

**Maulana Abul Kalam Azad University of Technology, West Bengal**

(Formerly West Bengal University of Technology)

**Syllabus for B. Tech in Electrical Engineering**

(Applicable from the academic session 2018-2019)

<b>Name of the course</b>	<b>HIGH VOLTAGE ENGINEERING</b>
<b>Course Code: PE-EE-501A</b>	<b>Semester: 5<sup>th</sup></b>
<b>Duration: 6 months</b>	<b>Maximum Marks: 100</b>
<b>Teaching Scheme</b>	<b>Examination Scheme</b>
Theory: 3 hrs./week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Practical: hrs./week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

**Objective:**

1. To understand the breakdown phenomenon of solid, liquid and gases.
2. To understand the method of generation of high voltage AC and DC.
3. To understand measurement techniques of high voltage and current
4. To understand the over voltage phenomenon and insulation coordination in Electric power systems
5. To understand different methods of high voltage testing.
6. To solve numerical problems of breakdown phenomena, generation and measurement of high voltage and currents, over voltage phenomena and high voltage testing.

**Pre-Requisite**

1. Electric Circuit Theory (PC-EE-301)
2. Electromagnetic field theory (PC-EE-303)
3. Electric Machine-I (PC-EE-401)
4. Electrical and Electronics measurement (PC-EE-403)

<b>Unit</b>	<b>Content</b>	<b>Hrs</b>	<b>Marks</b>
1	<p><b>Breakdown phenomena:</b></p> <p>Breakdown of Gases: Mechanism of Breakdown of gases, Charge multiplication, Secondary emission, Townsend Theory, Streamer Theory, Paschen's Law, Determination of Minimum breakdown voltage, Breakdown in non-uniform field, Effect of polarity on corona inception and breakdown voltage.</p> <p>Partial Discharge: definition and development in solid dielectric.</p> <p>Break Down of Solids: Intrinsic breakdown, Electromechanical breakdown, Thermal breakdown, Streamer Breakdown.</p> <p>Breakdown of Liquid: Intrinsic Break down, Cavitation Theory, Suspended particle Theory.</p> <p>Breakdown in Vacuum: Non-metallic electron emission mechanism, Clump mechanism,</p> <p>Effect of pressure on breakdown voltage.</p>	10	
2	<p><b>Generation of High Voltage and Currents</b></p> <p>Generation of high DC and AC voltages: half wave rectifier circuit, Cockcroft-Walton voltage multiplier circuit, Electrostatic generator, Cascaded transformers, Series resonant circuit.</p> <p>Generation of Impulse voltages and currents: standard impulse wave shapes, Multistage impulse generators, generation of switching surges, generation of impulse currents, tripping and control of impulse generators.</p>	08	
3	<p><b>Measurement of High Voltage and Currents</b></p> <p>Sphere gap, Uniform field spark gap, Rod gap, Electrostatic voltmeter, Generating voltmeter, Impulse voltage measurements</p>		

	using voltage dividers, Measurement of High DC and Impulse currents. Cathode ray oscilloscopes for impulse voltage and current measurements.	08	
4	<p><b>Over voltage phenomenon and insulation coordination in Electric power systems:</b></p> <p>Lightning Phenomena, Electrification of cloud, Development of Lightning Stroke, lightning induced over voltage, direct stroke, indirect stroke.</p> <p>Protection of Electrical Apparatus against over voltage, Lightning Arrestors, Valve Type, Metal Oxide arresters, Expulsion type. Effect of location of lightning arresters on protection of transformer. Protection of substation, Ground wires.</p> <p>Insulation Co-ordination, Basic Insulation level. Basic Impulse level, Switching Impulse level. Volt time characteristics of protective devices, Determination of Basic Impulse level of substation equipment.</p>	08	
5	<p><b>High Voltage Testing:</b></p> <p>Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers. High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H. V. Labs.</p>	06	

#### Text books:

1. High Voltage Engineering, C.L. Wadhawa, New Age International Publishers.
2. High Voltage Engineering, M.S. Naidu & V. Kamraju, Tata MC Graw Hill publication.

#### Reference books

1. High-Voltage Engineering : theory and practice, Mazen Abdel-Salam; Hussein Anis; Ahdab El-Morshedy; Roshdy Radwan, New York, N.Y. : Marcel Dekker, ©2000.
2. High Voltage Engineering, E. Kuffel, W.S. Zaengl, J. Kuffel, 2<sup>nd</sup> edition, Butterworth-Heinemann.

#### Course Outcome:

After completion of this course, the learners will be able to

1. explain breakdown phenomenon of gas, liquid and solid and vacuum
2. suggest methods for generation and measurement of high voltage and currents.
3. determine the basic insulation level of substation equipment.
4. apply methods for protection of electrical apparatus against over voltage
5. test insulators, bushings, isolators, circuit breakers, cables and power transformers.
6. solve numerical problems of breakdown phenomena, generation and measurement of high voltage and currents, over voltage phenomena and high voltage testing.

#### Special Remarks (if any)

The above-mentioned outcomes are not limited. Institute may redefine outcomes based their program educational objective.