

Branch Name:	Electrical Engineering
Program Code:	ET109
Course Name:	Department Elective-IV: Substation Design and Automation
Course Code:	1ET1090807
Pre-requisite Course:	Power System-I & II, Power system protection, Electrical Measurements.

Course Objectives:

1. The students can demonstrate the traditional and innovative design for substation the similarities between magnetic and electrical circuits.
2. To explore the different types of substations and the bus configurations. Also, Compare the different types of bus configurations.
3. Outline the communication protocols, structure of a SCADA (supervisory control and data acquisition) and discuss the need of security for substation communications.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)								
Lecture	Tutorial	Practical	Credit	Theory				Practical				Total
				University Assessment		Continuous Assessment		University Assessment		Continuous Assessment		
				Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
3	-	-	3	28	70	12	30	-	-	-	-	100

Course Contents:

Sr. No.	Topic	Total Hours	Weightage (%)
1	INTRODUCTION: Background, Need Determination, Budgeting, Financing, Traditional and innovative Substation Design, Site Selection and Acquisition, Design, Construction and Commissioning Process.	07	15%
2	HIGH VOLTAGE SWITCHING EQUIPMENT Ambient conditions, Disconnect switches, Load Break switches, high speed grounding switches, power fuses, circuit switches, circuit breakers.	07	15%
3	TYPES OF SUBSTATIONS & BUS/SWITCHING CONFIGURATIONS Transmission substation, distribution substation, collector substation, switching substations, gas insulated substations, air insulated substations, bus configurations: single bus, double bus, double break, main and transfer bus, double bus, single breaker, ring bus, break-and-a-half, Comparison of configurations.	12	30%

4	DESIGN OF SUBSTATION GROUNDING AND PROTECTION Reasons for substation grounding system, accidental ground circuit, Design Criteria-Actual Touch and step voltage, soil resistivity, grid resistance, grid current, use of the design equations, selection of conductors, grounding fence, other design considerations. Lightning stroke protection-lightning parameters, empirical design methods. Substation fire Protection-Fire hazards, fire protection measures, fire protection selection criterion.	09	20%
5	SUBSTATION AUTOMATION AND COMMUNICATIONS Introduction, components of substation automation system, automation applications, protocol fundamentals, supervisory control and data acquisition (SCADA) historical perspective, SCADA functional requirements, SCADA communication requirements, components of SCADA system, SCADA communication protocols, the structure of a SCADA communication protocol, security for substation communications, security methods, security assessment.	09	20%

Reference Books:

1. John D. McDonald- Electrical Power Substation Engineering, CRC Press, Third Edition, 2017.
2. R. S. Dahiya, VinayAttri- Sub-Station Engineering Design & Computer Applications, S.K.Kataria and sons Publications, 1st Edition, 2013.
3. P. S. Satnam, P. V. Gupta- Substation Design and Equipment, Dhanapat Rai Publications, 1st Edition, 2013.
4. Turan Gonen- Electric Power Distribution Engineering, CRC press, Third edition, 2014.

List of Open Source Software/learning website:

- <https://www.transgrid.com.au/what-we-do/our-network/connections>
- <https://new.abb.com/substations>
- <https://ieeexplore.ieee.org/document/178016>
- <https://www.sciencedirect.com/topics/engineering/substations>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Describe the main consideration in the process of substation design.	2 Understanding
CLO2	Outline the working principles of substation switching equipment.	1 Remembering
CLO3	Explain the different types of bus configurations.	2 Understanding
CLO4	Design criteria of substation grounding and protection.	5 Evaluating
CLO5	Illustrate the substation communication (SCADA).	3 Applying

Mapping of CLOs with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO1		L			M		L				L	L	L			M
CLO2	L			M		M			M	L	L			L		
CLO3		L					M			L	M	H	M			M
CLO4		H	M	L				L								
CLO5	M				L	L		M				L			M	

H: High, M: Medium, L: Low