Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Institute of Technology
Semester-7

Subject: High Voltage Engineering - BETEE17330

Type of course: Professional Core and Professional Elective Courses.

Prerequisite: Electrical Power System

Rationale:

This course provides a strong foundation in high-voltage engineering, essential for modern power transmission systems. It covers insulation concepts, HV generation and measurement techniques, overvoltages including lightning, and non-destructive testing of HV equipment.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	
4	0	2	5	60	30	10	20	30	150

Legends: CI-Classroom Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.

Course Content:

Unit No.	Course content	Hrs	% Weightage
1.	**Over Voltage in Power System** Causes of Over Voltages Theory and Mechanism of Lightning phenomenon, Overvoltage due to Switching Surges, Protection against over voltages, Reflection and Refraction of Travelling waves, Insulation Coordination.	12	15%

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2.	**Conduction and Breakdown in Dielectronics** Ionization of gases and current growth, Townsend's criterion for breakdown, Streamer theory of breakdown in gases. Paschen's Law, Vacuum breakdown, Various mechanisms of breakdown in liquid dielectrics, Various processes of breakdown in solid dielectrics.	15	25%
3.	**Generation of High Voltages and Currents** Generation of high DC voltages: Rectifier, Voltage doubler circuits, Cockcroft Walton voltage multiplier circuit, Van de Graffe generator, Generation of high AC voltage: Cascaded transformers, Resonant transformers, Generation of high frequency a.c. high voltage, Generation of impulse voltages: Standard impulse wave shapes, Marx Circuit, generation of switching surges, Generation of impulse current, Tripping and control of impulse generators.	15	25%
4.	**Measurement of High Voltages and Currents** High Resistance with series ammeter, Potential divider, Generating Voltmeters, Capacitance Voltage Transformer, Electrostatic Voltmeters, Sphere Gaps, Hall generators, Resistive Shunts, Rogowski coils, Cathode Ray Oscillographs for impulse measurement.	10	20%
5.	**Testing of Electrical Apparatus** Testing of Insulators and Bushings, Testing of Isolators and Circuit Breakers, Testing of Cables, Testing of Transformers, Testing of Surge arresters, Radio Interference Measurements, Standards and Specifications.	08	15%

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1	**HV Generation Techniques Presentation** Students will study different methods of high voltage generation (DC, AC, impulse) such as Cockcroft-Walton, Van de Graaff, and Marx circuits. Each group will present working principles with diagrams and applications. Upload report/PPT on GMIU web portal.	10
2	**Measurement Technique Comparison Study** Students will compare various high voltage and current measurement methods (sphere gap, CVT, Rogowski coil etc.) based on accuracy, application, and limitations. Prepare a comparative chart and analysis report. Upload report on GMIU web portal.	10

3	**Review Paper** Students have to prepare a review paper based on topics in High Voltage Engineering such as overvoltages, dielectric breakdown, HV generation, measurement techniques, or testing of electrical equipment. Upload it on the GMIU web portal. (No. of students per group - 03)	10
Total		30

Suggested Specification table with Marks (Theory):60

Distribution of Theory Marks **(Revised Bloom's Taxonomy)**						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage	25%	30%	25%	10%	10%	00%

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcome:

After learning the course, the students should be able to:	
CO1	Analyze overvoltages in power systems and apply suitable protection techniques.
CO2	Understand conduction and breakdown mechanisms in different dielectric materials.
CO3	Differentiate between various high-voltage generation methods.
CO4	Know about techniques for the measurement of high voltages and currents.
CO5	Interpret testing procedures and standards for electrical equipment.

List of Practical:

Sr. No	Descriptions	Unit No	Hrs
1.	To study design, planning and layout of high voltage laboratories.	1	2
2.	To study & measure breakdown strength of Air through horn gap Arrestor.	2	4
3.	To study about breakdown mechanism in oil dielectric and to measure the breakdown and dielectric strength of transformer oil.	2	2
4.	To plot the potential field lines for different types of electrode configurations using Electrolytic tank.	2	4
5.	To study corona cage apparatus and to measure visual of corona voltage in corona cage.	2	4
6.	To study the breakdown characteristics of sphere gap assembly using H.V.D.C. and H.V.A.C.	2	4
7.	To study the breakdown characteristics of uniform field (plane-plane) using H.V.D.C. and H.V.A.C.	2	2

8.	To study the breakdown characteristics of non-uniformfield (point-point) using H.V.D.C. and H.V.A.C.	3	2
9.	To study impulse wave and its effect on transformer	3	4
10.	To study and observe the components, control and operation of 150kV, 225J impulse generator.	4	2
	Total		**30**

Instructional Method:

The course delivery method will depend upon the requirement of content and the needs of students. The teacher, in addition to conventional teaching methods by black board, may also use any tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

From the content 10% topics are suggested for flipped mode instruction.

Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory

The internal evaluation will be done on the basis of Active Learning Assignment

Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in the laboratory.

Reference Books:

[1] M. S. Naidu and V. Kamaraju, High Voltage Engineering, 5th ed. New Delhi, India: Tata McGraw Hill, 2013.
[2] C. L. Wadhwa, High Voltage Engineering. New Delhi, India: New Age International, 2007.
[3] E. Kuffel and W. S. Zaengl, High Voltage Engineering Fundamentals, 2nd ed. Oxford, U.K.: Butterworth-Heinemann, 2000.
[4] H. M. Ryan, High Voltage Engineering and Testing, 2nd ed. London, U.K.: IET, 2001.
[5] F. A. M. Rizk and G. N. Trinh, High Voltage Engineering, 1st ed. Boca Raton, FL, USA: CRC Press, 2014.
[6] A. Haddad and D. F. Warne, Advances in High Voltage Engineering. London, U.K.: Institution of Engineering and Technology, 2004.
[7] D. V. Razevig, High Voltage Engineering, 2nd ed. New Delhi, India: Khanna Publishers, 2000