GUJARAT TECHNOLOGICAL UNIVERSITY
PDDC SEMESTER : VI
ELECTRICAL ENGINEERING

Subject Name: **HIGH VOLTAGE ENGINEERING**

Sr. No.	Course Contents	Total Hrs
1.	**Electrostatic fields and field stress control :** Electrical field distribution and breakdown strength of insulating materials -fields in homogeneous, isotropic materials - fields in multi-dielectric, isotropic materials - numerical method: charge simulation method (CSM)	02
2.	**Electrical breakdown in gases** Gases as insulating media - ionization and decay processes, Townsend first ionization coefficient, photo ionization, ionization by interaction of metastable with atoms, thermal ionization, deionization by recombination, deionization by attachment– negative ion formation, mobility of gaseous ions and deionization by diffusion, relation between diffusion and mobility, examples - cathode processes – secondary effects, photoelectric emission, electron emission by positive ion and excited atom impact, thermionic emission, field emission, Townsend second ionization coefficient, secondary electron emission by photon impact, examples - transition from non-self-sustained discharges to breakdown, the Townsend mechanism, examples - the streamer or 'kanal' mechanism of spark, examples - the sparking voltage–Paschen's law, penning effect, the breakdown field strength, breakdown in non-uniform fields - effect of electron attachment on the breakdown criteria, partial breakdown, corona discharges, polarity effect – influence of space charge - practical gaseous dielectrics: SF6, SF6 mixtures, vacuum, gas insulated substations.	10
3.	**Breakdown in liquid and solid dielectrics:** Liquid as insulators, breakdown in liquids - electronic breakdown, suspended solid particle mechanism, cavity breakdown, electro-convection and electro-hydrodynamic model of dielectric breakdown, examples – static electrification in power transformers, transformer oil filtration, transformer oil test, alternative liquid insulations like vegetable oils, esters and silicon oils - breakdown in solids, intrinsic breakdown, streamer breakdown, electromechanical breakdown, edge breakdown and treeing, thermal breakdown, erosion breakdown, tracking - breakdown of solid dielectrics in practice, partial discharges in solid insulation, solid dielectrics used in practice	10
4.	**Generation of high voltages :** Generation of high direct voltages, half and full wave rectifier circuits, voltage multiplier circuits, Van de Graff generators, electrostatic generators, examples - generation of alternating voltages, testing transformers, cascaded transformers, resonant transformers, examples - impulse voltages, impulse voltage generator circuits, Marx circuit, operation, design and construction of impulse generators, examples - impulse current generator - control systems	8
5.	**Measurement of high voltages :** High direct voltage measurement, peak voltage measurements by spark gaps, sphere gaps, reference measuring systems, uniform field gaps, rod gaps, factors affecting sphere gap measurements, examples – electrostatic voltmeters - ammeter in series with high ohmic resistors and high ohmic resistor voltage dividers - generating voltmeters	10

	and field sensors – the measurement of peak voltages, the Chubb–Fortescue method, high voltage capacitors for measuring circuits - voltage dividing systems and impulse voltage measurements, generalized voltage generation and measuring circuit, voltage dividers, interaction between voltage divider and its lead, the divider's low-voltage arm - digital recorders, errors inherent in digital recorders	
6.	**Over voltages, testing procedures and insulation coordination :** The lightning mechanism, energy in lightning, nature of danger – simulated lightning surges for testing - switching surge test voltage characteristics - laboratory high-voltage testing procedures and statistical treatment of results, examples - insulation coordination, insulation level, statistical approach to insulation coordination, correlation between insulation and protection levels - modern power systems protection devices, moa – metal oxide arresters	**4**
7.	**Non-destructive insulation test techniques :** Measurement of d.c. resistivity - dielectric loss and capacitance measurements, the Schering bridge, current comparator bridges, loss measurement on complete equipment, null detectors - partial-discharge (PD) measurements, the basic PD test circuit, PD currents, PD measuring systems within the PD test circuit, measuring systems for apparent charge, sources and reduction of disturbances, other PD quantities, calibration of PD detectors in a complete test circuit, digital PD instruments	**4**
8.	**High voltage testing:** Testing of insulators and bushings - testing of isolators and circuit breakers - testing of cables - testing of transformers - testing of surge diverters - radio interference measurements - design, planning and layout of high voltage laboratory	**3**

Note: It is suggested that based on the above syllabus, visits for LT/HT Electrification and 220KV/ 400 KV substations should be carried out.

Books:

1. Electrical Power System Design – M. V. Deshpande, TMH publication
2. Electrical Power System Design – B. R. Gupta, S. CHAND
3. Electrical Power System Planning – A. S. Pabla, TMH publication
4. Substation Design – Satnam & Gupta, Dhanpat Rai and Co.
5. A course in Electrical Power- Soni,,Gupta and Bhatnagar, Dhanpat Rai & Sons