Syllabus for the Academic Year – 2020 - 2021

Department: Electrical & Electronics Engineering

Semester: VII

Subject Name: COMPUTER TECHNIQUES IN POWER SYSTEM ANALYSIS

Subject Code: EE7T01 **L-T-P-C: 4-0-0-4**

Course Objectives:

1. To provide solid foundation in formation of Network matrices
2. To perform & study Load flow Analysis
3. To perform Economic Load dispatch
4. To perform Transient Stability studies

I	**Network Topology**: Introduction, Elementary graph theory – oriented graph, tree, co-tree, basic cut-sets, basic loops; Incidence matrices – Element-node, Bus incidence, Tree-branch path, Basic cut-set, Augmented cut-set, Basic loop and Augmented loop; Primitive network – impedance form and admittance form.	**10**
II	**Network Matrices:** Introduction, Formation of YBUS – by method of inspection (including transformer off-nominal tap setting), by method of singular transformation (YBUS = ATyA); Formation of Bus Impedance Matrix by step by step building algorithm (without mutual coupling elements).	**10**
III	**Load Flow Studies:** Introduction, Power flow equations, Classification of buses, Operating constraints, Data for load flow; Gauss-Seidal Method – Algorithm and flow chart for PQ and PV buses (numerical problem for one iteration only), Acceleration of convergence; Newton Raphson Method – Algorithm and flow chart for NR method in polar coordinates (numerical problem for one iteration only); Algorithm for Fast Decoupled load flow method; Comparison of Load Flow Methods.	**11**
IV	**Economic Operation of Power System:** Introduction, Performance curves, Economic generation scheduling neglecting losses and generator limits, Economic generation scheduling including generator limits and neglecting losses; Iterative techniques; Economic Dispatch including transmission losses – approximate penalty factor, iterative technique for solution of economic dispatch with losses; Derivation of transmission loss formula; Optimal scheduling for Hydrothermal plants – problem formulation, solution procedure and algorithm.	**11**

V	**Transient Stability Studies:** Numerical solution of Swing Equation – Point-by-point method, Modified Euler's method, Range-Kutta method, Milne's predictor corrector method. Representation of power system for transient stability studies – load representation, network performance equations. Solution techniques with flow charts.	**10**

Course Outcomes:

After completion of course, student will be able to:

1. Formulate the different incidence matrices for a given power system network
2. Formulate network matrices by different methods
3. Perform load flow analysis for a given power system network
4. Perform Economic generation scheduling, analysis of Transient Stability studies of given system

Text Books:

1. Computer Methods in Power System Analysis, Stag, G. W., and EI-Abiad, A. H International Student Edition. 1968.
2. Computer Techniques in Power System Analysis, Pai, M. A, 2nd edition, 2006.

Reference Books:

1. Modern Power System Analysis, Nagrath I J and Kothari D. P, 2003
2. Advanced Power System Analysis and Dynamics, Singh L P, 2001
3. Computer Aided Power System Operations and Analysis, Dhar R N, 1984.
4. Power System Analysis, Haadi Sadat, 2nd , 12th reprint, 2007

Syllabus for the Academic Year – 2020 - 2021

Department: Electrical & Electronics Engineering

Semester: VII

Subject Name: ELECTRICAL POWER UTILIZATION AND DRIVES

Subject Code: EE7T02 **L-T-P-C: 3-0-1-4**

Course Objectives:

1. To explain the concept of heating & welding methodologies
2. To provide the concept of Illumination methods
3. To train the students on traction system
4. To educate the students on drives

UNIT	Description	Hours
I	**HEATING AND WELDING:** Advantages and methods electric heating, resistance ovens, induction heating, dielectric heating, the arc furnace, heating of buildings, electric welding, resistance and arc welding, control device and welding equipment.	**08**
II	**ILLUMINATION:** Laws of illumination, lighting calculation, factory lighting, flood lighting, street lighting, different types of lamps, incandescent, fluorescent, Sodium vapor lamp and CFL and their working, Glare and its remedy.	**08**
III	**ELECTRIC TRACTION:** System of traction, speed time curve, tractive effort, co-efficient of adhesion, selection of traction motors, methods of speed control, energy saving by series parallel control, ac traction equipment. AC series motor, characteristics, regenerative braking, linear induction motor and their use. Diesel electric equipment, train lighting system, specific energy, factors affecting specific energy consumption.	**08**
IV	**AN INTRODUCTION TO ELECTRICAL DRIVES & ITS DYNAMICS**: Electrical drives. Advantages of electrical drives. Parts of electrical drives, choice of electrical drives, status of dc and ac drives, Dynamics of electrical drives, Fundamental torque equation, speed torque conventions and multiquadrant operation. Equivalent values of drive parameters, components of load torques, nature and classification of load torques, calculation of time and energy loss in transient operations, steady state stability, load equalization. **SELECTION OF MOTOR POWER RATING:** Thermal model of motor	**08**

	for heating and cooling, Classes of motor duty, determination of motor rating.	
V	**INDUCTION MOTOR DRIVES: (a)** Operation with unbalanced source voltage and single phasing, operation with unbalanced rotor impedances, analysis of induction motor fed from non-sinusoidal voltage supply, starting braking, transient analysis. **(b)** Stator voltage control variable voltage frequency control from voltage sources , voltage source inverter control, closed loop control, current source inverter control, current regulated voltage source inverter control, rotor resistance control, slip power recovery, speed control of single phase induction motors.	**08**

Course Outcomes:

After completion of course, student will be able to:

1. Knowledge about Heating and Welding systems.
2. Design of illumination systems for various applications.
3. Understand the Concept of Traction system.
4. Concept of conventional drives and electrical drives, Selection of suitable induction motor drive for particular applications.

Text Books:

1. Utilization Of Electric al Power, J B Guptha, 2nd Edition. 2009
2. Fundamentals of Electrical Drives, G.K Dubey, 2 nd Edition, 2002

Reference Books:

1. Utilization Of Electric al Power, R K Rajput, Second edition
2. Electrical Drives, N.K De and P.K. Sen, 2007

Syllabus for the Academic Year – 2020 - 2021

Department: Electrical & Electronics Engineering

Semester: VII

Subject Name: HIGH VOLTAGE ENGINEERING

Subject Code: EE7T03 **L-T-P-C: 4-0-0-4**

Course Objectives:

1. To appreciate the advantages of transmitting Electrical Power at High Voltages and Concept of breakdown mechanisms in solid, liquid and gaseous insulations.
2. To appraise the importance of equipments used to generate HVAC, HVDC and impulse voltages.
3. To provide knowledge about instruments in measuring HVAC, HVDC and impulse voltages.
4. To appreciate concept of non destructive testing techniques on Insulation and provide knowledge about tests on cables, insulators and transformers.

UNIT	Description	Hours
I	**INTRODUCTION:** Introduction to HV technology, advantages of transmitting electrical power at high voltages, need for generating high voltages in laboratory. Important applications of high voltage. B**REAKDOWN PHENOMENA:** Classification of HV insulating media. Properties of important HV insulating media under each category. Gaseous dielectrics: Ionizations: primary and secondary ionization processes, Criteria for gaseous insulation breakdown based on Townsend's theory, Limitations of Townsend's theory. Streamer's theory, breakdown in non uniform fields. Corona discharges. Breakdown in electro negative gasses. Paschen's law and its significance. Time lags for Breakdown. Breakdown in solid dielectrics: Intrinsic Breakdown, avalanche breakdown, thermal breakdown, and electro mechanical breakdown. Breakdown of liquid dielectric dielectrics: Suspended particle theory, electronic Breakdown, cavity breakdown (bubble's theory), electro convection breakdown.	**14**
II	**GENERATION OF HV AC AND DC VOLTAGE:** HV AC transformer; Need for cascade connection and working of transformers units connected in cascade. Series resonant circuit- principle of operation and advantages. Tesla coil. HV DC- voltage doubler circuit, Cock croft- Walton type high voltage DC set. Calculation of high voltage regulation, ripple and optimum number of stages for minimum voltage drop	**10**

III	**GENERATION OF IMPULSE VOLTAGE AND CURRENT:** Introduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator-expression for Output impulse voltage. Multistage impulse generator, working of Marx Circuit. Rating of impulse generator. Components of multistage impulse generator. Triggering of impulse generator by three electrode gap arrangement. Trigatron gap and oscillograph time sweep circuits. Generation of switching impulse voltage, Generation of high impulse current.	**10**
IV	**MEASUREMENT OF HIGH VOLTAGES:** Electrostatic voltmeter-principle, construction and limitation. Chubb and Fortescue method for HV AC measurement. Generating voltmeter- Principle, construction. Series resistance micro ammeter for HV DC measurements. Standard sphere gap measurements of HV AC, HV DC, and impulse voltages; Factors affecting the measurements. Potential dividers-resistance dividers, capacitance dividers, mixed RC potential dividers. Surge current measurement-Klydanograph and magnetic links.	**10**
V	**NON-DESTRUCTIVE INSULATION TESTING TECHNIQUES:** Dielectric loss and loss angle measurements using Schering Bridge, Transformer ratio Arms Bridge. Need for discharge detection and PD measurements aspects. Factor affecting the discharge detection. Discharge detection methods - straight and balanced methods. **HIGH VOLTAGE TESTS ON ELECTRICAL APPARATUS:** Definitions of terminologies, tests on isolators, circuit breakers, cables insulators and transformers.	**08**

Course Outcomes:

After completion of course, student will be able to:

1. Appreciate the advantages of transmitting Electrical Power at High Voltages and Concept of breakdown mechanisms in solid, liquid and gaseous insulations.
2. Appraise the importance of equipments used to generate HVAC, HVDC and impulse voltages.
3. Knowledge about instruments in measuring HVAC, HVDC and impulse voltages.
4. Concept of non destructive testing techniques on Insulation and knowledge about tests on cables, insulators and transformers.

Text Books:

1. High Voltage Engineering Fundamentals, E. Kuffel and W.S. Zaengl, 2nd edition, 2005.
2. High Voltage Engineering, M.S.Naidu and Kamaraju, 3rd edition, 2007.
3. High Voltage Engineering, C.L.Wadhwa, 1995

Reference Books:

1. Extra High Voltage AC Transmission Engineering, Rakosh Das Begamudre, 1987
2. High Voltage Technology, L. L. Alston, 2007

Syllabus for the Academic Year – 2020 - 2021

Department: Electrical & Electronics Engineering

Semester: VII

Subject Name: TESTING & COMMISSIONING OF ELECTRICAL EQUIPMENTS

Subject Code: EE7PE411 **L-T-P-C: 3-0-0-3**

Course Objectives:

1. To Provide The basic knowledge about the specifications, tests conducted before and after commissioning of transformers, induction motors
2. To study the maintenance schedule and protections schemes for electrical equipments like Transformers, Induction motors, Synchronous machine and Switch gears.
3. To identify requirement for civil and electrical work before commissioning of electrical equipments.
4. To study the concept of maintenance schedule for various electrical equipments after installation.

UNIT	Description	Hours
I	**TRANSFORMERS:** **a. Specification:** **b. Installation:** Location & sites, selection & design of foundation details (like bolts size, their number, etc,) code of practice for terminal plates, polarity & phase sequence, oil tanks, drying of windings with & without oil, general inspection. **c. Commissioning Tests:** Following tests as per national & International standards, volt ratio test, earth resistance oil strength, Buchholz & other relays, tap changing gear, fans & pumps, insulation test, impulse test, polarizing index, load & temperature raise test. **d. Specific Tests:** Determination of performance curves like efficiency, regulation etc, determination of mechanical stress under normal & abnormal conditions. **Maintenance schedule:**	08
II	**INDUCTION MOTORS:** **a.** Specifications for different types of motors, Duty, el L.P.protection. **b.** Installation: Location of the motors (Including the foundation details) & its control apparatus, shift & alignment for various coupling, fitting of pulleys & couplings, drying of balancing.	08
III	**a. Commissioning Tests on Induction Motor:** Mechanical tests for alignment, air gap symmetry, tests for bearings, vibrations & balancing. **b. Electrical Tests:** Insulation test, earth resistance, high voltage test,	08

	starting up failure to speed up to take the load type of test, routine test, factory test & site tests (in accordance with ISI code) **c. Specific Tests:** Performance & temperature raise tests, stray load losses, shaft elements, re-rating & special duty capability. **Maintenance Schedule**	
IV	**SYNCHRONOUS MACHINES** **a. Specifications:** **b. Installation:** Physical inspection, rating name plate details, foundation details, alignments, excitation systems, cooling & control gear, drying out. **c. Commissioning Tests:** Insulation, resistance measurement of armature & field windings, wave form & telephone interference factors, line charging capacity. **d. Performance Tests:** Various tests to estimate the performance for generator and motor operations slip maximum lagging currents, maximum reluctance, power tests, sudden short circuit tests, transient & sub transient parameters, measurements of sequence impedances, capacitive reactance, separation of losses, temperature raise tests, retardation tests. **e. Factory Tests:** Gap length, magnetic centrity, balancing vibration, bearing performance.	08
V	**SWITHGEAR & PROTECTION DEVICES:** Standards, types, specification, installation, commissioning tests, maintenance schedule, type & routine tests.	07

Course Outcomes:

After completion of course, student will be able to:

1. Understand different international standards for manufacturing of transformers, induction motors, synchronous generators and switch gears.
2. Identify requirement for civil and electrical work before commissioning of electrical equipments.
3. Knowledge about different specifications and tests to be done on electrical equipments before and after commissioning.
4. Concept of maintenance schedule for various electrical equipments after installation.

Text Books:

1. Testing & Commissioning of electrical equipment, S. Rao, 6th edition, 2010
2. Testing & Commission of electrical equipment, B.V.S. Rao, Volume 1, 1963

Reference Books:

1. Relevant Bureau of Indian Standards.
2. Transformers-BHEL.
3. J&P transformer handbook.Martin J, 13th edition, 2010
4. J&P Switch Gear handbook.Butterworth-Heinemann, April 2009

Syllabus for the Academic Year – 2020 - 2021

Department: Electrical & Electronics Engineering

Semester: VII

Subject Name: OVER VOLTAGES IN POWER SYSTEM

Subject Code: EE7PE412 **L-T-P-C: 3-0-0-3**

Course Objectives:

1. To provide students with a solid foundation in over voltages phenomena ,
2. To study the analysis for different line termination for resistance, inductance and capacitance
3. To study the Behavior of equipments, line insulation and surge arrestors.
4. To study the performance & characteristics of grounding rods, counter poise, origin and characteristics of switching over voltages and temporary over voltages.

UNIT	Description	Hours
I	**Introduction to over voltages phenomenon in power system:** Transient on transmission lines: infinite line definition and its transient behavior	**08**
II	**Finite line analyses:** Analysis for different line terminations & problems, Bewely lattice diagram & problems.	**08**
III	**Use of transients network analyzer**: Digital and hybrid computers for solving large scale problems, characteristics of lightning discharges, theory of cloud formation origin of lightning, iso-Keronic level, leader development, return stroke, different types of lightning interaction & back flash over	**08**
IV	**Shielding angle calculation for line**: Grounding rods, counter poise, problems, origin and characteristics of switching over voltages and temporary over voltages & problems on switching surges.	**08**
V	Behavior of apparatus and line insulation under all types of over voltages, concept of BIL, protection of apparatus against over voltages, surge arresters & insulation Co-ordination	**08**

Course Outcomes:

After completion of course, student will be able to:

1. Knowledge about origin, classification and characteristics of over voltages
2. Analysis for different line terminations of over voltages.
3. Use of transient network analyzer, Behavior of equipments, line insulation and surge arrestors.
4. Grounding rods, counter poise, origin and characteristics of switching over voltages and temporary over voltages

Text Books:

1. High Voltage Engineering, R. S. Jha

Reference Books:

1. Extra High Voltage,AC Transmission Engineering, Rakosh Das Begamudre 1987
2. High Voltage Engineering Fundamentals, E.Kuffel and W.S.Zaengal and J. Kuffel 2nd Edition, 2005.
3. High Voltage Engineering, M.S.Naidu and V. Kamaraju 3rd Edition, 2007
4. Power System Transients Greenwood 1987
5. High Voltage Engineering C.L. Wadhwa,

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Syllabus for the Academic Year – 2020 - 2021

Department: Electrical & Electronics Engineering

Semester: VII

Subject Name: OBJECT ORIENTED PROGRAMMING WITH C++

Subject Code: EE7PE413 **L-T-P-C: 3-0-0-3**

Course Objectives :

1. To introduce Object Oriented Programming concept with overview of C++.
2. To Able to understand C++ concepts.
3. To Illustrate operators in C++ and demonstrate conditional branching statements.
4. To Comparison of structures and classes in C++

UNIT	Description	Hours
I	**Introduction:** Getting started with C++, Data types, Variable declaration, Operators, Miscellaneous topics, Keyboard input and Screen output.	**08**
II	**Control Statements and loops** Relational and Logical operators, if, if-else, switch statements, loops in general for, while and do while, Pointers, Addresses and Indirection operator: Importance of Pointers, data variable and memory, address operators, pointers.	**08**
III	**Functions Basics** Functions in C++, Basic format, requirement of writing functions, local, static and global variables, pointers and functions, Arrays: Using single data variables, array fundamentals, one-dimensional arrays and functions, Character strings.	**08**
IV	**User Defined Data Types** Customized data types, data structures, accessing structure elements, structure arrays, structure within structures, structures and functions, structure arrays and functions.	**08**
V	**Classes and Objects** Object Oriented principle and definitions, Classes and Objects, Writing Member function, class constructors and destructors, Inheritance and Virtual functions, Importance of inheritance and basics, Overload operators, Operators ++ and --, Operators new and delete, Multiple Inheritance, Public, private and protected inheritance.	**08**

Course Outcomes:

After completion of course, student will be able to:

1. Able to understand C++ concepts.
2. Illustrate operators in C++ and demonstrate conditional branching statements.
3. Knowledge about function and arrays.
4. Comparison of structures and classes in C++
5. Ability to understand the Object Oriented Concepts with C++.

Text Books:

1. Programming With C++, Barbara Johnston Low Price Edition, Pearson Education.

Reference Books:

1. Object Oriented Programming with C++, E. Balagurusamy, 4th edition, TMH Co. Ltd.
2. C++ Primer, S. B. Lippman and J. Lajole, Addison Wesley, 3rd edition
3. An introduction to Programming and Object Oriented Design, Cohoon and Davidson 3rd edition, TMH Publication

Syllabus for the Academic Year – 2020 - 2021

Department: Electrical & Electronics Engineering

Semester: VII

Subject Name: RELIABILITY ENGINEERING

Subject Code: EE7PE414 **L-T-P-C: 3-0-0-3**

Course Objectives :

1. To understand the concepts of reliability, Hazard models, component with preventive maintenance.
2. To analyze system reliability.
3. To apply system reliability state space methods.
4. To understand failure tree analysis & the basic probability theory concepts applied to reliability of electrical power systems.

UNIT	Description	Hours
I	**INTRODUCTION:** Concept of reliability, reliability indices, component reliability –Introduction, non repairable component, hazard models, components with preventive maintenance, repairable components.	**08**
II	**SYSTEM RELIABILITY**: network methods, Introduction; series configuration parallel configuration, mixed configuration, the r out of n configuration d composition method minimal-tie and minimal –cut methods logic diagrams.	**08**
III	System reliability state space method system representation basic concepts state probability state frequency and duration system of two independent component two components with dependent failures combining states failure effect analysis state enumeration methods	**07**
IV	System reliability other methods dependent failure models for non repairable components fault tree analysis monte- carlo simulation.	**08**
V	Basic probability theory probability concepts permutation and combination practical engineering concepts Venn-diagram rules for combining probabilities, probability distribution random variables density and distribution System reliability evaluation using probability distribution series system parallel system partially redundant system mean time to failure stand by system	**08**

Course Outcomes:

After completion of course, student will be able to:

1. Understand the concepts of reliability, Hazard models, component with preventive maintenance.
2. Analyze system reliability.
3. Apply system reliability state space methods.
4. Understand failure tree analysis
5. Understand the basic probability theory concepts applied to reliability of electrical power systems.

Text Book:

Concepts in Reliability Engineering, L S Srinath, 2nd edition

Reference Books:

1. Reliability modeling in electrical power system, J. Endrenyi
2. Reliability Evaluation of Engineering Systems, Roy Billintan & Ronald. N. Allar, 2nd Edition 1992
3. Reliability assessment of large electric power systems, Roy Billington Kluwer 1988
4. Evaluation of engineering systems; concepts R. Billington and A.N. Allen and techniques 1983
5. Monte Carlo Methods, Inc., Hammersley J.M., Handscomb D.C. 1964

Syllabus for the Academic Year – 2020 - 2021

Department: Electrical & Electronics Engineering

Semester: VII

Subject Name: REACTIVE POWER MANAGEMENT

Subject Code: EE7PE511 **L-T-P-C: 3-0-0-3**

Course Objectives:

1. To distinguish the importance of load compensation in symmetrical as well as unsymmetrical loads
2. To observe various compensation methods in transmission lines, Knowledge to solve various real life power system problems concerning reactive power compensation
3. Ability to extend the system compensation with the use of stator VAR compensator, thyristors and other power electronic configurations.
4. To distinguish demand side reactive power management & user side reactive power management

UNIT	Description	Hours
I	Introduction, Importance of reactive power control in EPS, Reactive power devices. Theory of Load Compensation : Introduction- Requirement for compensation, Objectives in load compensation, Specifications of a load compensator , Power factor correction and voltage regulations in single phase system, Phase balancing and p. f. correction of unsymmetrical loads, Compensation in term of symmetrical components.	**08**
II	Reactive Power Control: Fundamental requirement in AC Power transmission, Fundamental transmission line equation, Surge impedance and natural loading, Voltage and current profiles of uncompensated radial and symmetrical line on open circuit, Uncompensated line under load, Effect of line length, Load power and p. f on voltage and reactive power.	**08**
III	Passive and active compensators Uniformly distributed fixed compensation, Passive shunt compensation, Control of open circuit voltage by shunt reactance, Reactance of shunt reactors, multiple shunt reactors along the line.	**08**
IV	Series compensation: Objectives and practical limitation , Symmetrical line with mid-point series capacitor and shunt reactor, Power transfer characteristics and maximum transmissible power for a general case, Fundamental concepts of compensation by sectioning. Principles of Static Compensation: Principle of operation of thyristor controlled reactor, Thyristors switched capacitor. Series Capacitors:	**08**

	Introduction, protective gear, reinsertion schemes, Varistor protective gear.	
V	Synchronous Condenser: Introduction, Power system Voltage control, Emergency reactive power supply, Starting methods, starting motor, reduced voltage starting, static starting. Harmonics effects, resonance, shunt capacitors and filters, telephone interferences, Reactive Power Co-ordination, Reactive power management, transmission benefits, reactive power dispatch & equipment impact.	**08**

Course Outcomes:

After completion of course, student will be able to:

1. Distinguish the importance of load compensation in symmetrical as well as unsymmetrical loads
2. Observe various compensation methods in transmission lines
3. Ability to extend the system compensation with the use of stator VAR compensator, thyristors and other power electronic configurations.
4. Knowledge to solve various real life power system problems concerning reactive power compensation
5. Distinguish demand side reactive power management & user side reactive power management

Text Book:

Reactive power control in electric power systems, T. J. E. Miller NY 1982

Reference Books:

1. Reactive Power Management D. Tagare
2. Power System Stability and Control, Chapter-11, P. Kundur
3. Voltage Stability C. W. Taylor,
4. Reactive power compensation: A practical guide Wolfgang Hofmann, Wolfgang Stolzel,Jurjen April 2007, Hardcover

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Department: Electrical & Electronics Engineering

Semester: VII

Subject Name: PROGRAMMABLE LOGIC CONTROLLER & SCADA

Subject Code: EE7PE512 **L-T-P-C: 3-0-0-3**

Course Objectives :

1. To analyze PLC system, standards and I/O devices
2. To understand PLC applications and data processing
3. To knowledge of ladder programming, sequential function chart, structured text
4. To apply the concept of timer, counter for ladder programming and SCADA.

UNIT	Description	Hours
I	**INTRODUTION:** Introduction to Programmable logic controller (PLC), role in automation (SCADA), advantages and disadvantages, hardware, internal architecture, sourcing and sinking, characteristics of I/O devices, list of input and output devices, examples of applications. I/O processing, input/output units, signal conditioning, remote connections, networks, processing inputs I/O addresses.	**08**
II	**PROGRAMMING:** Ladder programming- ladder diagrams, logic functions, latching, multiple outputs, entering programs, functional blocks, programme examples like location of stop and emergency switches	**08**
III	**PROGRAMMING LANGUAGES:** Instruction list, sequential functions charts & structured text, jump and call subroutines**.** **INTERNAL RELAYS:** ladder programmes, battery- backed relays, one - shot operation, set and reset, master control relay.	**08**
IV	**Timers and counters**: Types of timers, programming timers, ON and OFF-delay timers, pulse timers, forms of counter, programming, up and down counting, timers with counters, sequencer.	**08**
V	**SCADA:** Introduction, definition and history of supervisory control and data acquisition, typical SCADA system, architecture, communication requirements, desirable properties of SCADA system, features, advantages, disadvantages and applications of SCADA. SCADA architecture (first generation-monolithic, second generation-distributed, third generation-networked architecture).	**08**

Course Outcomes:

After completion of course, student will be able to:

1. Analyze PLC system, standards and I/O devices
2. Understand PLC applications and data processing
3. Knowledge of ladder programming, sequential function chart, structured text
4. Apply the concept of timer, counter for ladder programming and SCADA.

Text Books:

1. Programmable Logic controllers" W Bolton 2006.
2. Securing SCADA System ,Ronald L Krutz

Reference Books:

1. Programmable logic controllers - principles and applications, John W Webb, Ronald A Reis 2007
2. Programmable Controller Theory and Applications, L. A Bryan, E. A Bryan, 1997
3. Programmable Controllers – An Engineers Guide, E. A Paar, 2003
4. SCADA Supervisory Control and Data Acquisition, Stuart A Boyer, ISA

Syllabus for the Academic Year – 2020 - 2021

Department: Electrical & Electronics Engineering

Semester: VII

Subject Name: INSULATION ENGINEERING

Subject Code: EE7PE513 **L-T-P--C: 3-0-0-3**

Course Objectives:

1. To provide strong foundation in insulation of power system apparatus
2. To study the properties of insulation materials.
3. Able to understand the breakdown process in gaseous insulation.
4. Able to analyze the ageing phenomena of electrical insulation

UNIT	Description	Hours
I	**ELECTROSTATIC FIELD, THEIR CONTROL AND ESTIMATIONS**: Electric Field Intensity, Electric Strength, Classification of Electric Fields, Degree of Uniformity of Electric Fields, control of Electric field Intensity (stress control), Estimation of Electric Field Intensity, Basic Equations for potential and Field Intensity in Electrostatic Fields, Analysis of Electric Field Intensity in Homogeneous Isotropic single dielectric only direct solution of Laplace equation, Analysis of Electric field Intensity in Isotropic Multidielectric system.	**10**
II	**INSULATION SYSTEM IN POWER SYSTEM APPARATUS**: Insulation system in capacitors, bushings, And transformers modes of failure of insulation systems. Insulation in rotating machines **DIELECTRIC PHENOMENA**: Dielectric phenomena in in solid insulation. Macroscopic approach for describing the Dielectric phenomena microscopic treatment for Dielectric phenomena	**08**
III	**PROPERTIES OF INSULATION MATERIALS:** Introduction to properties of solid insulating materials (both of natural origin and synthetic types) Properties of liquid insulating materials,	**07**
IV	**GASEOUS INSULATION:** Requirement of gaseous insulation. Breakdown process: types of collision, Elastic and inelastic, collision cross-section, Mobility of ions, Diffusion of charges, Emission of radiation and excitation, various secondary process and recombination, Mobility controlled and diffusion controlled breakdown.	**07**
V	**AGEING PHENOMENA:** Failure of electric insulation due to ageing. Ageing mechanisms- Thermal ageing, Electrical ageing, combined thermal and electrical ageing. Analysis of insulation failure date Power law model, Graphical estimation of	**08**

	power law constants, ageing date, plotting position and cumulative probability.	

Course Outcomes:

After completion of course, student will be able to:

1. Able to understand the electric field, control and estimation.
2. Able to understand the dielectric phenomena in solid insulation.
3. To study the properties of insulation materials.
4. Able to understand the breakdown process in gaseous insulation.
5. Able to analyze the ageing phenomena of electrical insulation

Text Books:

1. Fundamentals of gaseous ionization and plasma electronics, Nasser E. 1971
2. Methods of statistical analysis and life data, Hann N.R. Schafer R.E. and Singapore wall N.D 1974

Reference Books:

1. Electrical insulation, Bradwell A. 1993
2. Electrical breakdown of gases, J.M. Meek and J.D. Craggs 1953
3. High voltage Engineering fundamentals, E. Kufell and W.S. Zaengl, and J. Kufell 2005

Syllabus for the Academic Year – 2020 - 2021

Department: Electrical & Electronics Engineering

Semester: VII

Subject Name: HIGH VOLTAGE POWER TRANSFORMERS

Subject Code: EE7PE514 **L-T-P-C: 3-0-0-3**

Course Objectives:

1. To provide students with solid foundation in breakdown mechanism of different dielectrics, generation, measurement of high voltages and tests conducted on different high voltage equipments.
2. To appreciate the advantages of transmitting Electrical Power at High Voltages and Concept of breakdown mechanisms in solid, liquid and gaseous insulations.
3. To appraise the importance of equipments used to generate HVAC, HVDC and impulse voltages.
4. Knowledge about instruments in measuring HVAC, HVDC and impulse voltages.

UNIT	Description	Hours
I	**Power transformer:** Equivalent Circuit, Limitations And Validity of Equivalent Circuit, Separation Of Leakage Reactance.	**4**
II	**Magnetic leakage and reactance calculation:** Inductance Evaluation In Two-Winding And Three-Winding Transformers; Interleaved Coils, Arbitrary Mmf Distribution, Scott Connection, Zig-Zag Coils And Coils Of Unequal Height Cases.	**8**
III	**Electromagnetic forces on short circuit:** Philosophy; Evaluation Of Radial And Tensile Forces; Hoop Tension And Copper Loss; Axial Force Calculation, Volts Per Turn And Concept Of At Thinning. **Magnetizing current inrush phenomena:** Estimation of Magnitude of Inrush Current and its Maximum Value. Inrush Current in 3-Phase Transformers; Eddy Current Loss in Conductors Placed in Alternating Magnetic Field; Its Evaluation and Minimization in Transformer.	**9**
IV	**On-load tap changing (OLTC)** In A Transformer; Reactor Type Buffer Reactor Symmetrical And Asymmetrical Types; Oltc With Single Untapped Reactor; Resistor Type of Oltc; Comparison of Reactor And Resistor Cycles. **Surge phenomena in transformers**: Equivalent circuit Initial voltage distribution with grounded and insulated neutral; Voltage gradient Line end stress; Effective capacitance evaluation.	**8**

V	**Traveling wave theory:** Role of inductance; Frequency behavior of velocity of propagation Equivalent circuits Fourier spectrum of unit step wave. **Standing wave theory** For Earthed Neutral And Insulated Neutral Cases; Insulation Requirement Of Transformers Against Surges Principle of Fully Shielded Transformers and Interleaved Disc Coils.	**11**

Course Outcomes:

After completion of course, student will be able to:

1. Appreciate the advantages of transmitting Electrical Power at High Voltages and Concept of breakdown mechanisms in solid, liquid and gaseous insulations.
2. Appraise the importance of equipments used to generate HVAC, HVDC and impulse voltages.
3. Knowledge about instruments in measuring HVAC, HVDC and impulse voltages.
4. Concept of non destructive testing techniques on Insulation.
5. Knowledge about tests on cables, insulators and transformers.

Text Book:

Principles, Operation and Design of Power Transformers, S. B. Vasutinsky 1962

Reference Books:

1. Transformers Engineering, L.F. Blume, A. Boyajian, G. Camilli, T.C. Lennox, S. Minneci and V.M. Montsinger, 1951
2. Transformers BHEL (Bhopal) 1990

Syllabus for the Academic Year – 2020 - 2021

Department: Electrical & Electronics Engineering

Semester: VII

Subject Name: RELAY AND HIGH VOLTAGE LAB

Subject Code: EE7L01 **L-T-P-C: 0-0-3-1.5**

Course Objectives:

1. To evaluate the flashover voltages for different electrode configuration using HVAC/HVDC.
2. To study the I-T characteristics of Static Relays.
3. To study the I-T characteristics of Numerical Relays.
4. To field map different electrode configurations.

UNIT	Description
I	I-T Characteristics of o Inverse over current relay.
II	IDMT Characteristics of Over / Under Voltage Relay.
III	Operating Characteristics of Over Voltage / Under Voltage Relay.
IV	Operation of Negative Sequence Relay.
V	Current-Time Characteristics of Fuse.
VI	Operating Characteristics of Microprocessor Based (Numeric) Over Current Relay.
VII	Operating Characteristics of Microprocessor Based (Numeric) Over/Under Voltage Relay.
VIII	Spark over Characteristics of Air Insulation Subjected to High Voltage AC with Spark Over Voltage Corrected to STP.
IX	Spark Over Characteristics of Air Insulation Subjected to High Voltage DC
X	Breakdown Strength of Transformer Oil Using Oil-Testing Unit.
XI	Field Mapping Using Electrolytic Tank for parallel and coaxial geometry.

Course Outcomes:

After completion of course, student will be able to:

1. Evaluation of flashover voltages for different electrode configuration using HVAC/HVDC.
2. Plotting of I-T characteristics of Static Relays.
3. Plotting of I-T characteristics of Num erical Relays.
4. Field mapping of different electrode configurations.

SRI SIDDHARTHA INSTITUTE OF TECHNOLOGY- TUMAKURU
(A constituent College of Siddhartha Academy of Higher Education, Tumakuru)

Syllabus for the Academic Year – 2020 - 2021

Department: Electrical & Electronics Engineering

Semester: VII

Subject Name: POWER SYSTEM SIMULATION LABORATORY

Subject Code: EE7L02 **L-T-P-C: 0-0-3-1.5**

Course Objectives:

1. To provide the students with solid foundation in formation of network matrices
2. To determine ABCD Parameters, Regulation & Efficiency of transmission lines
3. To study power angle characteristics of synchronous machines, analyze power system faults and load flow methods using Software package.
4. To perform economic load dispatch of a thermal power plant using Software package.

UNIT	Description
	PART-A (MATLAB Simulation)
I	Y_{BUS} formation for a given power system a) Formation of Y_{Bus} without mutual coupling by Inspection Method b) Formation of Y_{Bus} without mutual coupling using Singular transformation c) Formation of Y_{Bus} with mutual coupling using Singular Transformation Determination of bus currents, bus power & line flows for a specified system voltage
II	Determination of bus currents, bus power & line flows for a specified system voltage (bus) profile.
III	Determination of ABCD Parameters, Regulation & Efficiency of equivalent T/Pi Configuration for Short, Medium & Long transmission lines and also to verify AD-BC =1.
IV	Determination of power angle diagrams for salient and non-salient pole synchronous machines, reluctance power, excitation emf & regulation.
V	Solution of swing equation.
	PART-B (Mi-Power Package)
VI	Fault studies on a given power system.
VII	Load flow analysis using Gauss- Siedel method, N-R method, Fast Decoupled flow method for both PQ and PV buses.
VIII	Optimal generator scheduling of thermal power plants.

Course Outcomes:

After completion of course, student will be able to:

1. Formulate bus admittance matrix by Rule of Inspection and Singular transformation method using MATLAB.
2. Evaluate the transmission line performance using MATLAB.
3. Evaluate the power angle characteristics of synchronous machines.
4. Analyze power system faults and load flow using Software package and Perform economic load dispatch of a thermal power plant using Software package