Subject Description Form

Subject Code	EE509
Subject Title	High Voltage Engineering
Credit Value	3
Level	5
Pre-requisite / Co-requisite / Exclusion	Nil
Collaboration Institute	HK Electric Institute
Objectives	To provide students with the knowledge and skills required to study the physical insights and analysis techniques of high voltage engineering, including the causes and manner of insulation failures as well as the challenges and problems encountered in the practice of high voltage equipment.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Describe the insulation breakdown mechanisms for identifying the failure phenomena of different insulation systems. b. Apply the principles and practices of high voltage equipment for performing the pragmatic design and applications of high voltage equipment in the industry.
Subject Synopsis / Indicative Syllabus	1. ***Introduction to Electrical Insulation*****:** Electric fields; Dielectric breakdown; Electrical insulating materials; Industrial applications of electrical insulating materials. 2. ***Breakdown of Gaseous Insulation*****:** Ionization processes; Townsend breakdown mechanism; Experimental determination of Townsend's ionization coefficients; Breakdown in electronegative gases; Streamer breakdown mechanism; Paschen's law; Corona discharges; Breakdown in non-uniform fields; Post-breakdown phenomena and applications; Vacuum insulation and breakdown. 3. ***Breakdown of Liquid Insulation*****:** Breakdown in pure and commercial liquids; Purification and breakdown test; Power law for commercial liquids. 4. ***Breakdown of Solid Insulation*****:** Breakdown due to treeing, surface flashover, and surface tracking; Breakdown in composite insulation. 5. ***Partial Discharges & In-house Demonstration*****:** Classification of partial discharges by origin; Principle of partial discharge measurements; Demonstration of state-of-the-art measuring equipment. 6. ***High Voltage Equipment for Power System Networks*****:** Hierarchy of power system networks; Introduction to high voltage equipment and their general specifications. 7. ***Transmission Gas Insulated Switchgears*****:** Design and busbar topologies; Layout and internal construction; Environmental, health, and safety precautions in handling SF_6 gas; Type and routine tests; Inspection before installation; Commissioning test and precautions; Typical incidents around the world. 8. ***High Voltage Cables*****:** Basic high voltage cable technology; Dielectric properties; Types and constructions; Type, routine, and diagnostic tests; Health index; Water tree formation; Accessory design, operations, and maintenance considerations; Reliability reviews and failure analysis; Faulty joint dissections and lessons learned.

	9. ***Visit to HK Electric*:** Introduction to transmission and distribution facilities; Demonstration of transmission gas insulated switchgears and relevant high voltage test equipment used in the power industry.
Teaching / Learning Methodology	Lectures are the primary means of conveying the knowledge and skills required to study the physical insights and analysis techniques of high voltage engineering. In-house Demonstration and Visit to HK Electric are the complementary means of providing real-life experience on the pragmatic design and applications of high voltage engineering in the industry. Students are expected to solve design problems with real-life constraints and to attain pragmatic solutions with critical and analytical thinking.

Teaching/Learning Methodology	Outcomes	
	a	b
Lectures	✓	✓
In-house Demonstration	✓	
Visit to HK Electric		✓

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended learning outcomes to be assessed	
		a	b
1. Examination	60%	✓	✓
2. Continuous Assessment	40%	✓	✓
Assignments (Insulation breakdown)		✓	
Assignments (High voltage equipment)			✓
Log (In-house demonstration)		✓	
Log (Visit to HK Electric)			✓
Total	100%		

The assessment methods include: Examination (60%) and Continuous Assessment (40%), both aligning with intended learning outcomes a and b. Examination (60%) is a three-hour, closed-book, end-of-subject written examination. Continuous Assessment (40%) consists of assignments (32%) and logs (8%), which, in turn, are after-class exercises for lectures on Insulation Breakdown (16%) and High Voltage Equipment (16%) and records of practical learning for In-house Demonstration (4%) and Visit to HK Electric (4%), respectively.

Student Study Effort Expected		
	Class contact:	
	▪ Lecture/In-house Demonstration/Visit to HK Electric	39 Hrs.
	Other student study efforts:	
	▪ Assignments	16 Hrs.
	▪ Self-study	50 Hrs.
	Total student study effort	105 Hrs.

Reading List and References	**Textbooks:** NIL (Refer to Lecture Notes). **Reference books:** 1. M. S. Naidu and V. Kamaraju, High-Voltage Engineering, 5th Edition, Tata McGraw-Hill, 2013. 2. F. A. M. Rizk and G. N. Trinh, High Voltage Engineering, 1st Edition, Routledge, 2017. 2. V. Y. Ushakov, Insulation of High-Voltage Equipment, Springer Verlag, 2004. 3. E. Kuffel, W. S. Zaengl and J. Kuffel, High Voltage Engineering: Fundamentals, 2nd Edition, TBS, 2000. 4. C. L. Wadhwa, High Voltage Engineering, 3rd Edition, New Age Science, 2010. 5. A. Ravindra and M. Wolfgang, High Voltage and Electrical Insulation Engineering, Wiley: IEEE Press, 2011. 6. F. H. Kreuger, Partial Discharge Detection in High-Voltage Equipment, Butterworth-Heinemann, 1990. 7. IET Digital Library, Lightning Protection, Edited by C. Vernon, Institution of Engineering and Technology, 2010.