MOHAMED SATHAK A J COLLEGE OF ENGINEERING

Siruseri IT park, OMR, Chennai - 603103

LESSON PLAN

Department of Electrical and Electrical Engineering

Name of the Subject	High Voltage Engineering	Name of the handling Faculty	A.Kamalaselvan
Subject Code	EE 8701	Year / Sem	IV/VI
Acad Year	2022-2023	Batch	2019-2023

Course Objective

To impart knowledge on the following Topics :Various types of over voltages in power system and protection methods.

Generation of over voltages in laboratories.

Measurement of over voltages.

Nature of Breakdown mechanism in solid, liquid and gaseous dielectrics.

Testing of power apparatus and insulation coordination

Course Outcome

CO1: Describe the Transients in Power System

CO2: Explain the Generation of High Voltage and various types of over voltages in power system

CO3: Discuss the High Voltage testing in power system

CO4: Explain the measurement of High Voltage in power system

CO5: Discuss the testing of power apparatus and insulation coordination

Lesson Plan

Sl. No.	Topic(s)	T / R* Book	Periods Required	Mode of Teaching (BB / PPT / NPTEL / MOOC / etc)	Blooms Level (L1-L6)	CO	PO
UNIT I	**OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS**						
1	Causes of over voltages	T1,T 2	1	BB,PPT	L1	CO1	PO1-PO3
2	Effects of Power System	T1,T 2	1	BB,PPT	L1	CO1	PO1-PO3
3	Lightning	T1,T 2	1	BB,PPT	L1	CO1	PO1-PO3
4	Switching Surges	T1,T 2	1	BB,PPT	L2	CO1	PO1-PO3
5	Temporary Over Voltage	T1,T 2	1	BB,PPT	L2	CO1	PO1-PO3
6	Corona and its effects	T1,T 2	1	BB,PPT	L2	CO1	PO1-PO3
7	Bewley lattice diagram-Introduction	T1,T 3	1	BB,PPT	L2	CO1	PO1-PO3
8	Bewley lattice diagram- Problem	T1,T 2	1	BB,PPT	L2	CO1	PO1-PO3
9	Protection Agasist Over Voltage	T1,T 4	1	BB,PPT	L2	CO1	PO1-PO3

Suggested Activity: Assignment / Case Studies / Tuorials/ Quiz / Mini Projects / Model Developed/others Planned if any:
Assignment on Corona and its effects

Evaluation method
Assignment Marks

UNIT II	**DIELECTRIC BREAKDOWN**						
10	**Properties of Dielectric materials, Gaseous breakdown in non-uniform fields**	**T1,T2**	**1**	**BB,PPT**	**L1**	**CO1**	**PO1-PO3**
11	**Gaseous breakdown in uniform fields**	**T1,T2**	**1**	**BB,PPT**	**L2**	**CO1**	**PO1-PO3**
12	**Corona discharges**	**T1,T2**	**1**	**BB,PPT**	**L2**	**CO1**	**PO1-PO3**
13	**Vacuum breakdown**	**T1,T2**	**1**	**BB,PPT**	**L2**	**CO1**	**PO1-PO3**
14	**Conduction and breakdown in pure and commercial liquids**	**T1,T2**	**1**	**BB,PPT**	**L3**	**CO1**	**PO1-PO3**
15	**Maintenance of oil Quality**	**T1,T2**	**1**	**BB,PPT**	**L3**	**CO1**	**PO1-PO3**
16	**Breakdown mechanisms in solid Dielctrics**	**T1,T2**	**1**	**BB,PPT**	**L3**	**CO1**	**PO1-PO3**
17	**Breakdown mechanisms in Composite Dielctrics**	**T1,T2**	**1**	**BB,PPT**	**L3**	**CO1**	**PO1-PO3**
18	**Applications of insulating materials in electrical equipments.**	**T1,T3**	**1**	**BB,PPT**	**L3**	**CO1**	**PO1-PO3**
Suggested Activity: Assignment / Case Studies / Tuorials/ Quiz / Mini Projects / Model Developed/others Planned if any Assignment on Applications of insulating materials in electrical equipments.							
Evaluation method Assignment Marks							
UNIT III	**GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS**						
19	**Generation of High DC voltage: Rectifiers**	**T1,T2**	**1**	**BB.PPT**	**L2**	**CO2**	**PO1-PO3**
20	**Generation of High DC voltage: : voltage multipliers**	**T1,T2**	**1**	**BB.PPT**	**L2**	**CO2**	**PO1-PO3**
21	**Generation of High DC voltage: Vandigraff generator**	**T1,T2**	**1**	**BB.PPT**	**L2**	**CO2**	**PO1-PO3**
22	**Generation of high impulse voltage: Single and multistage Marx circuits**	**T1,T2**	**1**	**BB.PPT**	**L2**	**CO2**	**PO1-PO3**
23	**Generation of high AC voltages: cascaded transformers.**	**T1,T2**	**1**	**BB.PPT**	**L3**	**CO2**	**PO1-PO3**
24	**Generation of high AC voltages: resonant transformer and tesla coil.**	**T1,T2**	**1**	**BB.PPT**	**L3**	**CO2**	**PO1-PO3**
25	**Generation of switching surges**	**T1,T2**	**1**	**BB.PPT**	**L3**	**CO2**	**PO1-PO3**
26	**Generation of impulse currents**	**T1,T2**	**1**	**BB.PPT**	**L2**	**CO2**	**PO1-PO3**
27	**Triggering and control of impulse generators.**	**T1,T2**	**1**	**BB.PPT**	**L3**	**CO2**	**PO1-PO3**
Suggested Activity: Assignment / Case Studies / Tuorials/ Quiz / Mini Projects / Model Developed/others Planned if any Quiz conducted on Generation of High Voltages and High Currents							
Evaluation method Quiz Marks							
UNIT IV	**MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS**						
28	**High Resistance with series ammeter**	**R2**	**1**	**PPT**	**L4**	**CO4**	**PO1-PO4, PO7, PO12**
29	**Dividers: Resistance, Capacitance and mixed Divider**	**R2**	**2**	**PPT**	**L4**	**CO4**	**PO1-PO4, PO7, PO12**
30	**Peak Voltmeter**	**R3**	**1**	**PPT**	**L2**	**CO4**	**PO1-PO4, PO7**
31	**Generating Voltmeters**	**R2**	**1**	**PPT**	**L2**	**CO4**	**PO1-PO5**
32	**Capacitance Voltage Transformers**	**T3**	**1**	**PPT**	**L3**	**CO4**	**PO1-PO5**
33	**Electrostatic Voltmeters**	**T2**	**1**	**PPT**	**L3**	**CO4**	**PO1-PO5**
34	**Sphere Gaps**	**T3**	**1**	**PPT**	**L2**	**CO4**	**PO1-PO5**
35	**High current shunts-**	**T2**	**1**	**PPT**	**L2**	**CO4**	**PO1-PO5**
36	**Digital techniques in high voltage measurement.**	**T1**	**1**	**PPT**	**L3**	**CO4**	**PO1-PO5**

Suggested Activity: Assignment / Case Studies / Tuorials/ Quiz / Mini Projects / Model Developed/others Planned if any
Tutorials on Measurement of High Voltages and High Currents

Evaluation method
Paper based Evaluation

UNIT V HIGH VOLTAGE TESTING & INSULATION COORDINATION

37	International & Indian Standars of testing	T1T2	1	BB,PPT	L2	CO3	PO1-PO3
38	High voltage testing of insulators	T1T2	1	BB,PPT	L2	CO3	PO1-PO3
39	High voltage testing of Circuit breaker and Isolator	T1T2	1	BB,PPT	L3	CO3	PO1-PO4, PO7, PO12
40	High voltage testing of Bushing	T1T2	1	BB,PPT	L3	CO3	PO1-PO3
41	High voltage testing of Transformers	T1T2	1	BB,PPT	L4	CO5	PO1-PO4, PO7, PO12
42	High voltage testing of Cables	T1T2	1	BB,PPT	L4	CO5	PO1-PO4, PO7, PO12
43	High voltage testing of Surge Arrester	T1T2	1	BB,PPT	L3	CO5	PO1-PO3
44	Insulation Coordination.	T1T2	1	BB,PPT	L3	CO5	PO1-PO3
45	Volt-Time Curve	T1T3	1	BB,PPT	L3	CO5	PO1-PO3

Suggested Activity: Assignment / Case Studies / Tuorials/ Quiz / Mini Projects / Model Developed/others Planned if any
Assignment on Insulation Coordination

Evaluation method
Assignment Marks

Content Beyond the Syllabus Planned

1	Penning Effect
2	Measuring systems for apparent charges

Text Books

1	S.Naidu and V. Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, FifthEdition, 2013.
2	E. Kuffel and W.S. Zaengl, J.Kuffel, 'High voltage Engineering fundamentals',Newnes Second Edition Elsevier , New Delhi, 2005.
3	C.L. Wadhwa, 'High voltage Engineering', New Age International Publishers, ThirdEdition, 2010.

Reference Books

1	L.L. Alston, 'High Voltage Technology', Oxford University Press, First Indian Edition,2011
2	Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, Roshday Radwan, High Voltage Engineering – Theory &Practice, Second Edition Marcel Dekker, Inc., 2010.
3	Subir Ray,' An Introduction to High Voltage Engineering' PHI Learning PrivateLimited, New Delhi, Second Edition, 2013.

Website / URL References

1	https://nptel.ac.in/courses/108/104/108104048/
2	https://gcebargur.ac.in/sites/gcebargur.ac.in/files/lectures_desk/FALLSEM2013-14_CP1489_TB02_High-Voltage-Engineering-Kamaraju-and-Naidu_0.PDF
3	https://electrical-engineering-portal.com/download-center/books-and-guides/electricity-generation-t-d/lecture-notes-hv-engineering

Blooms Level

Level 1 (L1) : Remembering **Level 2 (L2) : Understanding** **Level 3 (L3) : Applying**	Lower Order Thinking	Fixed Hour Exams	**Level 4 (L4) : Analysing** **Level 5 (L5) : Evaluating** **Level 6 (L6) : Creating**		Higher Order Thinking	Projects / Mini Projects

Mapping syllabus with Bloom's Taxonomy LOT and HOT

Unit No	Unit Name	L1	L2	L3	L4	L5	L6	LOT	HOT	Total
Unit 1	Over Voltages in Electrical Power Systems	3	6	0	0	0	0	9	0	9
Unit 2	Dielectric Breakdown	1	3	5	0	0	0	9	0	9
Unit 3	Generation of High Voltages and High Currents	0	5	4	0	0	0	9	0	9
Unit 4	Measurement of High Voltages and High Currents	0	4	3	2	0	0	7	2	9
Unit 5	High Voltage Testing & Insulation Coordination	0	2	7	0	0	0	9	0	9

Total	4	20	19	2	0	0	43	2	45
Total Percentage	8.888889	44.44444	42.22222	4.444444	0	0	95.55556	4.444444	100

CO PO Mapping														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	PO6	PO7	PO8	PO9	PO10	PO11	PO12	**PSO1**	**PSO2**
CO1	3	3	2										1	1
CO2	3	3	3										1	1
CO3	3	3	3	2								1	1	1
CO4	3	2	1	1	1		1					1	1	1
CO5	3	2	2	1								1	1	1
Avg	**3**	**2.6**	**2.2**	**0.8**	**0.2**		0.2					0.6	1	1

Justification for CO-PO mapping	
CO1	High correlation for PO1 and PO2 and medium correlation for PO2, it can be used to apply knowledge of engineering in Over Voltage
CO2	High correlation for PO1, PO2 ,PO3 and it is having life long learning in the field of Dielectric Breakdown.
CO3	High correlation for PO1, PO2,PO3 medium correlation for PO4 it is having application in Generation Techniques.
CO4	High correlation for PO1 and Medium level correlation for PO2, Low level correlation for PO3. PO4, PO5 and PO7 can be used to apply knowledge of engineering to Identify , formulate and provide solutions by using relevant techniques and tools.
CO5	High correlation for PO1 and Medium level correlation for PO2, PO3 Low level correlation for PO4 and Learning the Insulation Techniques and testing.

1	**High level**	**2**	**Moderate level**	**2**	Low level

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