



**Department of Electrical Engineering**  
College of Engineering & Technology  
University of Sargodha

**OUTCOME BASE EDUCATION (OBE)**

Course File

**High Voltage Engineering**

8<sup>th</sup> Semester

BSc. Electrical Engineering

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# BSc. Electrical Engineering (Session 2018– 2022)

## 8<sup>th</sup> Semester

### 1. Course Time table

Course Number and Title: <b>EE-421</b> <b>High Voltage Engineering</b>	Name of Instructor: <b>Engr. Hafiz Ghulam Murtaza Qamar</b>	Class BSc. Electrical Engineering	Semester 8 <sup>th</sup>	Duration Jan-May, 2020
Credit hours:	(Theory) 3	<b>Class Timings:</b> <u>Tuesday 11:00 am – 12:30 pm</u> <u>Thursday 08:00 am – 09:30 am</u>		

### 2. Course Description/Objectives

This course is intended to provide a basic introduction to the theory of High voltage circuits linked with operation and characteristics of the liquid, gaseous and solid materials. The students should be introduced to high voltage generation, measurement, transient and insulation breakdown

### 3. Course Outlines

#### Course Outline:

#### Introduction:

Importance of High Voltage in all fields of daily life and medical applications.

#### Breakdown Mechanisms:

- Dielectric strength of solids, liquids and gases,
- Breakdown of solids, liquids and gases (Town send and streamer breakdown).
- Break down of unstable states of matter.
- Role of high voltage in production of unstable states of matter

#### Generation of High Voltages:

- Transformer,
- Series and Cascaded transformer connections,

- Bracketing in Transformer and its purpose,
- Series and Parallel Resonant Transformer, Tesla Coil, Transformer with rectifier,
- Voltage Multiplier Circuits, Walton Multiplier, Deltatron Multiplier,
- Electrostatic Voltage Generators (Van de Graff Generator, Sames Generator, Kelvin Water dropper, Whimshurst Machine)

### **Significance and Methods of Generation of Impulse:**

- Introduction to Impulse, Standard Impulse used for testing.
- Construction and working of MARX and Good-Let Generators for impulses.
- Impulse Current Generators.

### **Measurement of High Voltages:**

- Direct & Indirect Measurement of high voltages and its significance in a particular situation.
- Direct Measurement: HV probe, Potential Transformer, Ammeter in series with high resistance, Voltage divider
- Indirect Measurement: Spark gaps, Electrostatic Voltmeters, Electrodynamic Voltmeter, Hall Effect Sensor, Electro Optical Measurements.

### **Grounding and Earthing in Low and High Voltage Systems:**

- Basics and importance of grounding in low as well as high voltage devices and systems.
- Touch and step potentials in a HV lab.

### **Leakage Current in Insulation:**

- Introduction to leakage current, its types and components
- Methods of measuring and minimizing leakage current.

### **Insulation Materials:**

- Different types of polymeric & Ceramic Insulation materials and their X-tics w.r.t electrical, mechanical, optical, acoustical and environmental resistance.

### **High Voltage Testing Techniques:**

- Destructive, non-destructive, routine, fatigue, quantitative, qualitative, physical and chemical tests on different insulation materials.
- Health analysis of insulation systems.

### **Design Planning and Layout of HV Labs:**

- Classification of HV lab on small, medium and large scale.
- Typical facilities required in a HV lab.
- Designing a lab layout and equipment on customized demand.

**HVDC:**

- Scope trends technologies and future of HVDC.
- Advantages and issues in HVDC systems. HVDC distribution Systems.

**Applications of High Voltage:**

- Applications of high voltage in medical, research and daily life activities.

**Text Book:**

- High Voltage Engineering by Y. Kuffel, J. Kuffel and W. S. Zainger 2nd ed.

**Reference Books:**

- High Voltage Engineering by M.S. Naidu, V. Kamaraju, 4th ed
- High Voltage Engineering by Muhammad Naeem Arbab 1st ed
- High Voltage Engineering by J. R. Lucas 1st ed.

**4. Course Learning Outcomes (CLO's)**

Sr. No	CLO	Domain	Taxonomy Level	PLO	Assessment
1	RECOGNIZE various types of insulating materials and their applications in high-voltage equipment.	Cognitive	3	1	Quizzes + Mid + Assignment
2	Explain the breakdown mechanisms in solid, liquid and gaseous dielectrics.	Cognitive	5	2	Quizzes + Final Exam + Assignment
3	Ability to identify the performance of high-voltage generation and measurement devices.	Cognitive	5	2	Final Exam

**5.****Detailed Lecture plan**

Week No.	Lecture	Course contents to be covered	Reference
1	1-2	<b>Introduction:</b> Importance of high voltage on all fields of daily life and medical application	Text Book (HV Eng. By Y. Kuffel) Chapter 01
2	3-4	<b>Breakdown Mechanisms:</b> Dielectric Strength of solids, liquid and gases Breakdown of solids liquids and gases (Townsend and streamer Breakdown).	Text Book ( HV Eng. By Y. Kuffel) Chapter 05
3	5-6	<b>Breakdown Mechanism:</b> Breakdown of unstable states of matter, Role of high voltage in production of unstable states of matter.	Text Book ( HV Eng. By Y. Kuffel) Chapter 06
4	7-8	<b>Generation of high Voltages:</b> Transformers, Series and cascaded connections, Bracketing in Transformers and its purpose.	Text Book ( HV Eng. By Y. Kuffel) Chapter 02
5	9-10	<b>High Voltage Generation:</b> Series and Parallel Resonant Transformer, Tesla Coil, Transformer with Rectifier, Voltage Multiplier, Deltatron Multiplier.	Text Book ( HV Eng. By Y. Kuffel) Chapter 02
6	11-12	<b>Generation of High Voltages:</b> Electrostatic Voltage Generators (Van de Graff Generator, SAME's Generator, Kelvin Water dropper, Whimshurst Machine)	Text Book ( HV Eng. By Y. Kuffel) Chapter 02
7	13-14	<b>Significance and Method of Generation of Impulse:</b> Introduction of Impulse, Standard Impulse used for testing Construction and working of MARX and Good-Let Generators for impulses, Impulse Current Generators.	Text Book ( HV Eng. By M.S Naidu) Chapter 06
8	15-16	<b>Measurement of High Voltages:</b> Direct and Indirect Measurement of high Voltages and its significance in a particular situation. Direct Measurement: HV probe, Potential Transformer, Ammeter in series with high resistance Voltage divider.	Text Book ( HV Eng. By Y. Kuffel) Chapter 03
9	Mid-term Examination		
10	17-18	<b>Indirect Measurement:</b> Spark gaps, Electrostatic Voltmeter, Electrostatic Voltmeter, Electrodynamic	Text Book ( HV Eng. By Y. Kuffel) Chapter 01

		Voltmeter, Hall Effect Sensor, Electro Optical Measurement	
11	19-20	<b>Grounding and Earthing in Low and High Voltage Systems:</b> Basics and importance of grounding in low as well as High Voltage Devices and systems, Touch and step potential in HV lab.	
12	21-22	<b>Leakage Current in Insulation:</b> Introduction to leakage current, its types and components, Method of measuring and minimizing leakage current.	
13	23-24	<b>Insulation Materials:</b> Different types of polymeric and Ceramic. <b>High Voltage Testing Techniques:</b> Destructive, non-destructive, routine, fatigue, quantitative, qualitative, physical and chemical tests on different insulation materials, Health analysis of insulation system	Text Book ( HV Eng. By M.S Naidu) Chapter 05, Chapter 10
14	25-26	<b>HVDC:</b> Scope trends technologies and future of HVDC, Advantages and issues in HVDC systems. HVDC distribution Systems and its applications.	
15	27-28	HVDC distribution Systems and its applications.	
16	Final Term Examination		

**7. Spring Calendar (Spring 2019)**

Commencement of Classes:	13-01-2020
Mid Term exam:	16-03-2019 to 20-03-2020
Classes End:	30-4-2020
End Term exam:	04-05-2020 to 08-05-2020
Result Declaration:	15-05-2020

**6. Evaluation Criteria**

<b>Component of Assessment</b>	<b>Method</b>	<b>Marks</b>
<b>During The Semester</b>	Quiz 1	10
	Quiz 2	5
	Assignment 1	10
	Assignment 2	5
<b>Through Examination</b>	Mid Term Exam	20
	End Term Exam	50
<b>Total</b>		100