SIXTH SEMESTER

Utilization of Electrical Energy (EL20611)

Objectives:

- To introduce various electric drives and their applications
- To discuss different methods of electrical heating and electric welding.
- To explain various techniques for designing indoor &outdoor lighting schemes
- To illustrate the fundamentals on electrolytic and electrometallurgical processes

Syllabus:

UNIT-I Electric Drives:
Advantages of electric drives, Characteristics of different mechanical loads, Parts of electric drives electric motors, close loop of electric drive system, Types of motors used in electric drive pulley drives etc., Examples of selection of motors for different types of domestic loads, Selection of drive for applications such as general workshop, textile mill, paper mill, steel mill, printing press, crane and lift etc.

UNIT-II Illumination:
Nature of light, visibility spectrum curve of relative sensitivity of human eye and wave length of light, Definition: Luminous flux, solid angle, luminous intensity, illumination, luminous efficiency, depreciation factor, coefficient of utilization, space to height ratio, reflection factor, glare, shadow, lux, Laws of illumination, Different type of lamps, construction and working of incandescent and discharge lamps – their characteristics, fittings required for filament lamp, mercury vapour lamp, fluorescent lamp, metal halide lamp, neon lamp, Main requirements of proper lighting; absence of glare, contrast and shadow, General ideas bout street lighting, flood lighting, monument lighting and decorative lighting, light characteristics etc**.**

UNIT- III Electric Heating:
Advantages of electrical heating, Heating methods: Resistance heating – direct and indirect resistance heating, electric ovens, their temperature range, properties of resistance heating elements, domestic water heaters and other heating appliances and thermostat control circuit, Induction heating; principle of core type and coreless induction furnace, Electric arc heating; direct and indirect arc heating, construction, working and applications of arc furnace

UNIT -IV Electric Welding:
Advantages of electric welding, Welding method, Principles of resistance welding, types, Principle of arc production, electric arc welding, characteristics of arc; carbon arc, metal arc, hydrogen arc welding method of and their applications.

UNIT- V
Electrical Circuits used in Refrigeration and Air Conditioning and Water Coolers:
Principle of air conditioning, vapour pressure, refrigeration cycle, eco-friendly

Refrigerants, Electrolytic Processes, Laws of electrolysis, process of electro-deposition - clearing, operation, deposition of metals, polishing, buffing.

Text Books:

1. "Utilization of electrical energy" by E.O.Taylor.
2. "Electrical Drives: Concept and applications" by VedamSubrahmanyam" THM**.**

Reference Books:

1. "Art and Science of Utilisation of Electrical Energy" by H.Pratab, DhanpatRai& Co.

Course Outcomes:

After the completion of the course the student will be able to:

- Investigate on the various essential requirements and acquire the ability to design a safe and cost-effective electric traction system
- Judge the suitability of different motor drives to be used for a specific purpose
- Review, analyse, and control the operation of various electric appliances used
- Develop, select, and apply appropriate techniques for designing indoor & outdoor lighting schemes
- Create, select, and apply appropriate techniques, tools and resources in designing/developing electrolytic and electrometallurgical processes
- Design and develop smart electrical heating and welding systems through the use of modern Electrical Engineering and IT tools

PO's / CO's	a	b	c	d	e	f	g	h	i	j	k
1	✓	✓			✓		✓		✓	✓	✓
2	✓	✓	✓		✓						✓
3	✓	✓	✓		✓				✓	✓	✓
4	✓	✓							✓	✓	✓
5	✓	✓									✓
6	✓	✓			✓		✓			✓	✓

Power system analysis (EL20613)

Objectives

- To understand the symmetrical and unsymmetrical faults in the power system.
- To understand the basic concepts of voltage control, power system stability and load flow in power system.

Syllabus:

UNIT I: Symmetrical Three-Phase Short Circuit
Calculation of interrupting capacity of circuit breakers, current limiting reactors, symmetrical components, synthesis of unbalanced phasors from symmetrical components, representation of phase variables voltage, current and power in terms of symmetrical components, sequence impedances of power system elements, sequence networks of power system elements, phase shift in star-delta transformer banks.

UNIT II: Unsymmetrical Short Circuits
Single line-to-ground, line-to-line, double-line-to-ground faults on unloaded alternators, unsymmetrical faults on power systems, fault through impedance, open conductor faults.

UNIT III: Power System Stability
The stability problem, steady-state stability, transient stability, Swing equation, Equal area criterion of stability, application of equal area criterion, step-by-step solution of the swing equation, factors affecting transient stability,

UNIT IV: Load Flow Studies
Formulation of bus admittance matrix, formulation of load-flow equations and their solution techniques, digital computer techniques, reactive power optimization.

UNIT V: Automatic Generation & Voltage control
Introduction, single area and two area load frequency control, and Economic dispatch control, optimal (two area) load frequency control, automatic voltage control, Tie-line bias control.

Text Books:

1. Modern power system analysis, Nagrath and Kothari, TMH
2. Power System Analysis", HaddiSaddat, TMH

Reference books:

1. "Electrical Power Systems", Ashfaq Hussain, CBS Pbs.
2. "Electrical energy system theory", Elgerd, TMH.
3. "Power system analysis", Bergen, Pearson Pbs
4. "*Power System Analysis*", Grainger and Stevenson, TMH Pbs.

Course Outcomes:

After the completion of the course the student will be able to :

- Analyze and apply the concepts of symmetrical components.
- Identify and solve symmetrical & unsymmetrical faults.
- Utilize the knowledge of power system stability to evaluate the operation under steady state & transient state condition.
- Predict the load demand using load flow analysis.
- Develop the capability to estimate economical load distribution

PO's / CO's	a	b	c	d	e	f	g	h	i	j	k
1	✓	✓	✓		✓	✓				✓	✓
2	✓	✓	✓		✓	✓				✓	✓
3	✓	✓	✓		✓	✓				✓	✓
4	✓	✓	✓		✓	✓				✓	✓
5	✓	✓	✓		✓	✓				✓	✓

Power System Protection and Switchgear (EL20614)

Objectives

- To explain the basic operating principle of main and back-up protection used in power system.
- To explain the basic operating system protection and device protection.
- To outline the operation of power system switchgear and the important factors related to switchgear.

Syllabus:

UNIT-I Relays

Terminology, basic circuit, relay connection with trip circuit and circuit breaker, objectives of protection, types of relay, construction and operation of instantaneous over current relay. IDMT relay, directional unit, differential relay, percentage differential relay, Buchholz relay, generalized torque expression, logical construction of impedance reactance, MHO and off-set MHO relays using generalized torque expression.

UNIT-II Protection of Alternators & Transformers:
Differential protection of alternator, protection of stator against phases to ground fault, phase to phase faults, inter turn fault, protection against unbalanced loading, protection of rotor against ground fault, field failure, reverse power, back up protection, field suppression, protection of bus bars, frame leakage protection. Differential protection of transformer for different winding configurations, difficulties encountered in differential protection and their remedies.

UNIT III Protection of Transmission Lines:
Over current protection, directional o/c, distance protection, unit protection schemes, carrier aided distance protection, protection of feeders, protection of ring main and parallel feeders, protection of radial feeders by over current relays, distance relays and carrier current protection scheme.

UNIT IV Static and Numerical Relays:
Amplitude and phase comparator techniques, directional relay, impedance relay, admittance relay, description of numerical relays, relaying algorithms, use of numerical relays as fault locator and disturbance recorder.

UNIT V Circuit Breakers and Fuses:
Arc formation, arc interruption and restriking voltage, current chopping, resistance switch, Air blast circuit breakers, minimum and bulk oil circuit breakers, SF6 and Vacuum Circuit breakers, circuit breakers rating, testing of CB, point on wave switching, Definitions of terms in fuses, HRC fuses.

Text Books:
1. "Power system protection and switchgear", Ravindranath and Chander, TMH
2."Fundamentals of power system protection", Paithankar and Bhide, PHI

Reference books:
1. "Electrical power system", Wadhwa, New Age.
2. "Power system protection", Badri Ram, TMH.

Course Outcomes:

After the completion of the course the student will be able to:

- Analyse the operating principle of primary and back-up protection.
- Explain the operation of power system equipment protection system.
- Develop protection schemes for power system component and integrated power network.
- Design advanced and adaptive numerical protection schemes.
- Demonstrate the operation of different circuit breaker.

PO's / CO's	a	b	c	d	e	f	g	h	i	j	k
1	✓	✓	✓	✓	✓	✓			✓	✓	✓
2	✓	✓	✓	✓	✓	✓			✓	✓	✓
3	✓	✓	✓	✓	✓	✓			✓	✓	✓
4	✓	✓	✓	✓	✓	✓			✓	✓	✓
5	✓	✓	✓		✓	✓			✓	✓	✓

Power System Protection & Switchgear Lab (EL20622)
B.Tech. (Electrical Engineering) VIth Semester

List of Experiments

1. Location of cable faults using Varley loop test.
2. To study the gas actuated Buchholz relay for transformer.
3. To perform CT polarity test and study the operating principle of current differential relay.
4. To check voltage and current condition for unsymmetrical and symmetrical fault in short, medium and long transmission line.
5. Simulation of various faults and verification of symmetrical components of currents.
6. To study the operating principle of Microcontroller based differential relay.
7. To study the operating principle of under frequency relay.
8. To study the operating principle of motor protection relay.
9. To study the operating principle of Reverse Power relay (Model No: RW 12)
10. Study the single-phase directional overcurrent relay (Model No: JRP011)
11. Study the overcurrent relay for three phase protection (IRI1)'
12. Study of differential static relay:
    (i) Overcurrent relay
    (ii) Impedance relay
    (iii) MHO relay
13. Study of Air circuit breaker and SF6 breaker.

Course Outcomes (COs):

On successful completion of the course the students will be able to:

- Distinguish and validate the application of electromechanical relay or digital relayfor power system equipment.
- Analyze different fault conditions developed in power system.

- Demonstrate and experiment with real world settings to numerical relays based on calculations.
- Interpret and demonstrate protection scheme in power system.
- Analyze and evaluate the performance of circuit breaker and relay mechanism in the real-world applications.

COs \ POs	a	b	c	d	e	f	g	h	i	j	k
1	✓	✓	✓	✓	✓	✓				✓	✓
2	✓	✓	✓	✓	✓	✓			✓	✓	✓
3	✓	✓	✓	✓	✓	✓			✓	✓	✓
4	✓	✓	✓	✓	✓	✓			✓	✓	✓
5	✓	✓	✓	✓	✓	✓			✓	✓	✓

Electrical Machine-II(EL20612)

Objectives:

- To introduce synchronous and induction machines.
- Operation, control and various applications of synchronous machines.
- To facilitate students about the practical applications,starting and control of Induction Motors for industrial purpose.

Syllabus:

UNIT I: Electrical Machines Principles
Principle of electromechanical energy conversion.Construction of various rotating machines.Singly excited magnetic system, co-energy and field energy.Doubly excited magnetic system. Winding factors, MMF of concentrated and distributed windings, rotating magnetic fields.

UNIT II: Non-salient pole synchronous machines
Theory of non-salient pole synchronous machines, equivalent circuit and phasor diagrams of synchronous machines, saturation effects, armature reaction, open circuit, short circuit and zero power factor lag tests on synchronous machines, synchronous reactance, SCR, voltage regulation of alternators by synchronous impedance, MMF and zero power factor method, Steady state power angle characteristics, Excitation systems of alternators.

UNIT III: Salient synchronous machines
Theory of salient pole synchronous machines, two- reaction theory, phasor diagram, power angle characteristics, determination of X_d and X_q, phasor diagrams, parallel operation of synchronous machines, load sharing, operation of synchronous machines with infinite bus

bars, synchronizing torque, active and reactive power flows.

UNIT IV: Synchronous Motor
Synchronous motor: Construction, general load/phasor diagram, Torque and power in salient and non salient pole motors, V-curves, Capability curve, synchronous condenser, starting of synchronous machines, damper winding, Hunting, Applications.

UNIT V: Polyphase Induction Machines
Cage and slip-ring induction motors, equivalent circuit, phasor diagram, torque-speed (slip) relationship, testing of induction motors, Circle diagram. starting and speed control of induction motors, cogging and crawling, double cage induction motors.

Text Books:
1.Electrical Machines by SmarajitGhosh, Pearson Education
2.Electric machinery by Kingsley, Fitzgerald and Umans, TMH

Reference Books:
1. Electric Machines by Nagrath& Kothari**,** TMH Pbs.
2. Electric Machines by P.K. Mukherjee &S.Chakravarti, DhanpatRai
3. Electrical machines by B. R, Gupta, New age international.
4. Performance & Design of A.C. Machines by M.G. Say, C.B.S. Publishers

Course Outcomes:

After the completion of the course the student will be able to

- Illustrate the principle of energy conversion of singly & doubly excited machines and their Designing features.
- Analyse the working principles, equivalent circuit & tests performed on Salient and Non-Salient pole synchronous machines
- Evaluate the performances of synchronous machines.
- Develop, select and apply various methods for thestarting, speed control and tests of the induction machine.

PO's / CO's	a	b	c	d	e	f	g	h	i	j	k
1	✓	✓	✓		✓		✓		✓	✓	✓
2	✓	✓	✓		✓				✓	✓	✓
3	✓	✓	✓		✓				✓	✓	✓
4	✓	✓	✓		✓				✓	✓	✓
5	✓	✓	✓		✓				✓	✓	✓

Electrical Machines –II Lab (EL20621)
B.Tech. (Electrical Engineering) VIth Semester

List of experiments

1. To perform open circuit & short circuit test on 3-ø alternator to calculate voltage regulation.
2. To perform ZPF (zero power factor) test on 3-ø alternator to calculate voltage regulation.
3. To perform no load and blocked rotor test on 3-phase induction motor to calculate equivalent circuit parameters using circle diagram.
4. To calculate the slip of three phase slip ring induction motor.
5. To plot V curve and inverted V curve of a 3-ø synchronous motor.
6. To perform single phasing on 3-ø induction motor.
7. To study the synchronization of alternators with infinite bus.
8. To perform load test on 3-ø alternator to calculate voltage regulation and efficiency.
9. To study AC machines with the help of Cut-view model or Dismantled Motor.
10. To Study various starters and provide connection to 3- phase Induction motor.
11. To perform load test on Slip Ring Induction Motor.

Course Outcomes (COs):

- Utilize measuring instruments (Ammeter, Voltmeter, Multimeter and Tachometer) for analyzing the operation of AC motor.
- Examine the working of alternator and Induction motor for different supply and load settings.
- Infer the various tests conducted on AC Motor with regard to their applicability in determining the variables of interest and performance indices
- Infer the various tests conducted on alternator with regard to their applicability in determining the variables of interest and performance indices
- Demonstrate the synchronization of alternators with infinite bus.

COs \ POs	a	b	c	d	e	f	g	h	i	j	k
1	✓		✓	✓		✓				✓	
2	✓	✓	✓		✓	✓			✓	✓	✓
3		✓	✓	✓		✓				✓	✓
4		✓	✓	✓		✓				✓	✓
5	✓	✓	✓	✓	✓	✓			✓	✓	✓

HVDC Power Transmission (EL20634)

Objectives:

- To introduce the concepts of High Voltage DC Power Transmission.
- To explain operation of basic converter station & MTDC System.
- Effects of Harmonicson HVDC system & compensation of Harmonics .

Syllabus:

Unit-I Thyristorsvalve:

Thyristors devices, steady state switching characteristic, light activated power thyristors, valve firing, parallel & series connection of thyristors

Unit-II Converter Circuit :

Rectification, The 3-phase Bridge rectifier or Graetz circuit, Inversion, Kinds of D.C links, Paralleled and Series connection of thyristors, Power flow in HVDC transmission system. Converter Station: Major components of a converter station-converter unit, filters, reactive power sources, Ground return and ground electrode.

Unit-III Basic principles of DC link control:

Converter control characteristics, firing angle control and extinction angle control. Parallel operation of D.C. link with A.C. transmission line, Converters Fault and Protection: conveter fault and protection against over current, over voltage in converter protection of DC Line and DC circuit breaker.

Unit-IV Active and Passive Filters:

Reactive power control: reactive power requirement in steady state, sources of re active power and reactive power control. Harmonics and Filters: Generation of harmonics, Characteristics and non Characteristics harmonic, types of ac filter: single tuned and double tuned filter, high pass filter, DC smoothing reactor and filters

Unit-V Multi-terminal Types of MTDC system:

comparison of series and parallel MTDC system, control and protection of MTDC system and application of MTDC systems

Test Books:

1. J. Arrillaga.; High Voltage Direct Transmission; Peter Peregrinus Ltd. London, 1983.
2. E. W. Kimbark.; Direct Current Transmission, Vol.I; Wiley Interscience, 1971.

Reference Books

1. K. R. Padiyar.; HVDC Power Transmission Systems; Wiley Eastern Ltd., 1990.
2. Erich Uhlmann.; Power Transmission by Direct Current, B.S. Publications, 2004.

Course Outcomes:

After the completion of the course the student will be able to

1. Demonstrate the concepts of thyristor.
2. Utilize the operation of three pulse and six pulse converter station.
3. Infer the concepts of converter fault and protection and converter control characteristics.
4. Analyze reactive power effects of Harmonics on the system .
5. Justify the basic operation and performance of Multi Terminal DC System.

PO's / CO's	a	b	c	d	e	f	g	h	i	j	k
1	✓	✓	✓			✓				✓	✓
2	✓	✓	✓			✓				✓	✓
3	✓	✓	✓			✓				✓	✓
4	✓	✓	✓			✓				✓	✓
5	✓	✓	✓			✓				✓	✓

Microprocessors (EL20616)

Objectives:

- Basic idea of microprocessor and its main parts
- Microprocessor 8085A programming and its applications in various fields.
- Interfacing of various peripheral devices (like 8255 PPI, 8259 interrupt controller, 8257 DMA controller etc.) with 8085 microprocessor.
- How to design microprocessor base systems by interfacing of various peripheral devices such as key board, seven segment display.
- Some advanced microprocessors like 8086, Zilog and microcontrollers 8051 apart from microprocessor 8085A. .

Unit 1: Microprocessors Architecture & Interfacing:

Introduction: Basic concepts of microprocessors and microcomputers, Introduction to microprocessor based systems, single chip, and microcontrollers.Architecture& microcomputer systems: Architecture and operations of microprocessors in general, memory, I/O devices, and logic devices for interfacing, assembler and cross- assembler, bit- slice microprocessors.Architecture& memory interfacing: Architecture of INTEL 8085, pin diagram, internal registers, bus timings, control signals, ALU, machine cycle,

read and write timing requirements in 8085.Interfacing I/O devices: Basic concepts of interfacing, output displays and input devices, memory mapped I/O.

Unit 2: Programming the 8085:

Introduction to 8085 programming: Instruction classification, instruction format, opcode format,flowchart,8085 instruction set.8085 Instructions: Data transfer operations, addressing modes, arithmetic logic and branch operations, writing an assembly language program.Programming Techniques: Looping, counting, indexing, 16 bit arithmetic instructions, data transfer and arithmetic operations related to memory, logic operations.

Unit 3: Microprocessors operations and programming:

Counter & time delays with illustrative programs for HEX counter, module-n counter, generating pulse waveforms etc.Stacks&Subroutines with illustrative programs. Write assembly language program for code conversion, BCD arithmetic and 16 bit data operations.Input/output ports, programmable I/O ports, programmable Peripheral interface, programming the 8255 A, Programmable Interrupt controller (8259), Programmable DMA controller (8257), Communication Interface (The 8251 USART).

Unit 4: Interfacing peripherals:

Interrupts: 8085 interrupts, vector interrupts ,RST Interfacing D-A and A-D converters.
SDK-85 programmable Interface Devices: 74LS245 programmable transceiver, hand shake signals, control words, 8155/8156 and 8355/8755 programmable devices. General purpose programmable peripheral devices: 8255A, status word, 8254/8253 timer, 8259 interrupt controller, 8257 DMA controller

Unit 5: Microprocessors application & Design:

Serial I/O & Data communication: Basic concepts, software and hardware controlled synchronous and asynchronous serial transmission, baud-rate, error checks, RS-232-C.Microprocessor applications and design: Designing scanned display, matrix keyboard, memory design. Recent trends in microprocessors technology: Architectural features of 8/16/32 bit microprocessors of Intel, Zilog, and Motorola etc. Single chip **microcontrollers**, selected case studies.Introduction of microcontroller, 8051microcontroller.

Text Book:

"Microprocessor Architecture , programming and application with 8085" Ramesh S. Gaonkar, WielyPbs.

Reference Books:

1. Microprocessors and interfacing: "Programming and hardware "Donglas V Hall, Tata-Mc-graw Hill Edn.
2. Introduction to microprocessors, Aditya P. Mathur,TMHPbs
3. Fundamental s of microprocessors and microcomputers", B.Ram, DhanpatRai

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Course Outcomes:

After the completion of the course the student will be able to :

1. Relate the basic knowledge of architecture for assembly language programming of different microprocessors.
2. Formulate the basic steps involved in the interfacing of microprocessors to peripheral devices.
3. Infer the use of different microprocessors.
4. Design microprocessor based control schemes for different real world applications.

POs / COs	a	b	c	d	e	f	g	h	i	j	k
1	✓	✓	✓	✓	✓	✓			✓		✓
2	✓	✓	✓	✓	✓	✓					✓
3	✓	✓	✓	✓	✓	✓					✓
4	✓	✓	✓	✓	✓	✓			✓		✓

Microprocessor Laboratory (EL20623)
B.Tech. (Electrical Engineering) VIthSemester

List of Experiments

1. To study the pin diagram and block diagram of Microprocessor 8085A.
2. To perform addition &subtraction of two 8-bit numbers using 8085A.
3. To perform the multiplication& division of two 8 bit numbers using 8085A.
4. To perform addition & subtraction of two 16- bit number using 8085A.
5. To add two 4 digit BCD no. assume data is already existing in BC and DE register pair
6. Program to find the greatest number of 8 numbers which are stored from given memory location and result must be stored at given location.
7. Program to find the 1's and 2's complement of the number and store the result at given memory location.
8. Write a program for performing AND/OR/XOR operation.
9. Interfacing of microprocessor 8085 to stepper motor.
10. Interfacing of microprocessor 8085 to seven segment display.
11. Interfacing of microprocessor 8085 to elevator simulator.
12. Interfacing of microprocessor 8085 to dc motor.
13. Interfacing of microprocessor 8085 to Traffic light control.
14. To perform arithmetic & logical operation using 8086 microprocessors.

Course Outcomes(COs)

- Interpret the architecture of microprocessors.

- Develop assembly language programming of microprocessor for real world applications.
- Outline the basic steps for interfacing peripheral devices to microprocessors.
- Design microprocessor-based control schemes**.**

COs \ POs	a	b	c	d	e	f	g	h	i	j	k
1	✓	✓	✓	✓	✓	✓			✓	✓	✓
2	✓	✓	✓	✓	✓	✓			✓	✓	✓
3	✓	✓	✓	✓	✓	✓			✓	✓	✓
4	✓	✓	✓	✓	✓	✓			✓	✓	