental Implications (7) Storage Technologies (8) Tax Credits		
h.	**Case Studies and Test Beds for the SMART Grids** (1) Demonstration Projects (2) Microgrid with Renewable Energy (3) Testbeds and Benchmark Systems (4) Challenges and Benefits of Smart Transmission System	B	3
	Total		45