GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering
Level: PG
Subject Code: ME02000651
Subject Name: Power Converter Topologies in Smart Grid

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Concepts of Power grid, power system, power electronics, communication systems etc.
Rationale:	The smart grid of the future is a complex electrical power system. Its study, design, and management require the integration of knowledge from various disciplines including sustainability, technology and mathematics. This course introduces the definition of a smart grid, its heterogeneity, dynamics, control, security and assessment strategies. The challenge of modeling such a system is also discussed. Use of Power converters as part of smart grid is discussed. Considering all these aspects, this is one of the important subjects for the students.

Course Outcome:

After Completion of the Course, the student will be able to:

No	Course Outcomes
01	understand the concepts and design of Smart grid.
02	understand the various communication and measurement technologies in smart grid
03	learn the renewable energy resources and storages integrated with smart grid
04	judge appropriate power converter topology for smart grid application.

Teaching and Examination Scheme:

Teaching Scheme (in Hours /Week)			Total Credits (L+T+ (PR/2))	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA	PA/CA	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**INTRODUCTION TO SMART GRID:** Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient & Self-Healing Grid	6	10
2.	**WIDE AREA MONITORING SYSTEM**: Fundamentals of synchro phasor technology, concept and benefits of wide area monitoring system, Structure and functions of Phasor Measuring Unit (PMU) and Phasor Data Concentrator (PDC)	6	10
3.	**INFORMATION AND COMMUNICATION TECHNOLOGY:** Overview of smart grid communication system, Modulation and	8	20

	Demodulation techniques, Radio communication, Mobile communication, Power line communication, Optical fiber communication. Communication protocol for smart grid, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.		
4.	**SMART METERS:** Introduction to Smart Meters, category of smart meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, AMI needs in the smart grid, Intelligent Electronic Devices (IED) & their application for monitoring & protection.	8	20
5.	**SMART GRID APPLICATIONS:** Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Distribution systems: DMS, Volt/VAR control, Fault Detection, Isolation and service restoration, Protection in Smart grid environment. Outage management, Plug in Hybrid Electric Vehicles (PHEV), Demand Side Integration-Peak load, Outage and Power Quality management	9	20
6.	**POWER CONVERTER TOPOLOGIES IN SMART GRID:** High power DC- DC Converters, Multilevel Converters, Matrix converter Bidirectional Converters, advances in power converter topologies for smart grid applications.	8	20
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
40	**20**	**20**	**20**	**0**	**0**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. N. D. Hatziargyriou, Microgrids Architecture and control, IEEE Press Series, John Wiley & Sons Inc, 2013, 1st edition.
2. H. Bevrani, B. François, and T. Ise, Microgrid Dynamics and Control, John Wiley & Sons, 2017, 1st Edition.
3. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
4. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
5. Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
6. Kenneth C. Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014.
7. Salman K. Salman, Introduction to the Smart Grid: Concepts, Technologies and Evolution, The Institution of Engineering and Technology (IET).
8. Smart Grids: Infrastructure, Technology and Solutions —Edited by Stuart Borlase,CRC Press Publication, 2013.

9. Wayes Tushar, Chau Yuen, Tapan K. Saha, Thomas Morstyn, Archie C. Chapman, M. Jan E. Alam,
Sarmad Hanif, H. Vincent Poor, "Peer-to-peer energy systems for connected communities: A review of recent advances and emerging challenges," Applied Energy, Volume 282, Part A, 2021. https://doi.org/10.1016/j.apenergy.2020.116131
10. Slobodan N. Vukosavic, "Grid-Side Converters Control and Design Interfacing Between the AC Grid and Renewable Power Sources", Springer
11. Amirnaser Yazdani, Reza Iravani, Voltage-Sourced Converters in Power Systems: Modeling, Control, and Applications, John Wiley & Sons Inc, 2010.

(b) Open-source software and website:

1. https://resourcecenter.smartgrid.ieee.org/
2. https://nptel.ac.in/courses/108/107/108107113
3. https://onlinecourses.nptel.ac.in/noc23_ee60/preview……

Suggested Course Practical List:

1. Design of virtual PMU in MATLAB
2. Optimal PMU placements for proper monitoring of power system
3. Simulation of Grid connected PV MPPT (P&O) single stage
4. To study wide area control of two area systems
5. Relay coordination in smart grid protection scheme for Radial Circuit Topology
6. Relay coordination in smart grid protection scheme for Bidirectional Circuit Topology
7. Study and testing of islanding protection in microgrids
8. To study PLCC for remote measurement and control
9. To study about smart-substation
10. To study automation of the substation
11. To study power converters for smart grid applications.

List of Laboratory/Learning Resources Required:

PC/Laptop with installed MATLAB/ similar software

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