JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

**M. TECH (HIGH VOLTAGE ENGINEERING/
POWER SYSTEMS WITH EMPHASIS ON H.V. ENGINEERING)**

EFFECTIVE FROM ACADEMIC YEAR 2017- 18 ADMITTED BATCH

COURSE STRUCTURE AND SYLLABUS

I Semester

Category	Course Title	Int. marks	Ext. marks	L	T	P	C
PC-1	Generation and Measurement of High Voltages	25	75	4	0	0	4
PC-2	Dielectric and Insulation Engineering	25	75	4	0	0	4
PC-3	Advanced HVDC Transmission	25	75	4	0	0	4
PE-1	1. Gas Insulated Systems (GIS) 2. Flexibility AC Transmission Systems (FACTS) 3. Voltage Stability	25	75	3	0	0	3
PE-2	1. Advanced Power System Protection 2. Reactive Power Compensation & Management 3. Breakdown Phenomenon in Insulation	25	75	3	0	0	3
OE-1	***Open Elective – I**	25	75	3	0	0	3
Laboratory I	High Voltage Laboratory	25	75	0	0	3	2
Seminar I	Seminar -I	100	0	0	0	3	2
Total		**275**	**525**	**21**	**0**	**6**	**25**

II Semester

Category	Course Title	Int. marks	Ext. marks	L	T	P	C
PC-4	High Voltage Testing Technology	25	75	4	0	0	4
PC-5	EHV AC Transmission	25	75	4	0	0	4
PC-6	Surge Phenomena and Insulation Coordination	25	75	4	0	0	4
PE-3	1. Partial Discharge in High Voltage Equipment 2. Power System Transients 3. Programmable Logic Controllers and Applications	25	75	3	0	0	3
PE4	1. HV Transformers 2. Pulse Power Engineering 3. Advanced Electromagnetic Fields	25	75	3	0	0	3
OE-2	***Open Elective – II**	25	75	3	0	0	3
Laboratory II	Simulation Lab	25	75	0	0	3	2
Seminar II	Seminar -II	100	0	0	0	3	2
Total		**275**	**525**	**21**	**0**	**6**	**25**

III Semester

Course Title	Int. marks	Ext. marks	L	T	P	C
Technical Paper Writing	100	0	0	3	0	2
Comprehensive Viva-Voce	0	100	0	0	0	4
Project work Review II	100	0	0	0	22	8
Total	**200**	**100**	0	**3**	22	**14**

IV Semester

Course Title	Int. marks	Ext. marks	L	T	P	C
Project work Review III	100	0	0	0	24	8
Project Evaluation (Viva-Voce)	0	100	0	0	0	16
Total	**100**	**100**	**0**	**0**	**24**	**24**

***Open Elective subjects must be chosen from the list of open electives offered by OTHER departments.**

 # For Project review I, please refer 7.10 in R17 Academic Regulations.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (PS H.V. Engg. / H.V. Engg.)

GENERATION AND MEASUREMENT OF HIGH VOLTAGES
(Professional Core - I)

Course Objectives:

- To provide strong knowledge on different types electrical stresses on power system and equipment.
- To impart knowledge on generation of high AC, DC and impulse voltages and impulse currents.
- To know about generation and measurement of high voltages and high currents.

Course Outcomes: After completion of this course, student will be able to

- To design the suitable high voltage and high current generating and measuring circuits.
- To understand generation and measurement of impulse and peak voltages.

UNIT-I:

Electrostatic Fields and Field Stress Control: Electric fields in homogeneous Isotropic materials and in multi dielectric media – Simple configurations – field stress control. Methods of computing electrostatic fields – conductive analogues - Impedance networks, Numerical techniques – finite difference method – finite element method and charge simulation method.

UNIT-II:

Generation of High Voltages and Currents: Direct Voltages: AC to DC conversion methods, electrostatic generators – Cascaded Voltage Multipliers,
Alternating Voltages: Testing transformers – Resonant circuits and their applications.
Impulse Voltages: Impulse voltage specifications – Impulse generation circuits – Operation, construction and design of Impulse generators, generation of switching and long duration impulses.
Impulse Currents: Generation of high impulse currents and high current pulses.

UNIT-III:

Measurement of High Voltages: Measurement of high DC Voltages: Series resistance meters, voltage dividers and generating voltmeters.
Measurement of high AC Voltages: Series impedance meters, electrostatic voltmeters, potential transformers and CVTS – voltage dividers and their applications.

UNIT-IV:

Measurement of Peak Voltage: Sphere gaps, uniform field gaps, rod gaps. Chubbs – Fortesuere methods. Passive and active rectifier circuits for voltage dividers.

UNIT-V:

Measurement of Impulse Voltages & Currents: Measurement of Impulse Voltage: Voltage dividers and impulse measuring systems – generalized voltage measuring circuits – transfer characteristics of measuring circuits – L.V. Arms for voltage dividers – compensated dividers.
Measurement of Impulse Currents: Resistive shunts – current transformers – Hall Generators and Faraday generators and their applications – Impulse Oscilloscopes.

TEXT BOOKS:

1. High Voltage Engineering E Kuffel and W.S. Zaengl. Pergamon press, Canada Ltd., 1984.

2. High Voltage Engineering M.S. Naidu and V. Kamaraju, Tata McGraw Hill Book Co., New Delhi, 3rd edition 2004.
3. High Voltage Technology – LL Alston, Oxford University press, 1968

REFERENCES:

1. High voltage Measuring Techniques – A Schwab, MIT press Cambridge, USA 1972.
2. High Voltage Engineering – Sabeer Ray

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (PS H.V. Engg. / H.V. Engg.)

DIELECTRIC AND INSULATION ENGINEERING
(Professional Core - II)

Prerequisite: Electromagnetic Fields

Course Objectives:

- To gain in-depth knowledge on characteristics and behavior of dielectrics under static and alternating fields.
- To study the breakdown mechanism of gaseous, liquid and solid dielectrics.

Course Outcomes: After the completion of this course, the student will be able to

- Know the properties of various dielectric materials.
- Understand the fundamental behavior of gaseous, liquid, and solid dielectrics.
- Emphasize the breakdown phenomenon of dielectric materials.

Unit-I:
Dielectrics and Insulating Material: Review of Dielectric Phenomenon: Complex permittivity – Polarization – Relaxation and resonant models. Solid, Liquid and Gaseous insulating materials.

Unit-II:
Properties of Dielectrics and Insulating Materials: Physical Thermal & Electrical properties-Classification of Insulating Materials,
Solid Materials: Organic Fiber materials Ceramics & Synthetic polymeric and their applications.
Liquid Materials: Insulating oils their properties and applications.
Gaseous Materials: Air and SF6 – applications in electrical apparatus.

Unit-III:
Breakdown Phenomenon – I: Insulation and decay process-transition from self sustained discharges to breakdown. Townsend and streamer discharge paschen's law penning effect-Time lags-Surge breakdown voltage.

Unit-IV:
Breakdown Phenomenon – II: Breakdown in non uniform fields-Vacuum insulation and vacuum breakdown. Breakdown Phenomenon in Liquid and Solid insulation: pure and commercial liquids-suspended particle and bubble theories-stressed oil volume theory.

Unit-V:
Breakdown Phenomenon – III: Breakdown in solid insulation intrinsic breakdown-Treeing and tracking phenomenon-Thermal breakdown-Breakdown in composite dielectrics.

REFERENCE BOOKS:

1. High Voltage Engineering – by E. Kuffel and W.S. Zaenal Pergamon press. Oxford 1984.
2. High Voltage Engineering – by M.S. Naidu and V. Kamarajuu, Tata McGraw Hill Book Co., New Delhi, 2nd edition, 1995.
3. Electrical Engineering Materials – B. Tareev, M.I.R. Publications, Moscow.
4. A Physics of Dielectrics – B. Tareev, M.I.R. Publications, Moscow.
5. High Voltage Technology – LL Alston, Oxford University Press 1968.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (PS H.V. Engg. / H.V. Engg.)

ADVANCED HVDC TRANSMISSION
(Professional Core - III)

Prerequisite: Power Electronics and Power Systems

Course Objectives:

- To Comprehend the conversion principles of HVDC Transmission
- Analysis of 3, 6, 12 pulse converters, rectifier and inverter operations of HVDC converters
- To identify the different types of Harmonics and reduction by using Filters
- To comprehend interaction between HVAC and DC systems in various aspects
- To appreciate the reliable MTDC systems and protection of HVDC system

Course Outcomes: Upon the completion of this course, the student will be able to

- To find the applications of HVDC transmission in the power system with the acquired knowledge.
- To analyze different converter topologies viz. 3, 6 and 12 Pulse converters and understand it's control aspects.
- To understand the filter configuration for Harmonics in HVDC systems.
- To appreciate the reliable Multi terminal HVDC system.
- To have knowledge on the Protection of HVDC systems against Transient over voltages and over currents.

Unit-I:
Introduction: General consideration, Power Handling Capabilities of HVDC Lines Basic Conversion principles, static converter configuration.

Unit-II:
Static Power Converters: 3-pulse, 6-pulse, and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers. Harmonics in HVDC Systems, Harmonic elimination, AC and DC filters.

Unit-III:
Control of HVDC Converters and Systems: Constant current, constant extinction angle and constant ignition angle control Individual phase control and equidistant firing angle control DC power flow control. Interaction between HV AC and DC systems – Voltage interaction Harmonic instability problems and DC power modulation.

Unit-IV:
MTDC Systems & Over Voltages: Series parallel and series parallel systems their operation and control.
Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults.

Unit-V:
Converter Faults & Protection: Converter faults, over current protection – valve group, and DC line protection over voltage protection of converters, surge arresters.

TEXT BOOKS:

1. E.W. Kimbark: Direct current Transmission, Wiely Inter Science – New York
2. KR Padiyar : High Voltage Direct current Transmission Wiely Eastern Ltd New Delhi – 1992.

REFERENCES:

1. J. Arillaga HVDC Transmission Peter Peregrinus ltd. London UK 1983
2. E. Uhlman, “Power Transmission by Direct Current”, Springer Verlag, Berlin Helberg. 1985.
3. S. Rao, “EHVAC and HVDC Transmission Engineering Practice” Khanna publishers.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (PS H.V. Engg. / H.V. Engg.)

GAS INSULATED SYSTEMS (GIS)
(Professional Elective – I)

Prerequisite: Power Systems & Switch Gear and Protection

Course Objectives:

- To study the physical and chemical properties of SF6.
- To introduce design criteria of Gas Insulated Substation (GIS).
- To comprehend the substation insulation co-ordination and protection schemes.
- To understand the source and effect of VFTO's in GIS.
- To know various diagnostic methods of GIS.

Course Outcomes: After the completion of this course, the student will be to

- Develop the understanding of GIS equipment and their arrangements.
- Tto design the substation for present requirement with proper insulation coordination and protection against very fast transients.
- To perform various diagnostic methods of GIS.

UNIT–I:

Introduction to GIS and Properties of Sf_6: Characteristics of GIS- Introduction to SF_6 - Physical properties-Chemical properties - Electrical properties-Specification of SF_6 gas for GIS application - Handling of SF_6 gas before use - Safe handling of SF_6 gas in electrical equipment - Equipment for handling the SF_6 Gas - SF_6 and environment.

UNIT–II:

Layout of GIS Stations: Advancement of GIS station - Comparison with Air Insulated Substation - Economics of GIS - User Requirements for GIS - Main Features for GIS - Planning and Installation components of a GIS station.

UNIT–III:

Design and Construction of GIS Station: Introduction - Rating of GIS components - Design Features - Estimation of different types of Electrical Stresses - Design Aspects of GIS components - Insulation Design for Components - Insulation Design for GIS - Thermal Considerations in the Design of GIS - Effect of very Fast Transient Over-voltages (VFTO) on the GIS design - Insulation Coordination systems - Gas handling and Monitoring System Design.

UNIT-IV:

Fast Transient Phenomena In GIS: Introduction - Disconnector Switching in Relation to Very fast Transients-Origin of VFTO-Propagation and Mechanism of VFTO-VFTO Characteristics- Effects of VFTO-Testing of GIS for VFTO.

UNIT–V:

Special Problems in GIS and GIS Diagnostics : Introduction - particles their effects and their control- Insulating Spacers and their Reliability - SF_6 Gas Decomposition - Characteristics of imperfections in insulation - Insulation Diagnostic methods - PD Measurement and UHF Method.

TEXT BOOK:

1. M. S. Naidu," Gas Insulated Substations"- IK International Publishing House.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (PS H.V. Engg. / H.V. Engg.)

FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS)
(Professional Elective – I)

Prerequisite: Power Electronics and Power Systems

Course Objectives:

- To develop the understanding of uncompensated lines and their behavior under heavy loading conditions.
- To understand the concept and importance controllable parameters of FACTS controllers.
- To emphasize the objectives of Shunt compensation, and basic operation of SVC and STATCOM.
- To analyze the functioning of series controllers like GCSC, TSSC and TCSC

Course Outcomes: Upon the completion of this course, the student will be able to

- Choose proper controller for the specific application based on system requirements
- Understand various systems thoroughly and their requirements
- Interpret the control circuits of Shunt Controllers SVC & STATCOM for various functions viz. Transient stability Enhancement, voltage instability prevention and power oscillation damping
- Detect the Power and control circuits of Series Controllers GCSC, TSSC and TCSC

Unit-I:
Facts Concepts: Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters basic types of FACTS controllers, benefits from FACTS controllers.

Unit-II:
Voltage Source Converters: Single phase three phase full wave bridge converters transformer connections for 12 pulse 24 and 48 pulse operation. Three level voltage source converter, pulse width modulation converter, basic concept of current source Converters, and comparison of current source converters with voltage source converters.

Unit-III:
Static Shunt Compensation: Objectives of shunt compensation, mid-point voltage regulation voltage instability prevention, improvement of transient stability, Power oscillation damping, Methods of controllable VAR generation, variable impedance type static VAR generators switching converter type VAR generators hybrid VAR generators.

Unit-IV:
SVC and Statcom: The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping operating point control and summary of compensator control.

Unit-V:
Static Series Compensators: Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, and functional requirements of GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC), Control schemes for GSC TSSC and TCSC.

TEXT BOOKS:

1. Hingorani H G and Gyugyi. L “Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems” New York, IEEE Press, 2000.
2. Padiyar. K.R, “ FACTS Controllers in Power Transmission and Distribution” New Age Int. Publishers, 2007

REFERENCES:

1. Zhang, Xiao-Ping, Rehtanz, Christian, Pal, Bikash “Flexible AC Transmission Systems: Modeling and Control”, Springer, 2012
2. Yong-Hua Song, Allan Johns, “Flexible AC Transmission Systems”, IET, 1999

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – I Sem. (PS H.V. Engg. / H.V. Engg.)

VOLTAGE STABILITY
(Professional Elective – I)

Prerequisite: Power Systems
Course Objectives:

- To understand the dependency of voltage on reactive power, factors affecting the voltage collapse.
- To know various graphical methods to understand voltage collapse phenomenon.
- To comprehend voltage stability analysis of simple systems.

Course Outcomes: Upon the completion of the subject, the student will be able to

- Have knowledge related to voltage collapse phenomenon and factors affecting it.
- Analyse various power system loads for voltage stability.
- emphasize reactive power compensation techniques & their practical importance

Unit–I:
Introduction to Voltage Stability: Definitions: Voltage Stability, Voltage Collapse, Voltage Security; Physical relation indicating dependency of voltage on reactive power flow; Factors affecting Voltage collapse and instability; Previous cases of voltage collapse incidences.

Unit–II:
Graphical Analysis of Voltage Stability: Comparison of Voltage and angular stability of the system; Graphical Methods describing voltage collapse phenomenon: P-V and Q-V curves; detailed description of voltage collapse phenomenon with the help of Q-V curves.

Unit–III:
Analysis of Voltage Stability: Analysis of voltage stability on SMLB system: Analytical treatment and analysis.
Voltage Stability Indices: Voltage collapse proximity indicator; Determinant of Jacobin as proximity indicators; Voltage stability margin.

Unit–IV:
Power System Loads: Loads that influences voltage stability: Discharge lights, Induction Motor, Air-conditioning, heat pumps, electronic power supplies, OH lines, and cables.
Reactive Power Compensation: Generation and Absorption of reactive power; Series and Shunt compensation; Synchronous condensers, SVC s; OLTC s; Booster Transformers.

Unit–V:
Voltage Stability Margin: Stability Margin: Compensated and un-compensated systems.
Voltage Security: Definition; Voltage security; Methods to improve voltage stability and its practical aspects.

TEXT BOOKS:

1. "Performance, operation and control of EHV power transmission system"- A. Chakrabarthy, D. P. Kotari and A. K. Mukopadyay, A.H. Wheeler Publishing, I Edition, 1995.
2. "Power System Dynamics: Stability and Control" – K. R. Padiyar, II Edition, B.S. Publications.

REFERENCE:

1. "Power System Voltage Stability"- C.W. Taylor, McGraw Hill, 1994.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. TECH – I YEAR – I SEM. (PS H.V. Engg. / H.V. Engg.)

ADVANCED POWER SYSTEM PROTECTION
(Professional Elective – II)

Prerequisite: Switch Gear and Protection

Course objectives:

- To know construction of static relays
- To understand the operation of amplitude and phase comparators
- To comprehend the concepts of Static over current, static differential and static distance relays.
- To understand multi-input comparators and concept of power swings on the distance relays.
- To know the operation of microprocessor based protective relays.

Course outcomes: After the completion of this course, student will be able to

- Describe the construction of static relay and identify the advantages of static relay over electromagnetic relay.
- Explore the operation of rectifier bridge comparators, instantaneous comparators, phase comparators, multi input comparators, static differential and distance relays
- Describe instantaneous, definite time and inverse definite minimum time over current relays.
- Analyze the concept of power swings on distance relays and to identify the microprocessor based protective relays and their operation

UNIT-I:

Static Relays: Advantages of static relays - Basic construction of static relays - Level detectors - Replica impedance – Mixing circuits - General equation for two input phase and amplitude comparators -Duality between amplitude and phase comparators.

Amplitude Comparators: Circulating current type and opposed voltage type - rectifier bridge comparators, Direct and Instantaneous comparators.

UNIT-II:

Phase Comparators: Coincidence circuit type - block spike phase comparator, techniques to measure the period of coincidence - Integrating type - Rectifier and Vector product type - Phase comparators.

Static Over Current Relays: Instantaneous over-current relay - Time over-current relays-basic principles – definite time and Inverse definite time over-current relays.

UNIT-III:

Static Differential Relays: Analysis of Static Differential Relays – Static Relay schemes – Duo bias transformer differential protection – Harmonic restraint relay.

Static Distance Relays: Static impedance-reactance – MHO and angle impedance relay-sampling comparator – realization of reactance and MHO relay using sampling comparator.

UNIT-IV:

Multi-Input Comparators: Conic section characteristics -Three input amplitude comparator – comparator-switched distance schemes – Poly phase distance schemes - phase fault scheme – three phase scheme – combined and ground fault scheme.

Power Swings: Effect of power swings on the performance of distance relays – Power swing analysis - Principle of out of step tripping and blocking relays - effect of line and length and source impedance on distance relays.

UNIT-V:

Microprocessor Based Protective Relays: (Block diagram and flowchart approach only) - Over current relays – impedance relays - directional relay - reactance relay - Generalized mathematical expressions for distance relays -measurement of resistance and reactance – MHO and offset MHO relays - Realization of MHO characteristics - Realization of offset MHO characteristics - Basic principle of Digital computer relaying.

TEXT BOOK:

1. Badri Ram and D. N. Vishwakarma, “Power system protection and Switch gear “, TMH publication New Delhi 1995.

REFERENCES:

1. T.S. Madhav aRao , “Static relays”, TMH publication, second edition, 1989.
2. Protection and Switchgear, Bhavesh Bhalja, R. P. Maheshwari, Nilesh G. Chothani, Oxford University Press.
3. Electrical Power System Protection, C. Christopoulos and A. Wright, Springer International.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (PS H.V. Engg. / H.V. Engg.)

REACTIVE POWER COMPENSATION AND MANAGEMENT
(Professional Elective – II)

Prerequisite: Power Systems & Power System Operation and Control
Course objectives:

- To understand the fundamental concepts of compensation
- To impart knowledge on reactive power planning and coordination
- To comprehend the concepts of Demand side management.
- To interpret the reactive power compensation in arc furnaces.

Course outcomes: After the completion of this course, students will be able to

- Analyze the load compensation in transmission systems
- Develop the reactive power planning and coordination
- Apply the demand side management techniques

UNIT-I:
Load Compensation: Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads - examples.

UNIT-II:
Steady – State Reactive Power Compensation In Transmission System: Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples
Transient state reactive power compensation in transmission systems: Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation – compensation using synchronous condensers – examples.

UNIT-III:
Reactive Power Coordination: Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances - steady – state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences.

UNIT-IV:
Demand Side Management: Load patterns – basic methods load shaping – power tariffs - KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels.
Distribution side Reactive power Management::System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks.

UNIT-V:
User Side Reactive Power Management: KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations.
Reactive power management in electric traction systems and are furnaces: Typical layout of traction systems – reactive power control requirements – distribution transformers - Electric arc furnaces – basic operations - furnaces transformer – filter requirements – remedial measures – power factor of an arc furnace.

Reference Books:

1. Reactive power control in Electric power systems by T.J. E. Miller, John Wiley and sons, 1982 (Units I to IV)
2. Reactive power Management by D. M. Tagare, Tata McGraw Hill, 2004.(Units V to VIII)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (PS H.V. Engg. / H.V. Engg.)

BREAKDOWN PHENOMENON IN INSULATION
(Professional Elective – II)

Prerequisite: Electromagnetic Fields

Course Objectives:

- To know the phenomena of electric fields and field stress control around high voltage systems
- To understand the mechanism involved in non-destructive insulation and testing as well as over voltages in power systems.

Course Outcomes: After the completion of this course, the student will be able to

- select insulation materials in practice with the knowledge of requirements and compromises
- know different mechanisms that may lead to dielectric breakdown
- compute estimates of the electrical breakdown voltage from given models
- identify the fundamental physical mechanism behind given relaxation/permittivity curves

UNIT-I:
Introduction: Electric stress and Electric strength, Breakdown mechanisms, Estimation and control of electric stress, Field sketching, high voltage measurements.

UNIT-II:
Mechanisms Of Spark Breakdown In Gases: Basic process in gas breakdown-Primary process - secondary process, Mechanisms of breakdown - Townsend Mechanism, breakdown in electronegative gases, Time lags of spark breakdown,
Breakdown Characteristics In Gases: Phenomenon in uniform fields, Phenomenon in non uniform fields, Surface flashover, dielectric recovery.

UNIT-III:
Electrical Properties of High Vacuum: Pre-breakdown conduction, Factors affecting the breakdown voltage, Breakdown hypotheses, Vacuum breakdown criterion, Flashover across solid insulators.
The Electrical Conduction and Strength of Pure Liquids: pure liquids, purification, test cells, natural conduction, induced conduction, process of conduction, breakdown phenomenon and electric strength of liquids, breakdown process.

UNIT-IV:
Breakdown of Commercial Liquid and Liquid-Solid Dielectrics: breakdown due to gaseous inclusions, breakdown due to liquid globules, breakdown due to solid particles, deterioration due to internal discharges, electrochemical deterioration.
Intrinsic and Related Forms of Breakdown in Solids: definition of intrinsic strength, theories of intrinsic strength, its measurements, comparison of theory with experiment, current problems in measurement of intrinsic strength.

UNIT-V:
Thermal Breakdown Chemical and Electro Chemical Deterioration: thermal breakdown, chemical deterioration-oxidation, chemical stability, hydrolysis, leaching of chemically active substances, incompatibility of materials, electrochemical deterioration-nature, electrochemical effects in insulation with and without moisture.

TEXT BOOKS:

1. “High Voltage Engineering”, by M. S. Naidu, V. Kamaraju, Tata McGraw Hill Education, 2009.
2. “High Voltage Engineering”, by Farouk A.M. Rizk, Giao N. Trinh CRC Press Taylors, and Francis group.
3. “High Voltage and Electrical Insulation Engineering”, by Ravindra Arora and Wolfgang Mosch John Wiley & Sons, Inc.

REFERENCES:

1. “High Voltage Engineering Fundamentals”, by John Kuffel, Peter Kuffel second edition Newness, 2000.
2. “An introduction to high voltage engineering”, by Subir Ray, second edition PHI learning Pvt. Ltd., 2013.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (PS H.V. Engg. / H.V. Engg.)

HIGH VOLTAGE LAB

List of Experiments

1. Determination of Breakdown strength of oil by Variable Distance Electrodes.
2. Milli Volt Drop Test (Calibration of Tong-tester).
3. Breakdown characteristics of Sphere air gap.
4. Breakdown characteristics of Plane Rod gap.
5. Breakdown Voltage of pin Insulator & Measurement of Leakage Current.
6. Measurement of Leakage current & Breakdown voltage of Suspension Insulators.
7. Voltage Distribution of String Insulators.
8. Measurement of Leakage current & Insulation resistance of Poly propylene Rope.
9. Measurement of Leakage current & Insulation resistance of Poly propylene Scale.
10. Fault analysis of 3-phase Alternator.