Mandsaur University

Subject Code: - EEE360
Subject Name: - Analog Electronics
Semester: - V

L	T	P	C
3	-	-	3

Course Objective:
Any electronic trade has its basis on a certain number of components and some basic standard circuits. These common circuits are applied in all sections of the Electronics technology. A good understanding of the basic functioning of all these components and circuits will be a solid platform to enter into the more complex portion and specialized field of Electrical & Electronics Engineering.

Unit I : Feedback: Positive and negative feedback and their properties, Effect of positive and negative feedback on gain, noise, distortion, input and output impedance of an amplifier, Gain-stability. Voltage series, Voltage shunt, Current series, Current shunt feedback.
Sinusoidal Oscillators: Principle of operation, Barkhausen criterion for sustained oscillations, R-C Phase shift Oscillator, Wein Bridge oscillator, Hartley oscillator, Colpitt oscillators.

Unit II: Amplifiers: Small signal amplifier, Frequency response of an amplifier and its band width, Gain – Bandwidth product. Hybrid parameters: Definitions, Analysis of transistor amplifier using h-parameters, Current gain, Voltage gain, Input-output impedance and power gain.
Multistage Amplifiers: Cascading of transistor amplifiers, R-C coupled amplifiers, Voltage gain at low, Mid and high frequency.
Power Amplifiers: Class A, Class B and Class C, power amplifiers, Push pull amplifiers.

Unit III: Multivibrators: Introduction to multivibrators, Astable (free running multivibrator), Monostable and Bistable multivibrators and their analysis, Multivibrators using 555 timer IC, switched capacitor filters.

Unit IV: Operational Amplifiers (Op-Amp): Pin diagram representation of a typical Operational Amplifier, Ideal Op-Amp, Concept of virtual ground, Common-Mode Rejection Ratio (CMRR), Inverting and non-inverting modes and their characteristics.
Applications of Op-Amp: Scalar, Adder, Subtractor, Multiplier, Divider, Log, Differentiator, Integrator. Active filters, LPF, HPF, BPF, BEF filters.

Unit V: Acoustics: Microphones – Carbon, moving coil, ribbon, crystal, condenser, type microphones, their working principle and characteristic.
Loud Speakers – Moving Coil, electrodynamics horn type loudspeakers, multi-way speaker system, cross over network, Reverberations.

Course Outcomes:

Students who are successful in this class will be able to:

- Understand the fundamentals of operation of the main semiconductor electronic devices.
- Understand the basic parameters of electronic devices, their performance, and limiting factors.
- Understand the basic principles of electronic device operation.
- Understand about the Operational Amplifiers, Multivibrators, Power Amplifiers, Acoustics system.

Reference Books:

1. Tobey; OP- Amps their design and Application.
2. Gaikward RA; OP- Amp and linear Integrated circuits; PHI.
3. Salivahanan; Linear Integrated Circuits; TMH.
4. Kennedy J; Principles of communications; TMH.
5. R.G.Gupta; Audio and Video System; TMH.
6. Linear Integrated Circuits: D. Raychowdhary and Shail Jain.
7. Introduction to System Design using integrated ckt: B.S. Sonde (New Age Pub.).
8. Integrated Circuits: Botkar (Khanna).
9. Applications of linear Integrated circuits: Clayton.
10. Salivahanan: Electronic Circuits Analysis and Design, TMH.
11. Rashid: Electronic Devices and Circuits, Cengage learning.
12. Op-Amps and Linear Integrated Circuits by Ramakant A. Gayakwad.
13. Linear Integrated Circuits by D Choudhury Roy.

Mandsaur University

Subject Code: - EEE400
Subject Name: - Microprocessors & Microcontroller
Semester: - V

L	T	P	C
2	1	2	4

Course Objectives:

- To learn the basic concept of microprocessor architectures and its pin diagram.
- To learn various decision making aspects in applications with help of microprocessors and its programming.
- To learn interfacing methods of various ICs with processor.
- To learn the basic concept of microcontroller architectures and its pin diagram.

Unit-I

Microprocessor 8086: Introduction to 16-bit 8086 microprocessors, architecture of 8086, pin configuration, mode, timing diagram, memory interfacing, interrupts, instruction set of 8086, addressing mode, assembler directives & operations, assembly and machine language programming, subroutine call and returns, concept of stack, stack structure of 8086, timing and delay subroutines.

Unit-II

Input-output interfacing: Memory mapped I/O and peripheral mapped I/O. PPI 8255 architecture and modes of operation, interfacing keyboard, display to 16-bit microprocessor and its programming, DMA controller (8257) architecture.

Unit-III

Microcontroller 8051: Intel family of 8- bit microcontrollers, architecture of 8051, pin description, I/O configuration, interrupts; interrupt structure and interrupt priorities, port structure and operation, accessing internal & external memories, addressing modes, instruction set of 8051 and its programming.

Unit-IV

Microcontroller 8051 interfacing: interfacing to ADC and DAC, stepper motor interfacing, timer/ counter functions, 8051 serial communication and its basic modes, serial communication programming in assembly language as well as in C.

Unit-V

The AVR RISC Microcontroller: Introduction to AVR family microcontroller, ALU, memory access and instruction executions. I/O memory, EEPROM, I/O ports.

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Course Outcome:

After going through this course the student gets a thorough knowledge on:

- Understand the concept of microprocessor architectures and its working.
- Understand various assembly language programs and execute them on software.
- Ability to interface various ICs with microprocessor and microcontroller.
- Understand the AVR family microcontrollers and its applications.

Reference Books:

1. Hall Douglas V. Microprocessor and interfacing, Revised second edition 2006, Macmillan, McGraw Hill..
2. A.K. Ray &K. M. Bhurchandi, Advanced Microprocessors and peripherals- Architecture, Programming and Interfacing, Tata McGraw-Hill.
3. Kenneth J. Ayala, The 8086 microprocessor: programming and interfacing the PC.
4. Muhammad Ali Mazidi and Janice Gillespie Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson education,2005.
5. Udayashankara and M.S. Mallikarjunaswamy, 8051 Microcontroller: Hardware, Software & Applications, Tata McGraw-Hill, 2009.
6. McKinley, The 8051 Microcontroller and Embedded Systems-using assembly and C, PHI, 2006 / Pearson, 2006.

Practical List:

1. Programs for 16 bit arithmetic operations for 8086 (using Various Addressing Modes).
2. Program for sorting an array for 8086.
3. Program for searching for a number or character in a string for 8086
4. Program for string manipulations for 8086.
5. Program to form squares & cubes series.
6. Interfacing ADC and DAC to 8086.
7. Parallel communication between two microprocessors using 8255.
8. Serial communication between two microprocessor kits using 8251.
9. Interfacing to 8086 and programming to control stepper motor.
10. Programming using arithmetic, logical and bit manipulation instructions of 8051.
11. Program and verify Timer/Counter in 8051.
12. Program and verify Interrupt handling in 8051.
13. UART Operation in 8051.
14. Communication between 8051 kit and PC.
15. Interfacing LCD to 8051.

List of Software/Learning Websites:

i. Simulator such as: Emulator 2.57- used 8086.
ii. Latest up configuration: http://www.intel.com/pressroom/kits/quickreffam.html.
iii. Keil software for 8051 microcontroller programming's.

Mandsaur University

Subject Code: - EEE380
Subject Name: - Switch Gear & Protection
Semester:-V

L	T	P	C
2	1	2	4

Course Objectives:

- To introduce students to power system protection and switch gear.
- To teach students theory and applications of the main components used in power system protection for electric machines, transformers, bus bars, overhead and underground feeders.
- To teach students the theory, construction, applications of main types Circuit breakers, Relays for protection of generators, transformers and protection of feeders from over-voltages and other hazards. It emphasis on neutral grounding for overall protection.
- To develop an ability and skill to design the feasible protection systems needed for each main part of a power system in students.

Unit-I Fault Analysis
Fault Analysis per unit, representation and its advantages, faults in power systems (Symmetrical & Unsymmetrical), Single line and equivalent impendence diagram representation of power system components. Symmetrical components and its application to power systems, fault analysis, Sequence networks and their interconnection for different types of faults, Effect of fault impedance.

Unit-II Protective Relays
Requirement of relays, Primary & Backup protection, Desirable qualities of relays, Concept of Pickup, reset & drop-off, Drop off/ Pickup ratio, inverse time & definite time charterstics, Attracted armature, Balanced Beam, Induction disc, Induction cup, Moving coil & moving Iron, Rectifier, thermal, Bimetal directional relay, Frequency, DC, Over current, Over Voltage, Directional, Differential and Distance relays, Impedance mho & reactance relay. Introduction of static analog & digital relays, Classification of static relays.

Unit-III Circuit Breakers
Elementary principle of arc quenching, Recovery & Re-Striking voltage, Arc quenching devices, Description and operation of Bulk oil, Minimum oil, Air break, Air blast, SF6, Vacuum circuit breakers and DC circuit breakers, Their comparative merits, LT Switch gear, HRC fuses, Current limiting reactor & their design features, Influence of reactors in CB ratings Testing of circuit breaker.

Unit- IV System Protection -
Protection of Generators: Earth Fault, Percentage, Differential, Loss of excitation, Prime mover failure, Over current, Turn to turn fault, Negative phase sequence, heating, reverse power protection schemes,
Protection of Transformers: Internal & external fault protection, Differential, Earth fault, Over Current, Overheating, Protection schemes.

Protection of transmission lines: over current, distance and carrier current protection schemes.

Unit-V Surge Protection & insulation co-ordination

Switching surges, Phenomena of Lightning, over voltage due to lightning, Protection against lightning, lightning arrestors, selection of lightning arrestors, Surge absorbers and diverters, Rod gap, Horn gap expulsion type & valve type lightning arrestors, solid resistance and reactance earthing, Arc suppression coil, Earthing transformers, Earth wires, Earthing of appliances, insulation co-ordination.

Course Outcomes:

- Student gains knowledge on different Protective Equipments or Power Systems.
- Know about various protective systems- how it works and where it works?
- Different applications of the relays, circuit breakers, grounding for different elements of power system are also discussed in the subject.

Reference Books:

1. B. Ravindran and M Chander, "Power System protection and Switchgear", New Age International.
2. Fundamentals of Power System protection Y.G.Paithankar & S.R. Bhide; E.E.E.
3. CL Wadhwa, Electrical Power systems, New age International.
4. Haddi Saadet, "Power System Analysis, TMH
5. A.R. Bergen, Vijay Vittal, "Power System Analysis, Pearson Education, Asia.
6. Switchgear & protection Sunil S. Rao. Khanna Publication.
7. Ravindra P. Singh, Switchgear & Power System Protection, PHI Learning.
8. Badrirka, Power System protection and switchgear, TMH

Suggested List of Experiment:

1. Determination of drop out factor of an instantaneous over current relay.
2. Determination of operating characteristic of IDMT relay.
3. Determination of operating characteristic of differential relay.
4. Study and operation of gas actuated protective relay.
5. Study and operation of static over current relay.
6. Determination of transmission line parameters using MATLAB.
7. Analysis of power system faults (Symmetrical & Asymmetrical) using MATLAB.
8. Study of SF6 circuit breaker.
9. Protection simulation study of generator, Transformer, Feeder & Motor protection.

Mandsaur University

Subject Code: - EEE390
Subject Name: - Control System
Semester:-V

L	T	P	C
2	1	2	4

Course Objectives:
This course is aimed to introduce the students about:

- Principles and applications of control systems in every day life.
- The basic concepts of block diagram reduction techniques, time domain analysis of different order control systems and solutions to time invariant systems.
- This course also deals with the different aspects of stability analysis of systems in frequency domain and time domain.

Unit-I
Introduction: Elements of control system, concept of open loop and closed loop systems, examples and application of open loop and closed loop systems, brief idea of multivariable control systems.
Mathematical Modeling of Physical Systems: Representation of physical system (Electro-Mechanical) by differential equations, determination of transfer function by block diagram reduction techniques and signal flow graph method, Laplace transformation function, inverse Laplace transformation. State space analysis of control system.

Unit-II
Time Response Analysis of First Order and Second Order System: Characteristic equations, response to step, ramp and parabolic inputs. Transient response analysis, steady state errors and error constants. Brief idea of proportional, derivative and integral controllers.

Unit-III
Stability and Algebraic Criteria: concept of stability and necessary conditions, Routh-Hurwitz criteria and its limitations. Root Locus technique: The Root Locus concepts, construction of root loci.

Unit-IV
Frequency Response Analysis: Frequency response, correlation between time and frequency responses, polar and Bode plots.
Stability in Frequency Domain: Nyquist stability criterion, assessment of relative stability: gain margin and phase margin.

Unit-V
The Design Problem and Preliminary Considerations: lead, lag and lead-lag networks, design of closed loop systems using compensation techniques in time domain and frequency domain.

Course Outcomes:

After going through this course the student gets a thorough knowledge on:

- Open loop and closed loop control systems, concept of feedback in control systems
- Transfer function representation through block diagram algebra and signal flow graphs
- Time response analysis of different ordered systems through their characteristic equation and time domain specifications
- Stability analysis of control systems in s-domain through different criteria.
- Frequency response analysis through bode plot, Nyquist plot, Polar plots.
- Design of PID controllers, lag, lead, lag-lead compensators, with which he/she can able to apply the above conceptual things to real-world electrical and electronics problems and applications.

Reference Books:

1. B. S. Manke, Linear Control System, Khanna Publisher.
2. Control Systems Theory and Applications - S. K. Bhattacharya, Pearson.
3. Control Systems - N. C. Jagan, BS Publications.
4. B. C. Kuo, Digital Control Systems, Oxford University Press, 2/e, Indian Edition, 2007.
5. K. Ogata, Discrete Time Control Systems, Prentice Hall, 2/e, 1995.
6. M. Gopal, Digital Control and State Variable Methods, Tata Mcgraw Hill, 2/e, 2003.
7. G. F. Franklin, J. D. Powell and M. L. Workman, Digital Control of Dynamic Systems,
8. Addison Wesley, 1998, Pearson Education, Asia, 3/e, 2000. K. J. Astroms and B. Wittenmark, Computer Controlled Systems - Theory and Design, Prentice Hall, 3/e, 1997.

Suggested List of Experiment:

1. Simulation of DC motor working.
2. Simulation of Synchros.
3. Simulation of generating standard test signals i.e. step, ramp and unit impulse on a simulator.
4. To study analysis of time response of second order system.
5. To study effect of P, PD, PI, PID Controller on a second order systems.
6. Plotting root locus of a given transfer functions using a simulator.
7. Plotting phase magnitude plot of a given transfer function with a simulator.
8. Obtaining frequency response of a common emitter amplifier and plotting on a Bode plot.
9. Simulation of a given transfer functions using OPAMPs.
10. Stability Analysis (Root locus, Bode, Nyquist) of Linear Time Invariant System.
11. Transfer function from zeros and poles.
12. Zeros and poles from transfer function.
13. Simulation of lag compensator.
14. Simulation of lead compensator.
15. Simulation of lead lags compensator.

Use SCILAB/MATLAB or other equivalent software as a simulator.

Mandsaur University

Subject Code: - EEE371
Subject Name: - Electrical Wiring, Estimating, Costing & Contracting
Semester:-V

L	T	P	C
3	-	-	3

Course Objective:-
To acquaint with the fundamental concepts of electrical wiring, their estimation, costing, maintenance and contracting.

Unit-I
Electrical Symbol Standards:-
Need of electrical symbols, list of symbols, electrical diagrams and methods of representation for wiring circuit.
Design of Simple Electrical Circuits-Light, Fan Circuit & Alarm Circuit:-
Introduction to simple light & fan circuit, system of connection of appliances and accessories and examples. Introduction to simple alarm circuit with or without relays and its examples.

Unit - II
Design considerations of electrical installations:-
Electric supply system, three-phase four wire distribution system, protection of electric installation against overload, short circuit and earth fault, earthing, general requirement of electrical installation, testing of installation, Indian electricity rules, types of loads, service connections, service mains, sub circuit, location of outlets, location of control switches, location of main board and distribution board, load assessment, permissible voltage drop and sizes of wires, estimation and costing of electrical installation.

Unit-III
Design & Drawing of Panel Boards:-
Introduction, design condition, standard sizes of boards and examples.

Substations:-
Introduction, types of substations, outdoor substations- pole mounted type and indoor substations- floor mounted type and examples of quantity estimation.

Unit-IV
Motor control circuit:-
Introduction to A. C. Motors, Starting - 3-phase squirrel phase induction motor, multi speed squirrel phase motors, wound rotor motors, synchronous motors, stopping of motors, contractor control circuits components, basic control circuit, motor protection, schematic and wiring diagrams for motor control circuits.

Unit-V

Overhead & Underground Transmission and Distribution Lines:-

Introduction, Supports for transmission lines, Distribution lines materials used, Underground cables, Mechanical design of overhead lines, Design of underground cables, examples for quantity estimation.

Principles of Contracting and Tender notices:-

Prepare Terms, conditions, and types of contract system, Define Tender, tendering procedure and preparation of simple tender, Prepare Terms and conditions of tender, procedure for inviting and scrutinizing of tender, Define Earnest Money Deposit, Security Deposit and S.O.R.

Course Outcome:-

- At the closing stage of the course, the students will be able to know the fundaments of different electrical wiring.
- They will be able to understand the estimating and costing of electrical equipment, contracting procedure in electrical engineering etc
- Prepare detail estimate and costing of a transmission line/Overhead and underground distribution project.

Reference Books:-

1. Dr .S.L. Uppal of Electrical Wiring, Estimating and Costing 6th addition by Khanna Publishers-2013.
2. K.B. Raina & S.K. Bhattacharya of Electrical Design Estimating and Costing 1st addition by new age international (p) limited. Publishers-2014.
3. Surjit Singh by of Electrical estimating & costing 2nd addition By Khanna Publishers-1997
4. A.K. Sawhney of Electrical & Electronics measurement &instrumentation 3rd addition By Khanna Publishers-2012.

Mandsaur University

Subject Code: - EEE372
Subject Name: - Flexible AC Transmission System
Semester: - V

L	T	P	C
3	-	-	3

Course Objectives:

- Introduction to the concept of FACTS and the types of devices used with an emphasis on working principle.
- Operation of TCSC in various modes and its applications.
- A brief study of emerging facts controllers and their coordination with existing system.

Unit-I: Introduction
Flexible AC transmission system, reactive power control in electrical power transmission lines, uncompensated transmission line, series and shunt compensation. Overview of FACTS devices: Static VAR Compensator (SVC), Thyristor Switched Series capacitor (TCSC), Unified Power Flow controller (UPFC), Integrated Power Flow Controller (IPFC).

Unit-II: Static VAR Compensator (SVC) and Applications
Voltage control by SVC, advantages of slope in dynamic characteristics, influence of SVC on system voltage. Applications, enhancement of transient stability, steady state power transfer, enhancement of power system damping, prevention of voltage instability.

Unit-III: Thyristor Controlled Series Capacitor (TCSC) and Applications
Operation of the TCSC, different modes of operation, modeling of TCSC, variable reactance model, modeling for power flow and stability studies. Applications, improvement of the system stability limit, enhancement of system damping, voltage collapse prevention.

Unit-IV: Emerging FACTS Controllers
Static Synchronous Compensator (STATCOM): operating principle, V-I characteristics; Unified Power Flow Controller (UPFC): principle of operation, modes of operation, applications, modeling of UPFC for power flow studies.

Unit-V: Co-ordination of FACTS Controllers
Controller interactions, SVC–SVC interaction, co-ordination of multiple controllers using linear control techniques, quantitative treatment of control co-ordination.

Course Outcomes:

- Students will be able to understand new methods adopted in power system control.
- Students will understand the quantitative treatment of control coordination.
- Students will be skilled to work for modeling and development of new devices used for reactive power control and other factors.

Reference Books:

1. Mohan Mathur, R.,Rajiv. K.Varma, "Thyristor–Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc.
2. A.T. John, "Flexible AC Transmission System", Institution of Electrical and Electronic Engineers (IEEE), 1999.
3. Narain G. Hingorani, Laszio. Gyugyl, "Understanding FACTS Concepts and Technology of Flexible AC Transmission System", Standard Publishers, Delhi 2001.
4. Vijay K. Sood, "HVDC and FACTS Controller: Application of Static Converters in power systems", IEEE Power Electronics and Power Systems series, Kluwer Academic publishers, Boston, First edition January 2004.
5. K.R.Padiyar," FACTS Controllers in Power Transmission and Distribution", New Age International(P) Limited, Publishers, New Delhi, 2008.

Mandsaur University

Subject Code: - EEE373
Subject Name: - Signal and System
Semester-V

L	T	P	C
3	-	-	3

Course Objectives:

- Demonstrate an understanding of the different types of signals and fundamental properties of linear systems.
- Use linear systems tools, especially transform analysis and convolution, to analyze and predict the behavior of linear systems.

Unit-I: Overview of signals: Basic definitions. classification of signals, continuous and discrete time signals, signal operations and properties, discretization of continuous time signals, signal sampling and quantization, Basic system properties, Representation of digital signals.

Unit-II: Discrete Time System: Impulse response characterization and convolution sum, causal signal response to DT-LTI systems. Properties of convolution summation, Impulse response of DT-LTI system and its properties. basic system properties: linearity, static and dynamic, stability and causality, time invariant and variant system.

Unit-III: Fourier analysis of discrete time signals: Introduction, properties and application of discrete time Fourier series, representation of aperiodic signals, Fourier transform and its properties, convergence of discrete time Fourier transform, Fourier transform for periodic signals, applications of DTFT.

Unit-IV: Z-Transform: Introduction, ROC of finite duration sequence, ROC of infinite duration sequence, Relation between Discrete time Fourier Transform and z-transform, properties of the ROC, Properties of z-transform, Inverse z-Transform, Analysis of discrete time LTI system using z-Transform, Unilateral z-Transform.

Unit-V: Systems with Finite and infinite duration response: Recursive and non-recursive discrete time systems-realization structures-direct form-I, direct form-II, Transpose, cascade and parallel forms, state space analysis: Representation and solution for continuous and discrete time LTI system.

Course Outcomes:

After learning the course the students should be able to:

- Understand about various types of signals, classify them, analyze them, and perform various operations on them.
- Understand about various types of systems, classify them, analyze them and understand their response behavior.

Reference Books:

1. Simon Haykins and Barry Van Veen: Signals and Systems, John Wiley & sons.
2. Rawat: Signal and Systems, Oxford Publication.
3. Edward W. Kamen & Bonnie's Heck, "Fundamentals of Signals and Systems", Pearson
4. Education.
5. H. P. Hsu, Rakesh Ranjan "Signals and Systems", Schaum's Outlines, Tata McGrawHill.
6. Nagoorkani: signal and system (TMH).
7. Gabel, Roberts, "Signals and Linear Systems" Wiley India Pvt. Ltd, 2012.
8. Rao: Signal and system (TMH).
9. A. Anandkumar signal and system 3rd Edition, PHI.
10. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, Signals and Systems, Pearson Education.

Mandsaur University

Subject Code: - EEE3410
Subject Name: - Electrical CAD Lab
Semester:-V

L	T	P	C
1	-	6	4

Course Objective:
CAD lab includes the drawing, design, installation & machines, including computer awareness. Different drawings are done using computer. This subject helps the students to analyze the drawings. The knowledge gained in this subject is help full to the students in future as well as job opportunities.

Module
Introduction to computer aided drafting (cad), advantages, applications, cad packages, software for cad, auto cad an overview, drafting settings, toolbars, Advantages of using CAD, Application of CAD.

Course Outcome:
At the end of course, students will be able to:

- Simulate design of electrical & electronics networks.
- Draw single line diagram of power transmission & distribution system in Auto CAD software.
- Draw electrical & electronics wiring in Auto CAD software.

Reference Books:

1. LP Editorial Board, Electrical AUTO 2007.
2. AutoCAD Manual, Publication.
3. AutoCAD by A problem solving Approach
4. Rubenstein, AutoCAD, Publication:

List of Experiments:

1. To understanding of Auto CAD Software.
2. To draw electrical symbols in Auto CAD Software.
3. To draw electronic symbols in Auto CAD Software.
4. To draw electrical design of AC in Auto CAD software. (2D and 3D).
5. To draw electrical design of DC machines in Auto CAD software. (2D and 3D).
6. To draw electrical design of transformers in Auto CAD software. (2D and 3D).
7. To simulate electrical circuit in circuit maker in Auto CAD software.
8. To simulate electronic circuit in circuit maker in Auto CAD software.
9. To draw single line diagram of power plant in Auto CAD software.
10. To draw single line diagram of substation in Auto CAD software.
11. To simulate design of electrical power system in MATLAB software.
12. To draw single line diagram of power transmission and distribution system software.