SCHEME AND DETAILED SYLLABUS

of

T. Y. B. Tech. (Electrical Engineering)

of

FOUR YEAR DEGREE COURSE IN ENGINEERING & TECHNOLOGY

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

FACULTY OF ENGINEERING AND TECHNOLOGY
SYLLABUS FOR B.TECH- III-YEAR – (ELECTRICAL ENGINEERING) 2016-17

Sub No.	SEMESTER-V	Contact Hrs / Week				Examination Scheme						
	Subject	**L**	**T**	**P**	**Total**	**CT**	**TH**	**T W**	**P**	**Total**	**Credits**	**Duration of Theory /Practical Exam**
EE301	Power Electronics	3	1	-	4	20	80	-	-	100	4	3 Hrs
EE302	Microprocessor and Microcontroller	4	-	-	4	20	80	-	-	100	4	3 Hrs
EE303	Design of Electrical Machines	3	1	-	4	20	80	-	-	100	4	3 Hrs
EE304	Control System Engineering	3	1	-	4	20	80	-	-	100	4	3 Hrs
EE305	Transmission and Distribution	4	-	-	4	20	80	-	-	100	4	3 Hrs
EE306	Energy Management	2	-	-	2	10	40	-	-	50	2	2 Hrs
EE321	Lab I : Power Electronics	-	-	2	2	-	-	25	25	50	1	
EE322	Lab II : Microprocessor and Microcontroller	-	-	2	2	-	-	25	25	50	1	
EE323	Lab III: Design of Electrical Machines	-	-	2	2	-	-	50	-	50	1	
EE324	Lab IV : Control System Engineering	-	-	2	2	-	-	25	25	50	1	
EE325	Lab V:Seminar	-	-	2	2	-	-	50	-	50	1	
	Total of semester-V	**19**	**3**	**10**	**32**	**110**	**440**	**175**	**75**	**800**	**27**	

Sub No.	SEMESTER-VI	Contact Hrs / Week				Examination Scheme						
	Subject	**L**	**T**	**P**	**Total**	**CT**	**TH**	**T W**	**P**	**Total**	**Credits**	**Duration of Theory /practical Exam**
EE351	Power System Analysis	3	1	-	4	20	80	-	-	100	4	3 Hrs
EE352	Digital Signal Processing	3	1	-	4	20	80	-	-	100	4	3 Hrs
EE353	Electrical Drives	4	-	-	4	20	80	-	-	100	4	3 Hrs
EE354	Electromagnetic Field	3	1	-	4	20	80	-	-	100	4	3 Hrs
EE355	Electrical Testing and Maintenance	2	-	-	2	10	40	-	-	50	2	2 Hrs
	Elective-I	4	-	-	4	20	80	-	-	100	4	3 Hrs
EE371	Lab VI: Power System Analysis	-	-	2	2	-	-	25	25	50	1	
EE372	Lab VII : Digital Signal Processing	-	-	2	2	-	-	25	25	50	1	
EE373	Lab VIII : Electrical Drives	-	-	2	2	-	-	25	25	50	1	
EE374 EE375 EE376 EE377	Lab IX : Elective I	-	-	2	2	-	-	50	-	50	1	
EE378	Lab X: Project Part –I	-	-	2	2	-	-	50	-	50	1	
	Total of semester-VI	**19**	**3**	**10**	**32**	**110**	**440**	**175**	**75**	**800**	**27**	
	Grand Total of V & VI	**38**	**6**	**20**	**64**	**220**	**880**	**350**	**150**	**1600**	**54**	

ELECTIVES - I:

1. EE391 - Recent Trends in Power System
2. EE392 - Electrical System Planning and Design
3. EE393 - Illumination Engineering
4. EE394 - Industrial Automation

L: Lecture hours per week **T**: Tutorial hours per week **P**: Practical hours per week **CT**: Class Test
TH: University Theory Examination **TW**: Term Work **P**: Practical/Oral Examination

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Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester - V

Code No. : EE301	**Title: Power Electronics**
Teaching Scheme: 04Hrs/week	**Class Test: 20**
Theory : 03 Hrs/week	**Theory Examination (Duration): 03 Hrs**
Tutorial: 01Hr/week	**Theory Examination (Marks): 80**
Credits: 04	

Objectives	**:**	• To get an overview of different types of power semi-conductor devices and their switching characteristics. • To understand the operation, characteristics and performance parameters of controlled rectifiers. • To learn the different modulation techniques of pulse width modulated inverters and to understand the harmonic reduction methods. • To study the operation of AC voltage controller and Matrix converters.
Unit – I	**:**	**Power Semi-conductor Devices:** Study of switching devices, - Frame, Driver and snubber circuit of SCR, TRIAC, BJT, IGBT, MOSFET - Turn-on and turn-off characteristics, switching losses, Commutation circuits for SCR. **(10 Hrs)**
Unit - II	**:**	**Single Phase AC to DC Converter:** Half wave converter, Mid-point converter, Fully controlled converter (rectification and inversion mode), Half controlled converter (Semi-converter), Operation of all converters with R, RL and RLE load, derivation of Average and RMS output voltage, power factor, THD, TUF. Effect of source inductance, Single phase dual converter. **(12 Hrs)**
Unit - III	**:**	**Three Phase AC to DC Converter:** Half wave converter, Fully controlled converter, rectification and inversion mode, Half controlled converter (Semi-converter), Operation of all converters with R, RL and RLE load, derivation of Average and RMS output voltage, power factor, THD, TUF. Numerical based on output voltage and current calculations. **(12 Hrs)**
Unit – IV	**:**	**DC to DC Converter**: Principle of operation of chopper, classification on the basis of Operating quadrants. Control techniques: CLC, TRC, PWM and FM Techniques. Analysis of Step up Chopper and step down chopper, Areas of application. **(10 Hrs)**
Unit – V	**:**	**Inverter:** Single phase and three phase (both 120° mode and 180° mode) inverters, PWM techniques: Sinusoidal PWM modified sinusoidal PWM, multiple PWM, Introduction to space vector modulations, Voltage and harmonic control, Series resonant inverter, Current source inverter. **(08 Hrs)**

Unit – VI	**:**	**AC to AC Converters**: Single phase AC voltage controllers, Multistage sequence control, single and three phase Cyclo-converters, Introduction to Integral cycle control, Power factor control and Matrix converters. **(08 Hrs)**
Text Books	**:**	1. Power Electronics: Circuits, Devices and Applications - M.H. Rashid, Pearson Education, PHI Third edition, New Delhi 2004. 2. Elements of Power Electronics - Philip T.Krein, Oxford University Press, 2004 Edition.
Reference Books	**:**	1. Power Electronics for Technology - Ashfaq Ahmed Pearson Education, Indian reprint, 2003. 2. Power Electronics - P.S.Bimbra, Khanna Publishers, third Edition 2003. 3. Power Electronics: Converters, Applications and Design - Ned Mohan, Tore.M.Undeland, William.P.Robbins, John Wiley and sons, third edition, 2003.

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI.

Pattern of Question Paper:

The Six units in the syllabus shall be divided in two equal parts i.e. 3 units respectively. Question paper shall be set having two sections A and B. Section A questions shall be set on first part and Section B questions on second part. Question paper should cover the entire syllabus.

For 80 marks Paper:

- Minimum ten questions.
- Five questions in each section.
- Question No-1 from section A and Question No-6 from section B be made compulsory and should cover complete syllabus of the respective section and should be set for ten marks each. The Question no.1 and 6 should be of objective nature.
- Two questions of 15 marks each from remaining questions from each section A and B be asked to solve.

COURSE OUTCOMES:

1. Students will be able to introduce about the characteristics of different power semiconductor devices, Snubber circuits and commutation circuits.
2. Students will be able to analyze the single-phase AC – DC converter for different loads and their performance characteristics.
3. Students will be able to analyze the three-phase AC – DC converter for different loads and their performance characteristics.
4. Students will be able to analyze the principle of operation, classification, different control techniques, analysis and applications of DC – DC converter.
5. Students will be able to analyze the single-phase and three-phase inverter on different modes, PWM techniques and current source inverter.
6. Students will be able to analyze single-phase AC voltage controller, three-phase Cyclo-converter, different control strategies and Matrix converter.

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Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester - V

Code No. : EE302 **Title: Microprocessor and Microcontroller**
Teaching Scheme: 04Hrs/week **Class Test: 20**
Theory : 04 Hrs/week **Theory Examination (Duration): 03 Hrs**
Credits: 04 **Theory Examination (Marks): 80**

Objectives	**:**	To study- • The architecture, instruction set, Programming and applications of the 8 bit microprocessor 8085. • Overview of a Microcontroller processor.
Unit – I	**:**	**Overview to Microprocessor:** Digital Computer, Evaluation of Microprocessor, Architecture of 8085, Pin description, addressing modes**,** Instruction set, different programs, Timing diagram. **(08 Hours)**
Unit - II	**:**	**Microprocessor 8085 & Interfacing:** Different data transfer schemes, Memory mapping, memory mapped I/O and I/O mapped I/ O, Stack & subroutines, Delay subroutines, Interrupt structure, Need of I/O ports, Introduction to 8253, 8255, Interfacing of LED's, 7 Segment display, Switches, Relays, D.C motors, Stepper motor with 8255, ADC, DAC. **(12 Hours)**
Unit – III	**:**	**Microprocessor 8086:** Architecture of 8086, Pin diagram, Programming model of 8086, Physical addressing, Addressing modes, and overview of instruction set, Interrupt structure, Min-Max mode. **(10 Hours)**
Unit – IV	**:**	**Introduction to 8051 Microcontroller:** Comparison of microprocessor and microcontroller, Evolution, Features of MCS 51 families, 8051 Architecture, pin detail, Instruction set, programming model, addressing modes and i/o ports, Memory organization **(12Hours)**
Unit – V	**:**	**8051 Microcontroller Interfacing:** I/O port programming, interrupts, Timer/ Counter Programming, Serial Communication, Interfacing of LED, LCD ADC, DAC, SPI bus devices, RS232. (**12Hours)**
Unit – VI	**:**	**PIC Microcontroller** Concept of RISC & CISC, Overview and features PIC16Cx/7X, Architecture, Compression of PIC with Conventional controller. (**06 Hours)**
Text Books	**:**	1. Ramesh Gaonkar, "Microprocessor, Architecture, Programming and Application", Willey Eastern Ltd, Fourth Edition. 2. Sridhar Ghosh , "0000 to 8085" Prentice Hall India. 3. B. Ram, "Fundamentals of Microprocessor and Microcomputer", Dhanpat Rai and Sons New Delhi. 4. A.K.Ray, K.M.Bhurchandi ,"Advanced Microprocessors and

		Peripherals", Tata McGraw Hill Publications,2000. 5. Muhammad Ali Mazidi and Janice Gillispie Mazidi, "The 8051 Microcontroller and Embedded Systems", Pearson Education Asia. 6. Ajay V Deshmukh, "Microcontrollers - Theory and Applications", Tata McGraw – Hill Education, New Delhi. 7. John B. Peatman, "Design with PIC Microcontrollers", Pearson Education.
Reference Books	**:**	1. Berry Bray and C.R.Sharma, "The Intel Microprocessors Architecture, Programming & Interfacing" Pearson Education. 2. Mohammad Raffiquazaman, "Microprocessor and Microcomputer Based System Design" Universal Book Stall, New Delhi. 3. Uffenbeck, "The 8086/8088 Family –Design, Programming and Interfacing", Prentice Hall India. 4. Kenneth J. Ayala, "The 8051 Microcontroller – Architecture, Programming and Applications", Penram International Publishing (India), Second Ed. 5. Intel Data Book on MCS 51 family. 6. http://datasheet.octopart.com/PIC16C73B-04/SP-Microchip-datasheet-3121.pdf 7. http://ww1.microchip.com/downloads/en/devicedoc/39597b.pdf

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI.

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For 80 marks Paper:

- Minimum ten questions.
- Five questions in each section.
- Question No-1 from section A and Question No-6 from section B be made compulsory and should cover complete syllabus of the respective section and should be set for ten marks each. The Question no.1 and 6 should be of objective nature.
- Two questions of 15 marks each from remaining questions from each section A and B be asked to solve.

COURSE OUTCOMES:

1. Students will be able to introduce about the evaluation of microprocessor, features, architecture, pin description, addressing modes Instruction sets and Timing diagram, of 8085.
2. Students will be able to understand the 8085 Memory mapping and interfacing with LED, 7 segments display, D.C Motor and Stepper motor.
3. Students will be able to introduce about the features, architecture, pin description, programming model, instruction sets and addressing modes of 8086.
4. Students will be able to introduce about the evolution, features, architecture, pin description, Instruction sets and programming model of 8051.
5. Students will be able to understand about the interrupts, serial communication and interfacing with LED, LCD, RS232 etc.,
6. Students will be able to understand the concepts of RISC and CISC, Architecture, overview, features of PIC16Cx/7X.

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Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester - V

Code No. : EE303 **Title: Design of Electrical Machines**
Teaching Scheme: 04Hrs/week **Class Test: 20**
Theory : 03 Hrs/week **Theory Examination (Duration): 03 Hrs**
Tutorial: 01Hr/week **Theory Examination (Marks): 80**
Credits: 04

Objectives	**:**	• To design transformer. • To understand determination of parameters of transformer. • To understand specifications of transformer. • To design Induction motor. • To understand determination of parameters of Induction motor.
Unit – I	**:**	**Principles Of Electrical Machine Design:** Design of Electrical machines – With special features, rating, Specifications, Standards, Performance and other criteria, Brief study of magnetic, electric, dielectric and other materials related to machines designs. **(06 Hrs)**
Unit - II	**:**	**Design of DC Machines:** Output equation, choice of specific loadings and choice of number of poles, design of Main dimensions of the DC machines, Design of armature slot dimensions, commutator and brushes, magnetic circuit - estimation of ampere turns, design of yoke and poles-main and inter poles, field windings – shunt, series and inter poles. **(10 Hrs)**
Unit – III	**:**	**Design of Transformers (Single phase and Three phases):** Output equation for single phase and three phase transformers, choice of specific loadings, expression for volts/turn, determination of main dimensions of the core, types of windings and estimation of number of turns and conductor cross sectional area of Primary and secondary windings, estimation of no load current, expression for leakage reactance and voltage regulation. Design of tank and cooling tubes. (Round and Rectangular) **(12 Hrs)**
Unit – IV	**:**	**Designs of Induction Motors:** Output equation, Choice of specific loadings, main dimensions of three phase induction motor, Stator winding design, choice of length of the air gap, estimation of number of slots for the squirrel cage rotor, design of Rotor bars and end ring, design of Slip ring induction motor, estimation of No load current and leakage reactance, and circle diagram. **(14 Hrs)**
Unit – V	**:**	**Designs of Synchronous Machines:** Output equation, Choice of specific loadings, short circuit ratio, design of main dimensions, armature slots and windings, slot details for the stator of salient and non-salient pole synchronous machines. Design of rotor of salient pole synchronous machines, magnetic circuits, dimensions of the pole body, design of the field winding, and design of

		rotor of non-salient pole machine. **(12 Hrs)**
Unit – VI	**:**	**Computer Aided Design of Electrical Machine:** Introduction, advantages various approaches of Computer Aided Designing, Computer Aided Designing of transformer, Winding of rotating Electrical Machines. Optimization of Design. **(06 Hrs)**
Text Books	**:**	1. A Course In Electrical Machine Design, A.K.Sawhney, Dhanpatt Rai & Sons 2. Design Of Electrical Machines, V. N. Mittle, 4th edition
Reference Books	**:**	1. Performance And Design Of AC Machines, M. G. Say, CBS Publishers and Distributors Pvt. Ltd. 2. Design Data Handbook, A. Shanmugasundarm, G. Gangadharan, R. Palani,Wiley Eastern Ltd. 3. A Course in Electrical Machine Design (Prentice Hall Of India) Deshpande. M. V - (Design and Testing Of Electrical Machines). 4. Computer aided design of Electrical Machines – S. K. Sen.

Industrial Visit: Industrial visit to a manufacturing unit of transformer or Induction motor.

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- Two questions of 15 marks each from remaining questions from each section A and B be asked to solve.

COURSE OUTCOMES:

1. Students will be able to introduce about the design of electrical machines on different criteria.
2. Students will be able to analyze the design criteria of DC machines like choice of number of poles, dimensions, commutator, brushes and magnetic circuits.
3. Students will be able to analyze and design of single-phase and three-phase transformers.
4. Students will be able to analyze and design of squirrel cage and slip-ring induction motor.
5. Students will be able to analyze and design of synchronous motor.
6. Students will be able to introduce about the computer aided design of transformer, electrical machines.

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Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester - V

Code No. : EE304	**Title: Control System Engineering**
Teaching Scheme: 04Hrs/week	**Class Test: 20**
Theory : 03 Hrs/week	**Theory Examination (Duration): 03 Hrs**
Tutorial: 01Hr/week	**Theory Examination (Marks): 80**
Credits: 04	

Objectives	**:**	• To understand basic concepts of the classical control theory. • To model physical systems mathematically. • To analyze behavior of system in time and frequency domain. • To design controller to meet desired specifications.
Unit – I	**:**	**Control System Modeling:** Basic concepts of control system, open loop, close loop, classification of control systems. Types of control system: Feedback, tracking, regulator system, feed forward system. Transfer function, Pole and zero concept. Modeling and representation of control system-Basic concept. Mechanical, Electrical and equivalent system. Block diagram reduction, signal flow graph, Mason's gain formula. **(10 Hrs)**
Unit - II	**:**	**Control System Components:** Modeling and transfer function of control system components such as simple electrical, mechanical, electromechanical systems, Lag network, lead network, Potentiometer, Synchros, AC and DC servo motors, Gear trains, AC-DC Tacho-Generators, Optical encoder, Two tank systems. **(10 Hrs)**
Unit – III	**:**	**Time Domain Analysis:** Standard test signal – step, ramp, parabolic and impulse signal, type and order of control system, time response of first and second order systems to unit step input, steady state errors – static and dynamic errors coefficients. Generalized errors series method. Time domain specifications of second order systems. Dominant closed loop poles of higher order systems Design specifications in time domain. **(10 Hrs)**
Unit – IV	**:**	**Stability Analysis And Root Locus:** Concept of stability-Absolute, relative and marginal. Nature of system response for various locations of roots in S plane of characteristics equation. Routh's criterion and Hurwithz criterion. Root Locus: Basic properties of root locus. Construction of root locus. Angle and magnitude condition for stable system. Root contour design concept. **(10 Hrs)**
Unit – V	**:**	**Frequency Domain Analysis:** Steady state response of a system due to sinusoidal input. Relation between time and frequency response for second order system. Frequency domain specifications, analysis with Bode plot, Polar plot, Nyquist plot, stability analysis using Nyquist plot and Bode plot. **(10 Hrs)**

Unit – VI	**:**	**PID Controllers:** Basic concept of PID controller, Design specifications in time domain and frequency domain. Time design of P, PI, PID controllers. Frequency domain design of P, PI, PID controllers, Tuning of PID controllers. Zigler-Nichol Method. **(10 Hrs)**
Text Books	**:**	1. Control System Engineering - I.J. Nagrath, M. Gopal, New Age International Publishers, 4th Edition, 2006. 2. Modern control system engineering - Katsuhiko Ogata, Prentice Hall, 2010. 3. Control Systems Engineering - Natarajan Ananda, Babu P. Ramesh, Second Edition, Scitech Publication, 2010. 4. Automatic Control Engineering - Benjamin C. Kuo, Prentice Hall of India Pvt. Ltd.
Reference Books	**:**	1. Modern control system - Richard C Dorf and Robert H Bishop, Pearson Education, 12th edition, 2011. 2. Control Systems Engineering - Nise N. S., John Wiley & Sons, Incorporated, 2011. 3. Control Engineering: An Introductory Course - Jacqueline Wilkie, Michael Johnson, Reza Katebi, Palgrave Publication, 2002. 4. Modern Control Engineering - D. Roy Choudhary, PHI Learning Pvt. Ltd., 2005. 5. Control Systems: Theory and Applications - Smarajiti Ghosh, Dorling Kindersley (RS), 2012. 6. Control Systems – N.K. Sinha, New Age International (P) Ltd Publishers, 3rd Edition, 1998.

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI.

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- Two questions of 15 marks each from remaining questions from each section A and B be asked to solve.

COURSE OUTCOMES:

1. Students will be able to introduce about the basic concepts of control system, its types, modeling and block diagram reduction.
2. Students will be able to understand the modeling and transfer function of control system components, lag-lead networks.
3. Students will be able to analyze the time domain analysis of standard test signal, time response, steady state errors and design specifications.
4. Students will be able to analyze the concept of stability analysis and basic properties of root locus.
5. Students will be able to analyze the steady state response of systems, Bode plot, Polar plot, Nyquist plot and stability analysis.
6. Students will be able to understand the basic concept of PID controller, time domain and frequency domain design of P, PI, PID controllers.

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Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester - V

Code No. : EE305 **Title: Transmission and Distribution**
Teaching Scheme: 04 Hrs/week **Class Test: 20**
Theory : 04 Hrs/week **Theory Examination (Duration): 03 Hrs**
Credits: 04 **Theory Examination (Marks): 80**

Objectives	**:**	• To explain the generation of Electric Energy by different sources. • To describe the basic structure of power system and its components. • To explain Distribution system with classification and to describe the importance and equipment's used to improve the power factor. • To discuss the overhead transmission line and Underground cables.
Unit – I	**:**	**Mechanical design of Transmission Line:** Line supports, spacing between the conductors, length of span, calculation of sag, equal and unequal supports, and effect of ice and wind loadings, Types of insulators, pin type, suspension type and strain type insulators, voltage distribution along string of suspension insulators, string efficiency. Corona: Phenomenon of corona, factors affecting the corona, power loss & disadvantages **(12Hrs)**
Unit - II	**:**	**Inductance and Resistance of Transmission Line:** Definitions of Inductance, Flux Linkages of an isolated current carrying conductor, Inductance of 1-Phase two-wire line, Conductors types, Flux linkages of one conductor in group, Inductance of composite conductor lines, Inductance of 3-phase lines, Double circuit 3-phase lines, Bundle Conductor, Resistance, Skin effect and proximity effect, Magnetic field induction. **(10 Hrs)**
Unit – III	**:**	**Capacitance of Transmission Line:** Introduction**,** Electrical field of Long state conductor, Potential difference between two conductors of a group of parallel conductor, Capacitance of two wire line, Capacitance of 3-phase line with equilateral spacing, Capacitance of 3-phase line with unsymmetrical spacing, Effect of Earth on transmission line capacitance, Method of GMD (modified), Bundled Conductors, Electrostatic Induction. **(10 Hrs)**
Unit – IV	**:**	**Characteristics and Performance of Transmission Line**: Short, medium and long lines, Voltages and currents at sending and receiving end of line, Evaluation of ABCD constants, surge impedance loading of transmission line, Power flow through transmission line, Sending end and receiving power circle diagrams, Power transmission capability, Tuned power lines, Ferranti Effect, Nominal 'Pi' and 'Tee' Representation. **(12 Hrs)**
Unit – V	**:**	**Classification of Distribution Systems:** AC Distribution- Primary and Secondary Distribution systems, Overhead and Underground systems, Connection scheme of distribution system, Radial system, Ring main

		system, Interconnected systems, feeders and distributors, AC distribution calculations, carrier current equipments (P.L.C.C.) **(08 Hrs)**
Unit – VI	**:**	**Underground Cable:** Classification, Construction of cable, XLPE cables, insulation resistance, capacitance, cable faults and location of faults. **(08 Hrs)**
Text Books	**:**	1. A text book on Power System Engineering by A Chakraborty, M.L.Soni, P.V.Gupta, U.S. Bhatnagar,Dhanpat rai & Co., Delhi. 2. Power System Analysis & Design by B.R.Gupta, 4th Reprint, S.Chand Publishing Co. 3. Power System Analysis by W.D. Stevenson, Tata McGraw Hill Publications. 4. Transmission and Distribution by J.B. Gupta, S.K.Kataria& Sons, New Delhi. 5. Electric Power Generation, Transmission and Distribution by S.N.Singh, Prentice Hall of India.
Reference Books	**:**	1. Elements of Power Station Design by M.V. Deshpande, Wheeler Publishing. 2. Modern Power System Analysis by I.J. Nagrath and D.P.Kothari, Tata Mc Graw Hill Publications. 3. Generation and Economic Considerations by J.B.Gupta, S.K.Kataria& Sons, New Delhi. 4. Power System Engineering by Nagrath& Kothari, Tata McGraw Hill Publications. 5. Websites of MERC and MSEDCL 6. Power System Analysis by Arthur R. Bergen. Pearson Education, New Delhi.

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI.

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- Five questions in each section.
- Question No-1 from section A and Question No-6 from section B be made compulsory and should cover complete syllabus of the respective section and should be set for ten marks each. The Question no.1 and 6 should be of objective nature.
- Two questions of 15 marks each from remaining questions from each section A and B be asked to solve.

COURSE OUTCOMES:

1. Students will be able to understand the mechanical design of transmission line of line support, spacing between conductors, span calculations, insulator types and corona.
2. Students will be able to understand the Inductance and Resistance of transmission Line like double circuit, bundle conductors, skin effect and proximity effect.
3. Students will be able to introduce about the Capacitance of transmission line three-phase line with unsymmetrical spacing, equilateral spacing, bundled conductors and electrostatic induction.
4. Students will be able to understand the characteristics and performance of transmission line by evaluation of ABCD constants, surge impedance, power circle diagrams, Ferranti Effect, Nominal 'Pi' and 'Tee' Representation.
5. Students will be able to introduce about the classification of distribution system, connection scheme of distribution system.
6. Students will be able to understand the classification and construction of underground cable.

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Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester - V

Code No. : EE306 **Title: Energy Management**

Teaching Scheme: 02 Hrs/week **Class Test: 10**

Theory : 02 Hrs/week **Theory Examination (Duration): 02 Hrs**

Credits: 02 **Theory Examination (Marks): 40**

Objectives	**:**	• Assessing present pattern of energy consumption in different cost centers of operations • Relating energy inputs and production output • Identifying potential areas of thermal and electrical energy economy. • Highlighting wastage in major areas. Fixing of energy saving potential targets for individual cost centers. Implementation of measures of energy conservation and realization of savings.
Unit – I	**:**	**Introduction:** Classification of Energy resources, Energy scenario – world and India, energy consumption, conservation. **(04 Hrs)**
Unit - II	**:**	**Energy Management:** Definition and Objective of Energy Management, Block diagram of Energy Management, Principles of Energy management, Energy Management Strategy, Responsibilities and duties of energy manager under Act 2001. Energy Efficiency Programme. **(05 Hrs)**
Unit – III	**:**	**Energy Audit and Types:** Definition, need of energy audit, types of audit, Walk through audit, Detailed audit, Energy auditing equipments/instruments, Audit report procedures to follow, data and information analysis, Energy audit Instrumentation, Energy consumption – production relationship, pie charts. **(05 Hrs)**
Unit – IV	**:**	**Energy Audit Report:** Outcome of energy audit and energy saving potential, action plans for implementation of energy conservation options. Bench- marking energy performance of an industry. Energy Audit Report writing as per prescribed format. **(05 Hrs)**
Unit – V	**:**	**Energy Efficiency in Thermal Utilities**: Fuels and Combustion, Boiler, Steam systems, Furnance, Cogeneration, Waste heat recovery. **(05 Hrs)**
Unit – VI	**:**	**Energy Efficiency in Electrical Utilities:** Motive power (motor and drive system), Illumination, Ventilation (Fan, Blower, Compressors) and Air Conditioning systems, Pumping systems and chemical industries. **(06 Hrs)**
Text Books	**:**	1. Energy Management - W.R. Murphy and Mackay, B.S. Publication. 2. Industrial Energy Management Systems, Arry C. White, Philip S.Schmidt, David R. Brown, Hemisphere Publishing

		Corporation, New York. 3. Industrial Energy Conservation - Reay D.A, 1stedition, Pergamon Press, 1977. 4. Hand book on energy auditing - TERI (Tata Energy Research Institute).
Reference Books	**:**	1. Fundamentals of Energy Engineering - Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey. 2. Electrical Power distribution, A S. Pabla, TMH, 5th edition, 2004. 3. Recent Advances in Control and Management of Energy Systems, D.P.Sen, K.R.Padiyar, Indrane Sen, M.A.Pai, Interline Publisher, Bangalore, 1993. 4. Energy Demand – Analysis, Management and Conservation, Ashok V. Desai, Wiley Eastern, 2005. 5. Demand Side Managementm, Jyothi Prakash, TMH Publishers. 6. Energy Auditing made simple by Balasubramanian, Bala Consultancy Services. 7. NPC energy audit manual and reports. 8. Energy management handbook, John Wiley and Sons - Wayne C. Turner 9. Guide to Energy Management, Cape Hart, Turner and Kennedy 10. Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI.

Pattern of Question Paper:

The six units in the syllabus shall be divided in two equal parts i.e. 3 units respectively. Question paper shall be set having two sections A and B. Section-A questions shall be set on first part and Section-B questions on second part. Question paper should cover the entire syllabus.

For 40 marks Paper:

- Minimum ten questions.
- Five questions in each section.
- Question No-1 from section A and Question No-6 from section B be made compulsory and should cover complete syllabus of the respective section and should be set for ten marks each. The Question no.1 and 6 should be of objective nature.
- Two questions of 06 marks each from remaining questions from each section A and B be asked to solve.

COURSE OUTCOMES:

1. Students will be able to introduce about the classification of energy resources and energy situation.
2. Students will be able to understand about the objective, principle of energy management and block diagram, Energy management Act 2001.
3. Students will be able to understand about the need of energy audit and its types.
4. Students will be able to understand about the Outcome, Bench- marking and conservation options of energy audit report.
5. Students will be able to understand about the energy efficiency in thermal utilities.
6. Students will be able to understand about the energy efficiency in electrical utilities.

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(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester – V

Code No. : EE321 **Lab I:**

Title: Power Electronics

Teaching Scheme: 02Hrs/week **Teachers Assessment: 25M**

Practical: 25M **Credits: 01**

Course Objectives	**:**	To develop ability among students for problem formulation, system design and solving skills
List of Experiments	**:**	**Group A: Perform any SIX experiments (Hardware)** 1. Static VI characteristic of SCR and TRIAC (Both) 2. dv / dt and di / dt protection of SCR 3. Forced Commutation circuits (Class A,B,C,D & E) 4. VI Characteristic of MOSFET and IGBT (Both) 5. Single phase fully controlled converter with R and RL load 6. DC Step-down and Step-up chopper. 7. Single phase series and parallel inverter. 8. Single phase A.C. voltage regulator. **Group B: Perform any THREE experiments (Hardware/Software)** 1. Design of snubber circuit and verification using simulation. 2. Single phase half controlled converter with R and RL load 3. Three phase AC-DC fully controlled bridge converter 4. Three phase voltage source inverter using 120^0 and 180^0 mode 5. Study of cascaded type multilevel inverter 6. Harmonic analysis of three phase VSI inverter with different PWM techniques.
Reference Books	**:**	1. "Power Electronics" - M.H.Rashid, 2nd Edition, Pearson publication 2. "Power Electronics" - Ned Mohan, T.M. Undeland, W.P. Robbins, 3rd Edition, John Wiley and Sons 3. "Power Electronics" - B.W. Williams, 2nd edition, John Wiley and sons 4. "Power Electronics for Technology" - Ashfaq Ahmed-, LPE Pearson Edition. 5. "Power Electronics" - Dr. P.S. Bimbhra, Third Edition, Khanna Publication.

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above

The assessment of practical examination shall be on the following criteria:

The practical examination shall consist of performing an experiment based on the practical work done during the course, the record of the experiments submitted by the candidate and viva-voce based on the syllabus.

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Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester – V

Code No. : EE322	**Lab II:** **Title: Microprocessor and Microcontroller**
Teaching Scheme: 02Hrs/week	**Teachers Assessment: 25M**
Practical: 25M	**Credits: 01**

Course Objectives	**:**	**The student should be made to:** • Introduce microprocessor & microcontroller concepts and features. • Write ALP for various operations in 8085, 8086 and 8051 • Differentiate Serial and Parallel Interface. • Interface different I/Os with Microprocessors & microcontroller.
List of Experiments	**:**	**Section A(Perform any SIX Experiments)** 1. Study of 8085 Microprocessor Kit used in laboratory. 2. Write a program to transfer a block of 10 bytes. 3. Write a program to find largest/smallest numbers from the array. 4. Write a program for data sorting in ascending and descending order. 5. Interfacing of 8255 study card with microprocessor 8085. 6. Interfacing of LED with 8085 through 8255 in mode 1/mode2 8085. 7. Interfacing of A/D converter with microprocessor 8085. 8. Study of 8086 Microprocessor Kit used in laboratory. 9. Write a program to add and Subtract two 16- bit number using 8086. **Section B (Perform any THREE Experiments)** 1) Write a program to multiplication and division using MUL and DIV instructions. 2) Write a program to find the sum of two numbers in decimal? 3) Write program for sorting the given set of numbers. 4) Interfacing DAC and ADC to the 8051. 5) Study of Interfacing Stepper motor with PIC 18F458
Reference Books	**:**	1) Microprocessor Architecture, Programming, and Applications with the 8085, By Romesh Gaonkar, Penram International Publishing (India) LTD. 2) Yu-Cheng Liu, Glenn A.Gibson, "Microcomputer Systems: The 8086 / 8088 Family – Architecture, Programming and Design", Second Edition, Prentice Hall of India, 2007. 3) Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson Education, 2011. 4) http://ww1.microchip.com/downloads/en/DeviceDoc/39564c.pdf

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above

The assessment of practical examination shall be on the following criteria:

The practical examination shall consist of performing an experiment based on the practical work done during the course, the record of the experiments submitted by the candidate and viva-voce based on the syllabus.

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Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester – V

Code No. : EE323 **Lab III:**

Title: Design of Electrical Machines

Teaching Scheme: 02Hrs/week **Teachers Assessment: 50M**

Credits: 01

Course Objectives	**:**	To develop ability among students for problem formulation, system design and solving skills
Term Work	**:**	The term work shall consist of three drawing sheets (**Minimum two** in AutoCAD/ Matlab). 1. Assembly of DC Machines (only sheet) 2. Details and layout of AC winding with design (only sheet). 3. Details and assembly of 3- phase transformer with design report. 4. Assembly of 3- phase induction motor.(only sheet) 5. Assembly of 3- phase Synchronous motor.(only sheet) 6. Report based on Industrial visit to a manufacturing unit. (Transformer or Induction motor).
Reference Books	**:**	1. Theory and Performance and Design of A.C. Machines - M.G. Say, 3rd Edition, ELBS London. 2. A Course in Electrical Machine Design - A.K.Sawhney, 10th Edition, - Dhanpat Rai and sons New Delhi. 3. Design of Electrical Machines - K. G. Upadhyay, New age publication. 4. Principles of Electrical Machine Design - R. K. Agarwal, S. K.Katariya and sons. 5. Design of Transformers - Indrajit Dasgupta, TMH

* The Term Work shall be preferred on Software.

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above

The assessment of practical examination shall be on the following criteria:

The practical examination shall consist of performing an experiment based on the practical work done during the course, the record of the experiments submitted by the candidate and viva-voce based on the syllabus.

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Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester – V

Code No. : EE324 **Lab IV:**

Title: Control System Engineering

Teaching Scheme: 02Hrs/week **Teachers Assessment: 25M**

Practical: 25M **Credits: 01**

Course Objectives	**:**	To develop ability among students for problem formulation, system design and solving skills
List of Experiments	**:**	**A) Minimum SEVEN experiments should be conducted.** 1. Experimental analysis of D.C. Position Control System. 2. Experimental determination of DC servo motor parameters for mathematical modeling, transfer function and characteristics. 3. Experimental determination of AC servo motor parameters for mathematical modeling, transfer function and characteristics. 4. Syncro Transmitter & receiver: Modeling, characteristics and transfer function. 5. Experimental study of time response characteristics of R-L-C second order system: Validation using simulation. 6. Experimental frequency response determination of Lag and Lead compensator. 7. Experimental determination of transfer functions of two tank system. 8. PID control of level/Pressure/Temperature control system. **B) Minimum THREE experiments should be conducted.** 1. Stability analysis using a) Bode plot b) Root locus c) Nyquist plot using software. 2. Time response of second order system effect of P, PI, PID on it. 3. Analysis of closed loop DC position control system using PID controller. 4. Effect of addition of pole-zero on root locus of second order system.
Reference Books	**:**	1. Control System Engineering - I.J. Nagrath, M. Gopal, New Age International Publishers, 4th Edition, 2006. 2. Modern control system engineering - Katsuhiko Ogata, Prentice Hall, 2010. 3. Control Systems Engineering - Natarajan Ananda, Babu P. Ramesh, Second Edition, Scitech Publication, 2010. 4. Automatic Control Engineering - Benjamin C. Kuo, Prentice Hall of India Pvt. Ltd.

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above

The assessment of practical examination shall be on the following criteria:

The practical examination shall consist of performing an experiment based on the practical work done during the course, the record of the experiments submitted by the candidate and viva-voce based on the syllabus.

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(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester - VI

Code No. : EE351 **Title: Power System Analysis**
Teaching Scheme: 04Hrs/week **Class Test: 20**
Theory : 03 Hrs/week **Theory Examination (Duration): 03 Hrs**
Tutorial: 01Hr/week **Theory Examination (Marks): 80**
Credits: 04

Objectives	**:**	• The present day power systems are characterized by large high interconnected network. Extensive system studies are required at almost all stages of its planning, operation and control. • Apply this knowledge to model and predict system behaviour. • Apply this knowledge to design power transmission and distribution systems to meet needs. • Simulation and analysis of such a large system is possible only with the help of digital computers. Most of the time, a power system, theoretically, remains under steady state.
Unit – I	**:**	**Representation of Power system Components**: Introduction (Characteristics of Modern Power Systems) Physical Structure, OLD & Impedance & Reactance Diagram, Per Unit System- P.U. Representation of Transformer, P.U. Impedance Diagram of Power system, Steady State Model of Synchronous Machine, Numerical treatment expected. **(10 Hrs)**
Unit - II	**:**	**Symmetrical Fault Analysis:** Transients on transmission line, Short Circuit on Unloaded Synchronous machine, Short Circuit on loaded Synchronous machine **,** Selection Checklist for circuit breaker, Short circuit MVA, Algorithm for Short circuit studies **,** Z- Bus Formulation, Numerical treatment expected. **(10 Hrs)**
Unit – III	**:**	**Symmetrical Components:** Sequence Impedances Synchronous machine, Sequence Impedances Transformer, Construction of Sequence network of Power Systems, Numerical treatment expected. **(10 Hrs)**
Unit – IV	**:**	**Unsymmetrical Fault Analysis** Symmetrical component analysis of Unsymmetrical Faults, Analysis of Single Line to Ground (LG) fault, Line-To-Line (LL) fault, Double-Line-To-Ground (LLG) fault, One conductor open fault, Bus Impedance Matrix for analysis of Unsymmetrical shunt faults, Numerical treatment expected. **(10 Hrs)**
Unit – V	**:**	**Load Flow Analysis** Load flow problem, Gauss-Seidel Method, Newton-Raphson Method, Decoupled Load Flow studies, Fast Decoupled Load Flow studies. Comparison of Load Flow methods, Numerical treatment expected. **(12 Hrs)**
Unit – VI	**:**	**Load dispatch center** Load dispatch center function, contingency analysis, preventive, emergency and restorative control. **(08 Hrs)**

Text Books	**:**	1. Modern Power System Analysis - I.J. Nagrath& D.P. Kothari, Tata McGraw Hill, New Delhi. 2. Power System Analysis and Design - B R Gupta , S.Chand 3. Power System Analysis - Abhijit Chakraborty and SunitaHaldar, J.B.Gupta."A course in power systems" 4. Power System Analysis - P.S.R. Murthy, B.S. Publications. 5. Power System Analysis - Hemalatha and Jayachrista, Scitech Publication. 6. Electrical Power Systems, Ashfaq Hussain, CBS publishers, New Delhi V edition
Reference Books	**:**	1. Power System Analysis - H. Hadi Sadat, Tata McGraw-Hill New Delhi. 2. Computer Methods in Power System Analysis - Stagg &Abid, Tata McGraw Hill, New Delhi. 3. Electric Power Systems: Design and Analysis - M.E.El-Hawary, IEEE Press, New York 4. Elements of Power System Analysis - Stevenson W.D. (4thEd.) Tata McGraw Hill, New Delhi.

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI.

Pattern of Question Paper:

The Six units in the syllabus shall be divided in two equal parts i.e. 3 units respectively. Question paper shall be set having two sections A and B. Section A questions shall be set on first part and Section B questions on second part. Question paper should cover the entire syllabus.

For 80 marks Paper:

- Minimum ten questions.
- Five questions in each section.
- Question No-1 from section A and Question No-6 from section B be made compulsory and should cover complete syllabus of the respective section and should be set for ten marks each. The Question no.1 and 6 should be of objective nature.
- Two questions of 15 marks each from remaining questions from each section A and B be asked to solve.

COURSE OUTCOMES:

1. Students will be able to introduce about the Characteristics of Modern Power Systems, Physical Structure, Steady State Model of Synchronous Machine and Numerical treatment.
2. Students will be able to understand symmetrical fault analysis, algorithm for Short circuit studies, Z- Bus Formulation and Numerical treatment.
3. Students will be able to understand the Impedances of Synchronous machine, transformer and Construction of Sequence network of Power Systems, Numerical treatment.
4. Students will be able to analyze component analysis of unsymmetrical faults, bus impedance matrix for analysis of unsymmetrical shunt faults and numerical treatment.
5. Students will be able to understand different load flow analysis and Comparison of load flow methods and numerical treatment.
6. Students will be able to understand the load dispatch center function, contingency analysis, preventive, emergency and restorative control.

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(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester - VI

Code No. : EE352 **Title: Digital Signal Processing**
Teaching Scheme: 04 Hrs/week **Class Test: 20**
Theory : 03 Hrs/week **Theory Examination (Duration): 03 Hrs**
Tutorial: 01Hr/week **Theory Examination (Marks): 80**
Credits: 04

Objectives	**:**	• To elaborate Sampling theorem, classification of discrete signals and systems • To analyze DT signals with Z transform, inverse Z transform and DTFT • To describe Frequency response of LTI system • To introduce Digital filters and analyze the response • To demonstrate DSP Applications in electrical engineering
Unit – I	**:**	**Introduction:** Discrete Time Signals, Shannon's sampling theorem, Difference equation description, characteristics of digital filters and time domain analysis, properties of discrete time system (linearity, time-variance, convolution), BIBO stability, Z-transformation and their application in solving difference equations, Relationship between Laplace and Z-transforms. **(10Hours)**
Unit - II	**:**	**Frequency domain analysis:** Discrete Time Fourier Transform (DTFT) and Discrete fourier Transform (DFT), Periodic convolution, Direct evaluation of DFT, FFT algorithms decimation, in time and frequency, Relationship between Fourier and Z-transforms. **(10Hours)**
Unit – III	**:**	**Digital Filter Structures:** Direct form I&II, cascade, parallel and ladder realizations. Filter Function Approximations and Transformations. Review of approximations of ideal analog filter response, Butterworth filter, Chebyshev Type I & II. **Frequency Transformations:** Frequency transformation in analog domain, frequency transformation in digital domain. . (**10Hours**)
Unit – IV	**:**	**Design of Filters:** **Design of IIR Filter:** Design based on analog filter approximations, Impulse invariance method, Matched Z-transformation, Bilinear transformation. **Design of FIR filters**: Symmetric and anti-symmetric FIR filters, design of linear phase FIR filters using windows and frequency – sampling methods, design of optimum equiripple linear phase FIR filters, comparison of FIR and IIR filters. (**10Hours)**

Unit – V	**:**	**Mathematical background to protection algorithms:** Finite difference techniques, Interpolation formulas: forward, backward and central difference interpolation, Numerical differentiation, Curve fitting and smoothing, Least squares method, Fourier analysis, Fourier series and Fourier transform, Walsh function analysis. Sinusoidal wave based algorithms: Sample and first derivative (Mann and Morrison) algorithm. Fourier and Walsh based algorithms: Fourier Algorithm: Full cycle window algorithm, fractional cycle window algorithm. Walsh function based algorithm. **(13 Hours)**
Unit – VI	**:**	**Applications:** Measurement of magnitude and phase of voltage, current, power and frequency, power factor correction, harmonic analysis, and measurement, application to machine control, DSP based protective relaying **(07 Hours)**
Text Books	**:**	1. Digital signal processing - Proakis J., Manolakis D., 3rd Edition, Prentice Hall, ISBN 81- 203-0720-8 2. Digital Signal Processing - P. Ramesh Babu, 4th Edition Scitech Publication 3. Digital Signal Processing - Dr.S. D. Apte, 2nd Edition Wiley India Pvt. Ltd ISBN: 978-81-265-2142-5 4. Digital Signal Processing in Power system Protection and Control - W.Rebizant, J.Szafran, A.Wiszniewski, Springer 2011 ISBN 978-0-85729-801-0
Reference Books	**:**	1. Digital Signal Processing: A Computer Based Approach - Mitra S., Tata McGraw-Hill, 1998, ISBN 0-07-044705-5 2. Discrete Time Signal Processing - A.V. Oppenheim, R. W. Schafer, J. R. Buck, 2nd Edition Prentice Hall, ISBN 978-81-317-0492-9

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI.

Pattern of Question Paper:

The Six units in the syllabus shall be divided in two equal parts i.e. 3 units respectively. Question paper shall be set having two sections A and B. Section A questions shall be set on first part and Section B questions on second part. Question paper should cover the entire syllabus.

For 80 marks Paper:

- Minimum ten questions.
- Five questions in each section.
- Question No-1 from section A and Question No-6 from section B be made compulsory and should cover complete syllabus of the respective section and should be set for ten marks each. The Question no.1 and 6 should be of objective nature.
- Two questions of 15 marks each from remaining questions from each section A and B be asked to solve.

COURSE OUTCOMES:

1. Students will be able to introduce about the properties of discrete time system, Shannon's sampling theorem, difference equations, characteristics of digital filters, relationship between Laplace and Z-transforms.
2. Students will be able to understand the discrete time fourier transform, Periodic convolution, algorithms, relationship between Fourier and Z-transforms.
3. Students will be able to understand the realization of cascade, parallel and ladder type filters, transformations, Butterworth filter and Chebyshev filter.
4. Students will be able to understand the design of IIR and FIR filters based on various transformation techniques.
5. Students will be able to understand the mathematical background to protection algorithms like finite difference techniques, interpolation formulas, Fourier series and transform, sinusoidal difference techniques and Walsh function algorithm.
6. Students will be able to understand the overall application of digital signal processing over electrical parameters.

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(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester - VI

Code No. : EE353 **Title: Electrical Drives**

Teaching Scheme: 04 Hrs/week **Class Test: 20**

Theory : 04 Hrs/week **Theory Examination (Duration): 03 Hrs**

Credits: 04 **Theory Examination (Marks): 80**

Objectives	**:**	• To understand the motor drivers and control • In-depth study on recent drives and its applications
Unit – I	**:**	**Introduction:** Definition, Advantages of electrical drives, Components of Electric drive system, Selection Factors, Types of Electrical Drives (DC & AC). Motor-Load Dynamics, Speed Torque conventions and multi quadrant operation, Equivalent values of drive parameters. Load Torque Components, Nature and classification of Load Torques, Constant Torque and Constant Power operation of a Drive. Steady state stability, Load equalization by using flywheel. **(10 Hrs)**
Unit - II	**:**	**Solid state controlled D.C. Motors:** Single phase and three phases fully controlled converter drives and performance of converter fed separately excited DC Motor for starting and speed control operations. Chopper controlled drives for separately excited and series DC Motor operations. Closed loop speed control of DC motor below and above base speed. **(10 Hrs)**
Unit – III	**:**	**Solid State Controlled Induction Motors:** Thyristorised stator voltage control (using ac regulators, for fixed frequency variable voltage control), Transistorised stator frequency control: v/f control, voltage source inverter (VSI) control, Steady State Analysis, current source inverter (CSI) control, Regenerative braking and multi quadrant operation of Induction motor drives, relative merits and demerits of VSI and CSI for induction motor drives. **(10 Hrs)**
Unit – IV	**:**	**Synchronous Motor Drives:** Review of starting, pull in and braking of Synchronous motor, Static variable frequency control for Synchronous motors, Load commutated inverter fed Synchronous motor drive, Introduction to closed loop control of Load commutated inverter fed Synchronous motor drive. **(10 Hrs)**
Unit – V	**:**	**Energy Saving Techniques:** Calculation of time and energy loss in transient operations: Starting, Speed variation and Braking. Energy Saving in starting of Induction Motor Drive: Static rotor resistance control, Slip Power recovery schemes: Static Scherbious Drive, Static Kramer Drive Energy Saving in running of Induction Motor Driving Pump and Blower: Consideration of load torque characteristics and energy saving calculations. Power Rating: Selection criteria of motors, motor duties, inverter duty motors.

		Load diagram, Heating and cooling, Thermal Resistance, determination of HP rating of motor based on duty cycle, de-rating of motor, effect of harmonic current and voltage harmonics, short time rating. **(10 Hrs)**
Unit – VI	**:**	**Latest Trends In Drives And Industrial Applications:** Latest trends in Drives: Rotor flux oriented vector control for induction motor drives. Commutator less DC Motor (How Induction Motor is converted to Characteristics of DC Motor), AC Servo Drives. Industrial Applications: Drives for Rolling mills (Four Quadrant Operation), Machine tools (Constant Torque Application), Textile mills (Synchronized operation of Drive in Tandem), Sugar Mills: Centrifuged Drive, Traction drives. **(10 Hrs)**
Text Books	**:**	1. Fundamentals of Electric Drives - G. K. Dubey, 2nd Edition, Narosa Publishing House 2. Electric Drives - N. K. De, P. K. Sen, Prentice Hall of India Eastern Economy Edition 3. Analysis of Thyristor Power Conditioned Motors - S. K. Pillai, University Press
Reference Books	**:**	1. Modern Power Electronics and AC Drives - K. Bose, Pearson Education 2. Practical Variable Speed Drives and Power Electronics - Malcolm Barnes, Newnes 3. Electric Motor Drives – Modeling Analysis and Control - R. Krishnan, PHI India 4. Electric Drives: Concepts & Application - V. Subrahmanyam, Tata Mc-Graw Hill (An imprint of Elsevier)

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI.

Pattern of Question Paper:

The Six units in the syllabus shall be divided in two equal parts i.e. 3 units respectively. Question paper shall be set having two sections A and B. Section A questions shall be set on first part and Section B questions on second part. Question paper should cover the entire syllabus.

For 80 marks Paper:

- Minimum ten questions.
- Five questions in each section.
- Question No-1 from section A and Question No-6 from section B be made compulsory and should cover complete syllabus of the respective section and should be set for ten marks each. The Question no.1 and 6 should be of objective nature.
- Two questions of 15 marks each from remaining questions from each section A and B be asked to solve.

COURSE OUTCOMES:

1. Students will be able to introduce about the components, selection factors, Types, classification and multi quadrant operation of electric drive system.
2. Students will be able to understand the various performance characteristics of solid state controlled D.C. Motors.
3. Students will be able to understand the various performance characteristics of solid state controlled Induction Motors.
4. Students will be able to understand the concepts of starting, braking, variable frequency control, load commutation and closed loop control of Synchronous motor drive.
5. Students will be able to understand the energy saving in starting of various motor drives, static Scherbious drive, Static Kramer drive, load diagram, current and voltage harmonics.
6. Students will be able to understand the latest trends in Electric drives and its industrial applications.

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(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester - VI

Code No. : EE354 **Title: Electro Magnetic Field**

Teaching Scheme: 04Hrs/week **Class Test: 20**

Theory : 03 Hrs/week **Theory Examination (Duration): 03 Hrs**

Tutorial: 01Hr/week **Theory Examination (Marks): 80**

Credits: 04

Objectives	**:**	• To impart knowledge on the basics of Static Electric and Static Magnetic Field and the associated laws. • To understand the boundary conditions • To analyze time varying electric and magnetic fields. • To understand Maxwell's equation in different form and media. • To give insight to propagation of EM waves
Unit – I	**:**	**Scalars and Vectors:** Scalar, Vector algebra, Unit Vector, Vector arithmetic Distance Vector, Vector multiplication- Dot & Cross Product Projection of a vector on other vector Scalar triple product Coordinate systems – rectangular, Cylindrical, Spherical Transformations-Cartesian, cylindrical and spherical coordinates. **(10 Hrs)**
Unit - II	**:**	**Static Electric Field:** Gradient, Divergence, Curl, Divergence theorem, Coulombs law, Electric field intensity over Point charge, Line charge, Surface charge and Volume charge distributions, Electric flux density, Gauss law and its applications, Gauss divergence theorem, Absolute Electric potential, Potential difference, Calculation of Potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density. **(10 Hrs)**
Unit – III	**:**	**Conductors, Dielectrics and Capacitance:** Current and current density, Continuity of current, Boundary conditions of perfect dielectric materials, Capacitance - Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations. **(10 Hrs)**
Unit – IV	**:**	**Static Magnetic Fields:** Biot-Savart Law, Ampere's Circuital Law, Stokes theorem, Magnetic flux and magnetic flux density, The Scalar and Vector Magnetic potentials, Derivation of Steady magnetic field Laws. **(08 Hrs)**
Unit – V	**:**	**Time Varying Fields and Maxwell's Equations:** Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces. **(10 Hrs)**

Unit – VI	**:**	**Electromagnetic Waves:** Derivation of Wave Equation – Uniform Plane Waves – Maxwell's equation in Phasor form – Wave equation in Phasor form – Plane waves in free space and in a homogenous material. Wave equation for a conducting medium – Plane waves in lossy dielectrics – Propagation in good conductors – Skin effect. Poynting's theorem. **(12 Hrs)**
Text Books	**:**	1. Engineering Electromagnetics - W H.Hayt & J A Buck, TATA McGraw-Hill, 7th Edition 2007. 2. Outline Theory and Problem of Electromagnetics – Edimister, TATA McGraw-Hill. 3. Electromagnetic Field Theory - S. P. Ghosh, Lipika Datta, McGraw-Hill Education India Private Limited. 4. Principles of Electromagnetics - Matthew N.O. Sadiku, Oxford University Press Inc, New Delhi, 2009. 5. Electromagnetic waves and Radiating Systems - Edward C. Jordan and Keith G. Balmain, PHI, 2nd Edition.
Reference Books	**:**	1. Electromagnetism - Ashutosh Pramanik, PHI Learning Private Limited, 2014 2. Electromagnetics with applications - Kraus Fleisch, McGraw Hill, 5th Edition. 3. Electromagnetic Field Theory Fundamentals - Bhag Singh Guru, Huseyin R. Hiziroglu, Cambridge University Press, 2nd Edition.

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI.

Pattern of Question Paper:

The Six units in the syllabus shall be divided in two equal parts i.e. 3 units respectively. Question paper shall be set having two sections A and B. Section A questions shall be set on first part and Section B questions on second part. Question paper should cover the entire syllabus.

For 80 marks Paper:

- Minimum ten questions.
- Five questions in each section.
- Question No-1 from section A and Question No-6 from section B be made compulsory and should cover complete syllabus of the respective section and should be set for ten marks each. The Question no.1 and 6 should be of objective nature.
- Two questions of 15 marks each from remaining questions from each section A and B be asked to solve.

COURSE OUTCOMES:

1. Students will be able to introduce about the scalars, vectors, dot and cross products and various coordinate systems.
2. Students will be able to understand the Gauss law, Coulombs law, divergence theorem, electric field intensity over point charge, line charge, surface charge and volume charge distribution and potential difference for different configurations.
3. Students will be able to understand the boundary conditions of perfect dielectric materials, Poisson's equations, Laplace equations and its applications.
4. Students will be able to understand the Biot-Savart law, Ampere's circuital law, Stokes theorem, magnetic flux density and derivations of steady state magnetic field.
5. Students will be able to understand the Faraday's Law, displacement current, Maxwell's equations in point form and integral form.
6. Students will be able to understand the derivation of wave equations for conduction medium, Maxwell equations in Phasor form, Plane waves in free space, homogeneous material, lossy dielectrics, Poynting's theorem.

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(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester - VI

Code No. : EE355 **Title: Electrical Testing and Maintenance**

Teaching Scheme: 02Hrs/week **Class Test: 10**

Theory : 02 Hrs/week **Theory Examination (Duration): 02 Hrs**

Credits: 02 **Theory Examination (Marks): 40**

Objectives	**:**	• To understand the basic concepts, design and estimation of distribution systems, substation • To enable candidate to design Earthing System for residential and commercial • To understand practical aspects of condition monitoring and maintenance of various electrical equipments • To learn the testing of various electrical equipments.
Unit – I	**:**	**Maintenance and Condition Monitoring:** Importance and necessity of maintenance, Planned and preventive maintenance of transformer, induction motor and alternator. Insulation stressing factors, insulation deterioration, polarization index, dielectric absorption ratio. Concept of condition monitoring of electrical equipments. **(03 Hrs)**
Unit - II	**:**	**Condition Monitoring of Transformer:** Testing and condition monitoring of oil as per the IS/IEC standards. Filtration/reconditioning of insulating oil. Failure modes of transformer. Condition monitoring of transformer bushings, On load tap changer, dissolved gas analysis, degree of polymerization. IS/Specifications for testing of transformer bushing and oil. **(05 Hrs)**
Unit – III	**:**	**Condition Monitoring of Induction Motor:** Parameters of induction motors, Induction motor fault diagnostic methods, the induction motor fault monitoring method and Remedies. **(03 Hrs)**
Unit – IV	**:**	**Underground Cables:** Inspection, storage, transportation and handling of cables, cable handing equipment, cable laying depths and clearances (water sewerage, gas, heating), power and telecommunication cables, excavation of trenches, direct cable laying, laying of cables into pipes and conduits, cable filling compounds epoxy resins and hardeners, cable jointing and terminations testing and commissioning. **(07 Hrs)**
Unit – V	**:**	**Testing of Electrical Equipments**: i) Testing of Power cables – Causes of cable failure, fault location methods and Remedial actions. ii) Testing of Transformer - Type tests, Routine tests and Special tests. Various abnormal conditions, trouble shooting, faults, causes and remedies iii)Testing of Induction motor – Various abnormal conditions, trouble

		shooting, faults, causes and remedies. **(05 Hrs)**
Unit – VI	**:**	**Substation:** Classification and types of substation, Indoor and Outdoor substations: Bus bar arrangements in substations, Substation earthing system, Types of earthing (Equipment and Neutral), Maintenance free earthing system. Methods of testing earth resistance. **(07 Hrs)**
Text Books	**:**	1. Testing Commissioning Operation and Maintenance of Electrical Equipment - S. Rao, Khanna publishers. 2. Electrical Power - S.L.Uppal, Khanna Publishers Delhi. 3. Hand book of condition monitoring by B.K.N.Rao, Elsevier Advance Tech.,Oxford(UK). 4. Preventive Maintenance of Electrical Apparatus - S. K. Shastri, Katson Publication House 5. Operation and Maintenance of Electrical Equipment - B. V. S. Rao, Asia Publication
Reference Books	**:**	1. Power system analysis and design - B. R. Gupta, 3th edition wheelers publication. 2. Electric power distribution - P.S. Pabla, 5th edition, Tata McGraw Hill. 3. Electrical Wiring and costing Estimation - S. L. Uppal, Khanna Publishers, New Delhi. 4. Electrical wiring, Estimation and Costing - Surjit Singh, Dhanpat Rai and company, a. New Delhi. 5. Electrical Design, Estimating and Costing - Raina K.B. and Bhattacharya S.K., Tata McGraw Hill, New Delhi 6. Electrical wiring, Estimation and Costing - B.D. Arora, New Heights, New Delhi. 7. Elements of Power Station Design and Practice - M.V. Deshpande, Wheelers Publication.

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI.

Pattern of Question Paper:

The Six units in the syllabus shall be divided in two equal parts i.e. 3 units respectively. Question paper shall be set having two sections A and B. Section A questions shall be set on first part and Section B questions on second part. Question paper should cover the entire syllabus.

For 40 marks Paper:

- Minimum ten questions.
- Five questions in each section.
- Question No-1 from section A and Question No-6 from section B be made compulsory and should cover complete syllabus of the respective section and should be set for ten marks each. The Question no.1 and 6 should be of objective nature.
- Two questions of 06 marks each from remaining questions from each section A and B be asked to solve.

COURSE OUTCOMES:

1. Students will be able to introduce about the importance and necessity of maintenance, insulation stressing factors, polarization index, concept of condition monitoring.
2. Students will be able to understand the testing and condition monitoring of transformers as per the standards.
3. Students will be able to understand the conditioning monitoring of induction motor like fault diagnostic methods, fault monitoring methods and its remedies.
4. Students will be able to understand the inspection, transportation, and handling. Laying depth and clearance, resins and hardeners, jointing and termination, testing and commissioning of cables.
5. Students will be able to understand the testing of power cables, transformers and induction motors.
6. Students will be able to understand the classification and types of substations, Earthing types and methods of testing earth resistance.

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(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester – VI

Code No. : EE371 **Lab VI:**

Title: Power System Analysis

Teaching Scheme: 02Hrs/week **Teachers Assessment: 25M**

Practical: 25M **Credits: 01**

Course Objectives	**:**	To develop ability among students by hardware and professional software's
List of Experiments **(Minimum 10 Experiments)**	**:**	1. Measurement of ABCD parameters of a medium transmission line 2. Measurement of ABCD parameters of a long transmission line 3. Plotting of receiving end circle diagram to evaluate performance of medium transmission line 4. Study of the effect of VAR compensation on the profile of receiving end voltage using capacitor bank. 5. Static measurement of sub-transient reactances of a salient-pole alternator. 6. Measurement of sequence reactances of a synchronous machine. 7. Formulation and calculation of Y- bus matrix of a system using software. 8. Unsymmetrical fault analysis of a 3-bus system a software 9. Calculation of inductance and capacitance for symmetrical and unsymmetrical configuration of transmission line using software. 10. Solution of a load flow problem using Gauss-Seidal method using software. 11. Solution of a load flow problem using Newton-Raphson method using software.
Reference Books	**:**	1. Modern Power System Analysis - I.J. Nagrath& D.P. Kothari, Tata McGraw Hill, New Delhi. 2. Power System Analysis and Design - B R Gupta , S.Chand 3. Power System Analysis - Abhijit Chakraborty and SunitaHaldar, J.B.Gupta."A course in power systems" 4. Power System Analysis - P.S.R. Murthy, B.S. Publications. 5. Power System Analysis - Hemalatha and Jayachrista, Scitech Publication. 6. Electrical Power Systems, Ashfaq Hussain, CBS publishers, New Delhi V edition

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above

The assessment of practical examination shall be on the following criteria:

The practical examination shall consist of performing an experiment based on the practical work done during the course, the record of the experiments submitted by the candidate and viva-voce based on the syllabus.

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(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester – VI

Code No. : EE372 | **Lab VII: Title: Digital signal Processing**

Teaching Scheme: 02Hrs/week | **Teachers Assessment: 25M**

Practical: 25M | **Credits: 01**

Course Objectives	**:**	• To elaborate Sampling theorem, classification of discrete signals and systems • To analyze DT signals with Z transform, inverse Z transform and DTFT • To describe Frequency response of LTI system • To introduce Digital filters and analyze the response • To demonstrate DSP Applications in electrical engineering
List of Experiments	**:**	**GROUP-A (Perform any SEVEN Experiments)** 1. Plotting of discrete time waveforms (a) Sine, (b) Unit Step, (c) Exponential. 2. Verification of Z-transform properties (any two) 3. Find Linear convolution and correlation of signals 4. Plot frequency response of given system function (Magnitude & Phase) 5. Find DFT & IDFT of sequence 6. Find Circular convolution Using DFT IDFT method and linear convolution using Circular convolution. 7. DIT- FFT or DIF-FFT algorithm 8. Design of IIR filters (Butterworth method). 9. Design of FIR filters (window (any one) method). **GROUP-B (Perform any THREE Experiments)** 1. Verification of Sampling Theorem. 2. Implementation Mann and Morrison Algorithm. 3. Implementation Least squares method. 4. Harmonic analysis of any non sinusoidal signal using Fourier analysis.
Reference Books	**:**	1. Digital signal processing - Proakis J., Manolakis D., 3rd Edition, Prentice Hall, ISBN 81- 203-0720-8 2. Digital Signal Processing - P. Ramesh Babu, 4th Edition Scitech Publication 3. Digital Signal Processing - Dr.S. D. Apte, 2nd Edition Wiley India Pvt. Ltd ISBN: 978-81-265-2142-5 4. Digital Signal Processing in Power system Protection and Control - W.Rebizant, J.Szafran, A.Wiszniewski, Springer 2011 ISBN 978-0-85729-801-0

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above

The assessment of practical examination shall be on the following criteria:

The practical examination shall consist of performing an experiment based on the practical work done during the course, the record of the experiments submitted by the candidate and viva-voce based on the syllabus.

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(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester – VI

Code No. : EE373 **Lab VIII:**

Title: Electrical Drives

Teaching Scheme: 02Hrs/week **Teachers Assessment: 25M**

Practical: 25M **Credits: 01**

Course Objectives	**:**	• To understand the motor drivers and control • In-depth study on recent drives and its applications
List of Experiments **(Minimum 10 Experiments)**	**:**	1. Study of Electrical braking of D.C. Shunt motor (Rheostatic, Plugging). 2. Study of Electrical braking of 3-phase Induction Motor (DC Dynamic Braking, Plugging). 3. Study of Single phase converter fed separately excited D.C. motor speed control characteristics (Fully controlled /Semi controlled). 4. Study of Three phase (Fully controlled/Semi controlled) converter fed / Dual converter fed/ separately excited D.C. motor (Open Loop Control). 5. Study of Chopper fed D.C. series motor speed control characteristics. 6. Study of VSI fed 3-phase Induction motor (using V/f control PWM inverter) speed control characteristics. 7. Study of Solid state stator voltage control of 3-phase Induction motor (Using AC voltage Regulator). 8. Study of Closed loop speed control of separately excited D.C. motor/ Induction Motor. 9. Simulation of starting characteristics of D.C. / 3-phase Induction motor. 10. Simulation of an electric drive system for steady state and transient analysis. 11. Energy saving Experiment for determining percentage energy saving with damper (Conventional) Control and AC Drive Control. 12. Study of parameterization of drives (AC/DC) using manufacturer's drive manual.
Reference Books	**:**	1. Fundamentals of Electric Drives - G. K. Dubey, 2nd Edition, Narosa Publishing House 2. Electric Drives - N. K. De, P. K. Sen, Prentice Hall of India Eastern Economy Edition 3. Analysis of Thyristor Power Conditioned Motors - S. K. Pillai, University Press

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above

The assessment of practical examination shall be on the following criteria:

The practical examination shall consist of performing an experiment based on the practical work done during the course, the record of the experiments submitted by the candidate and viva-voce based on the syllabus.

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(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester - VI

Code No. : EE391 **Title: Recent Trends in Power System**

Teaching Scheme: 04 Hrs/week **Class Test: 20**

Theory : 04 Hrs/week **Theory Examination (Duration): 03 Hrs**

Credits: 04 **Theory Examination (Marks): 80**

Objectives	**:**	• To provide students with in-depth understanding of smart grid technology and systems. • To provide students with the principles, devices used to harness solar energy. • To provide students with in-depth understanding of recent technologies in Photo voltaic. • To provide students with in-depth understanding of energy storage systems required in power system.
Unit – I	**:**	**Introduction to Smart Grid** Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid, Case study of Smart Grid, CDM opportunities in Smart Grid. **(10 Hrs)**
Unit - II	**:**	**Smart Grid Technologies - I** Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers **(10 Hrs)**
Unit – III	**:**	**Smart Grid Technologies - II** Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU). **(12 Hrs)**
Unit – IV	**:**	**Microgrids and Distributed Energy Resources** Concept of microgrid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, thin film solar cells, Variable speed wind generators, fuel cells, micro-turbines, Captive power plants, Integration of renewable energy sources. **(10 Hrs)**
Unit – V	**:**	**Technologies in Solar Photo Voltaic** Basic Semiconductor Physics, a Generic Photovoltaic Cell, the Simplest Equivalent Circuit for a Photovoltaic Cell from Cells to Modules to

		Arrays Crystalline Silicon Technologies, Single-Crystal Czochralski (CZ) Silicon, Ribbon Silicon Technologies, Cast Multicrystalline Silicon, Crystalline Silicon Modules, and Thin-Film Photovoltaic. **(10 Hrs)**
Unit – VI	**:**	**Energy Storage Systems** Flywheel energy storage system, superconducting magnetic energy storage system, other energy storage systems, active filters, shunt, series and hybrid filters **(08 Hrs)**
Text Books	**:**	1) The Smart Grid: Enabling Energy Efficiency and Demand Response - Clark W. Gellings, CRC Press. 2) Smart Grid: Technology and Applications - Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Wiley. 3) Smart Grids - Jean Claude Sabonnadière, Nouredine Hadjsaïd, Wiley Blackwell. 4) Smart Power: Climate Changes, the Smart Grid and the Future of Electric Utilities - Peter S. Fox Penner, Island Press; 1 edition 8 Jun 2010. 5) Smart Grids (Power Engineering - Stuart Borlase, CRC Press. 6) Solar Energy - S.P. Sukhatme, Tata McGraw Hill. 7) Renewable Energy Technologies: A Practical Guide for Beginners Chetan Singh Solanki, PHI Publication**.** 8) Renewable and Efficient Electrical Power Systems - Gilbert M. Masters, Wiley - IEEE Press, August 2004. 9) Power Electronic Control in Electrical Systems - E. Acha, Miller & Others, Newness, Oxford publication. 10) Microgrids and Active Distribution Networks - S. Chowdhury, S. P. Chowdhury, P. Crossley, Institution of Engineering and Technology, 30 Jun 2009
Reference Books	**:**	1) The Advanced Smart Grid: Edge Power Driving Sustainability: 1 - Andres Carvallo, John Cooper, Artech House Publishers July 2011. 2) Communication and Networking in Smart Grids - Yang Xiao, CRC Press**.** 3) Fundamentals of Photovoltaic Modules and Their Applications - G. N. Tiwari, Swapnil Dubey , RSC publishing series**.** 4) Solar Electricity Handbook, Michael Boxwell, Greenstream Publishing, 2013

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI.

Pattern of Question Paper:

The Six units in the syllabus shall be divided in two equal parts i.e. 3 units respectively. Question paper shall be set having two sections A and B. Section A questions shall be set on first part and Section B questions on second part. Question paper should cover the entire syllabus.

For 80 marks Paper:

- Minimum ten questions.
- Five questions in each section.
- Question No-1 from section A and Question No-6 from section B be made compulsory and should cover complete syllabus of the respective section and should be set for ten marks each. The Question no.1 and 6 should be of objective nature.
- Two questions of 15 marks each from remaining questions from each section A and B be asked to solve.

COURSE OUTCOMES:

1. Students will be able to introduce about the concept of Smart Grid, Need of Smart Grid, Functions and case study of Smart Grid.
2. Students will be able to introduce about the Smart Grid technologies based on real time pricing, smart appliances, automatic meter reading, outage management system, home and building automation, phase shift transformers.
3. Students will be able to understand the substation automation, feeder automation, information systems and electronics devices and its applications, smart storages and measurement systems.
4. Students will be able to introduce about the concept of microgrid, needs and its applications, solar cells fuel cells, micro- turbines, power plants and renewable energy sources.
5. Students will be able to introduce about the technologies in solar photovoltaic like basic concepts, equivalent circuits, modules to array, silicon technologies.
6. Students will be able to understand the energy storage system and filters.

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(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester – VI

Code No. : EE374 **Lab IX:**

Title: Recent Trends in Power System

Teaching Scheme: 02Hrs/week **Teachers Assessment: 50M**

Credits: 01

Course Objectives	**:**	• To provide students with in-depth understanding of smart grid technology and systems. • To provide students with the principles, devices used to harness solar energy. • To provide students with in-depth understanding of recent technologies in Photo voltaic. • To provide students with in-depth understanding of energy storage systems required in power system.
Term Work	**:**	Term work shall consist of case studies based on following topics: 1. Smart Grid implementation. 2. Grid connected solar photo voltaic**.** 3. Micro-grid implementation**.** 4. Distributed Generation. 5. Energy storage system.
Reference Books	**:**	1) The Smart Grid: Enabling Energy Efficiency and Demand Response - Clark W. Gellings, CRC Press. 2) Smart Grid: Technology and Applications - Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Wiley. 3) Smart Grids - Jean Claude Sabonnadière, Nouredine Hadjsaïd, Wiley Blackwell. 4) Smart Power: Climate Changes, the Smart Grid and the Future of Electric Utilities - Peter S. Fox Penner, Island Press; 1 edition 8 Jun 2010. 5) Smart Grids (Power Engineering - Stuart Borlase, CRC Press. 6) Solar Energy - S.P. Sukhatme, Tata McGraw Hill. 7) Renewable Energy Technologies: A Practical Guide for Beginners Chetan Singh Solanki, PHI Publication**.** 8) Renewable and Efficient Electrical Power Systems - Gilbert M. Masters, Wiley - IEEE Press, August 2004. 9) Power Electronic Control in Electrical Systems - E. Acha, Miller & Others, Newness, Oxford publication.

		10) Microgrids and Active Distribution Networks - S. Chowdhury, S. P. Chowdhury, P. Crossley, Institution of Engineering and Technology, 30 Jun 2009.

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above

The assessment of practical examination shall be on the following criteria:

The practical examination shall consist of performing an experiment based on the practical work done during the course, the record of the experiments submitted by the candidate and viva-voce based on the syllabus.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester - VI

Code No. : EE392 **Title: Electrical System Planning and Design**

Teaching Scheme: 04Hrs/week **Class Test: 20**

Theory : 04 Hrs/week **Theory Examination (Duration): 03 Hrs**

Credits: 04 **Theory Examination (Marks): 80**

Objectives	**:**	• To provide students in-depth study on design of power and control equipments installation and various illumination schemes.
Unit – I	**:**	**Design of Electrical Circuits:** Introduction, simple light and fan circuits, system of connection and accessories, solved examples on light and fan circuits, introduction of simple alarm circuits without and with relays. **(08 Hrs)**
Unit - II	**:**	**Design of Electrical Installation:** Introduction, Design consideration of Electrical installation, Protection devices such as fuse, Earthing and requirements such as Soil Resistivity, Electrode, Types of earthing, Single phase and three phase installation for residential load, Busbar and Busbar chambers, Mounting of CTs and PTs. **(10 Hrs)**
Unit – III	**:**	**Design of Illumination Schemes:** Introduction, Terminology in Illumination, Laws of Illumination, Various types of Light Sources, Practical lighting schemes, solved examples on lighting scheme. **(10 Hrs)**
Unit – IV	**:**	**Substation:** Introduction, Types of substation, Equipment and Accessories, Outdoor substation-pole mounting type and their SLD & estimation, Indoor substation- floor mounting type and their SLD & estimation. **(10 Hrs)**
Unit – V	**:**	**Electrical Installation in Building/Industries:** Electrical installation for commercial buildings, Electrical installation for small industries, PFC and APFC panel installation. **(10 Hrs)**
Unit – VI	**:**	**Motor Control Circuits:** Starting of 3-phase squirrel cage induction motor, Starting of multi speed squirrel cage induction motor, starting of wound rotor motor, starting of synchronous motor, Stopping of motor, Contactor-relay logic control circuit components and wiring. **(12 Hrs)**
Text Books	**:**	1) Electrical Design Estimating And Costing by K.B. Raina, S.K. Bhattacharya, New Age international LTD Publishers. 2) Electrical Wiring - Estimating & Costing By S.L. Uppal, Khanna Publishers. 3) Electrical Installation Estimating & Costing By J.B. Gupta, S.K. Kataria & Sons Publishers. 4) Residential, Commercial and Industrial Electrical Systems by Hemant Joshi, Tata Mcgraw-Hill Publishers.

		5) Performance & Design of A.C. Machines by M.G.Say, CBS Publishers. 6) Performance & Design of D.C. Machines by A. E. Clayton & N. N. Hancock CBS Publishers.
Reference Books	**:**	1) Manual of Auto CAD.

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI.

Pattern of Question Paper:

The Six units in the syllabus shall be divided in two equal parts i.e. 3 units respectively. Question paper shall be set having two sections A and B. Section A questions shall be set on first part and Section B questions on second part. Question paper should cover the entire syllabus.

For 80 marks Paper:

- Minimum ten questions.
- Five questions in each section.
- Question No-1 from section A and Question No-6 from section B be made compulsory and should cover complete syllabus of the respective section and should be set for ten marks each. The Question no.1 and 6 should be of objective nature.
- Two questions of 15 marks each from remaining questions from each section A and B be asked to solve.

COURSE OUTCOMES:

1. Students will be able to introduce about the design of electric circuits like light and fan connection with examples, alarm circuits with and without relays.
2. Students will be able to introduce about the design consideration of electrical installation, protection devices, and types of earthing, busbar chambers.
3. Students will be able to introduce about the terminology in illumination, laws and types of light sources with examples.
4. Students will be able to introduce about the substation equipments and accessories, Indoor and Outdoor substation and its types.
5. Students will be able to understand the electrical installation in building and industries.
6. Students will be able to introduce about the motor control circuits for starting and stopping of different motors.

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(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester – VI

Code No. : EE375 **Lab IX:**

Title: Electrical System Planning and Design

Teaching Scheme: 02Hrs/week **Teachers Assessment: 50M**

Credits: 01

Course Objectives	**:**	• To provide students in-depth study on design of power and control equipments installation and various illumination schemes.
Term Work	**:**	Electrical Drawing using design data or sketches or Computer Aided Electrical Drawing. a) Drawing sheet on problems solved on the topics of each unit. b) Drawing sheet on Single line diagram of generating station and substation. Or 1) Electrical Drawing using design data or sketches or both a) Electrical Drawing on problems from each unit. b) Transformer sectional views of single and three phase core and shell type transformer. c) D.C. Machine- sectional views of yoke, field system, armature and commutator. d) Alternator- sectional views of stator and rotor. 2) Winding Diagrams a) D.C. Machine- Simplex and multiplex double layer lap and wave windings b) A.C. Machine- Single layer windings- Un-bifurcated 2 and 3 tier windings, Mush winding, Integral and fractional slot double layer lap and wave winding.
Reference Books	**:**	1) Electrical Design Estimating And Costing by K.B. Raina, S.K. Bhattacharya, New Age international LTD Publishers. 2) Electrical Wiring - Estimating & Costing By S.L. Uppal, Khanna Publishers. 3) Electrical Installation Estimating & Costing By J.B. Gupta, S.K. Kataria & Sons Publishers. 4) Residential, Commercial and Industrial Electrical Systems by Hemant Joshi, Tata Mcgraw-Hill Publishers. 5) Performance & Design of A.C. Machines by M.G.Say, CBS Publishers. 6) Performance & Design of D.C. Machines by A. E. Clayton & N. N. Hancock CBS Publishers.

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above

The assessment of practical examination shall be on the following criteria:

The practical examination shall consist of performing an experiment based on the practical work done during the course, the record of the experiments submitted by the candidate and viva-voce based on the syllabus.

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(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester - VI

Code No. : EE393	**Title: Illumination Engineering**
Teaching Scheme: 04 Hrs/week	**Class Test: 20**
Theory : 04 Hrs/week	**Theory Examination (Duration): 03 Hrs**
Credits: 04	**Theory Examination (Marks): 80**

Objectives	**:**	• To provide students on fundamentals and importance of Illumination. • The students have to know the detailed study on design and control of Light sources.
Unit – I	**:**	**Fundamentals of Illumination:** Light and Electromagnetic Radiation: Light, Ultraviolet Radiation, Infrared Radiation. Basic Concepts in Optics : Reflection, Refraction (Snell's law), Reflection and the Index of Refraction , Total Internal Reflection (TIR) , Dispersion, Transmission, Absorption, Diffusion (Scattering), Filtering. Basic Radiometric and Photometric Quantities, Spectral Response , Solid Angle, Radiant and Luminous Energy and Energy Density , Radiant and Luminous Flux ,Spectral Luminous Efficacy, Radiant Existence, Irradiance (Radiant Incidence) and illuminance. **(10 Hrs)**
Unit - II	**:**	**Importance of Lighting:** Optical systems of human eye, Dependence of human activities on light, performance characteristics of human visual system, External factors of vision-visual acuity, contrast ,sensitivity, time luminance, color, visual perception, optical radiation hazards, Good and bad effects of lighting and perfect level of illumination, Artificial lighting as substitute to natural light, Ability to control natural light, Production of light, physics of generation of light, Properties of light, Quantification and Measurement of Light. **(10 Hrs)**
Unit – III	**:**	**Light Source:** Lamp materials, Theory of gas Discharge phenomena, lamp design considerations, Low Vapor Pressure discharge lamps - Mercury Vapour lamp, Fluorescent Lamp, Compact Fluorescent Lamp (CFL), High Vapour Pressure discharge lamps, Metal halide Lamps, Solid Sodium Argon Neon lamps, SOX lamps, Electro luminescent lamps, LEDs characteristics, features and applications, LASERS, characteristics, features and applications. **(10 Hrs)**
Unit – IV	**:**	**Photometric Control of Light Sources:** Basic Radiometric and Photometric Measurement : The Inverse Square Law, Lambert's Cosine Law, Lambertian Emission and Reflection, Light Sources, Incandescent Lamps Spectrum and Color, Optical Modeling schemes, Ray Tracing, Sequential Ray Tracing, Non sequential Ray Tracing, Computer Modeling Design Steps ,Construction

		and working principles of Spectro-radiometer, spectrophotometer & colorimeter, Luminaries design considerations, optical control schemes, design procedure of reflecting and refracting type of luminaries. Lighting Fixture types, use of reflectors and refractors, physical protection of lighting fixtures. **(10 Hrs)**
Unit – V	**:**	**Lighting Design:** Indoor Lighting Design, COU (coefficient of utilization), beam angles and polar diagrams, glare calculations, Applications, Indian Standard recommendation for indoor lighting, selection criteria for selection of lamps and luminaries, design consideration and design procedure. (Problems on COU, beam angles and polar diagrams). Outdoor Lighting Design, Road classifications according to BIS, pole arrangement, terminology, lamp and luminaries selection, different design procedures, beam lumen method, point by point method, isolux diagram, problems on point by point method. **(12 Hrs)**
Unit – VI	**:**	**Condition based Lighting:** Energy Efficient Lighting: Comparison between different light sources, comparison between different control gears, overcoming problems in energy efficient lighting, payback calculation, life cycle costing, (problems on payback calculations, life cycle costing) **(08 Hrs)**
Text Books	**:**	1) Book on Lighting - H. S. Mamak, Publisher International lighting Academy. 2) Illumination Engineering from Edison's Lamp to Lasers - Joseph B. Murdoch. 3) Lamps and Lighting - M. A. Cayless, A. M. Marsden. 4) Illumination Fundamentals - Author: Alma E. F. Taylor.
Reference Books	**:**	1) "BIS, IEC Standards for Lamps, Lighting Fixtures and Lighting", Manak Bhavan, New Delhi 2) Lighting", 4th Edition, Longman Scientific and Technical - D. C. Pritchard, ISBN 0-582-23422-0 3) Design of Reflectors – Elmer. 4) "IES Lighting Handbook", (Reference Volume 1984), Illuminating Engineering Society of North America. 5) "IES Lighting Handbook", (Application Volume 1987), Illuminating Engineering Society of North America.

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI.

Pattern of Question Paper:

The Six units in the syllabus shall be divided in two equal parts i.e. 3 units respectively. Question paper shall be set having two sections A and B. Section A questions shall be set on first part and Section B questions on second part. Question paper should cover the entire syllabus.

For 80 marks Paper:

- Minimum ten questions.
- Five questions in each section.
- Question No-1 from section A and Question No-6 from section B be made compulsory and should cover complete syllabus of the respective section and should be set for ten marks each. The Question no.1 and 6 should be of objective nature.
- Two questions of 15 marks each from remaining questions from each section A and B be asked to solve.

COURSE OUTCOMES:

1. Students will be able to introduce about the light and electromagnetic radiations, concepts in Optics.
2. Students will be able to understand the importance of lighting based on dependence of human activities, performance characteristics, and external factors, generation of light, properties, quantification and measurement of light.
3. Students will be able to understand the lamp materials, theory of gas discharge phenomena, low vapor pressure discharge lamps and high vapor pressure discharge lamps, characteristics, features and applications of LED's and LASERS.
4. Students will be able to understand the basic radiometric and photometric measurements based on different law factors, modeling design steps, construction and working principles of Spectro-radiometer, spectrophotometer & colorimeter, light fixture and its types.
5. Students will be able to understand the indoor and outdoor lighting design based on various parameters.
6. Students will be able to understand the energy efficient lighting by comparing between different light sources and different control gears, payback calculation and life cycle costing.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester – VI

Code No. : EE376 **Lab IX:**

Title: Illumination Engineering

Teaching Scheme: 02Hrs/week **Teachers Assessment: 50M**

Credits: 01

Course Objectives	**:**	• To provide students on fundamentals and importance of Illumination. • The students have to know the detailed study on design and control of Light sources.
Term Work	**:**	Minimum 8 experiments should be conducted. 1) Measurement of Light. 2) LED Intensity Measurements. 3) Electrical Control of Light Sources. 4) Planning of Lighting Scheme. 5) To study Airport Lighting. 6) To study the Laws of Illumination and illumination from point. 7) To study Indoor Stadium Lighting. 8) To study Photovoltaic Lighting. 9) Design of Indoor Lighting Scheme. 10) Design of Industrial Lighting Scheme.
Reference Books	**:**	1) Book on Lighting - H. S. Mamak, Publisher International lighting Academy. 2) Illumination Engineering from Edison's Lamp to Lasers - Joseph B. Murdoch. 3) Lamps and Lighting - M. A. Cayless, A. M. Marsden. 4) Illumination Fundamentals - Author: Alma E. F. Taylor.

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above

The assessment of practical examination shall be on the following criteria:

The practical examination shall consist of performing an experiment based on the practical work done during the course, the record of the experiments submitted by the candidate and viva-voce based on the syllabus.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester - VI

Code No. : EE394	**Title: Industrial Automation**
Teaching Scheme: 04 Hrs/week	**Class Test: 20**
Theory : 04 Hrs/week	**Theory Examination (Duration): 03 Hrs**
Credits: 04	**Theory Examination (Marks): 80**

Objectives	**:**	• To provide students on fundamentals Automation. • The students have to know the in-depth study on PLC, SCADA in software along with hardware.
Unit – I	**:**	**Introduction:** Introduction, Definition of Automation, Mechanical (levers, linkages, Gearboxes) /Hydraulic/Pneumatic/Electrical/Electronic/Computerized), Concepts of Hierarchy of Automation: i) Operation Automation [to Automate only one operation], ii) Machine Automation, Machine & Equipment Automation: Sequential Logic Control. iii) Process Automation, Process automation needs: Continuous event based action control. iv) Factory Automation, v) System Automation vi) Industrial Automation System. **(10 Hrs)**
Unit - II	**:**	**Levels of Automation:** Levels of automation: Manually operated/Semi-automatic/Fully Automatic. Techno-commercial requirement & feasibility decides level of automation. i) Discrete process control. ii) Batch process control iii) Continuous process control. Technologies used for Automation a) Traditional control system, its features, merits and de-merits, b) Distributed control system, its features, merits and de-merits, c) System of Supervisory control and data acquisition, its features, merits and de-merits. **(10 Hrs)**
Unit – III	**:**	**Programmable Logic Controllers:** Review of PLC: Ladder diagram, Programming, Communication standard (RS232, RS485), Modbus (ASCII/RTU), Analog PLC operation, PLC interface. Motors Controls: AC Motor starter, AC motor overload protection, DC motor controller, Variable speed (Variable Frequency) AC motor Drive. **(10 Hrs)**
Unit – IV	**:**	**SCADA:** Basic SCADA system Architecture: Human Machine Interface, Master Terminal Unit, Remote Terminal Unit. Alarm Handling and Trending, Access Control, Automation Logging, Archiving, Report Generation. Interfaces to H/W and S/W Types of interfaces**:** i) Command-line interfaces, ii) Graphical user interfaces, iii) Web-based user interfaces. Operational interfaces: i) Batch interface ii) Gesture interfaces iii) Reflexive user interfaces. iv) Tactile interfaces v) Tangible User Interface. vi)Text user interfaces. vii) Touch interface. SCADA

		Communication, standard communication protocols. **(10 Hrs)**
Unit – V	**:**	**SCADA Hardware:** SCADA Hardware: Hardware Architecture, Properties and Functions of Software, Configuration of SCADA system. **SCADA Applications:** Operation and control of interconnected power system, Automatic substation control, Conventional Electric Power Generation, Transmission and Distribution sector operation. **(10 Hrs)**
Unit – VI	**:**	**Distributed Control System:** Introduction and overview, history, system architecture, system elements, communication links, difference between centralized and distributed control system. Displays: group display, overview display, detail display, local control units, mean time between failures, data Highways, field buses, multiplexers and remote sensing terminal units, I/O hardware, study of any one DCS. **(10 Hrs)**
Text Books	**:**	1) "Process Control", Peter Harriot, Tata McGraw-Hill. 2) "Process System analysis and Control", Donald R. Coughnour, McGraw-Hill, 1991. 3) "Process dynamics and control", D E Seborg, T. F. Edger, John Wiley, 1989. 4) "Programmable Logic Devices and logic Controllers", Enrique Mandado, Jorge Marcos and Serafin A Perrez, Prentice-Hall, 1996. 5) "Distributed Computer Control for Industrial Automation", Dobrivoje Popovic, Vijay P Bhatkar, Marcel Dekker INC, 1990. 6) Hughes: Programmable Controllers, ISA Publications, 1989. 7) Stuart A Boyer: SCADA supervisory control and data acquisition. 8) Gordan Clarke, Deon Reynders, Practical Modern SCADA Protocols. 9) M. Lucas: Distributed Control Systems. 10) Understanding Distributed Process Systems for Control, Samuel Herb, ISA.
Reference Books	**:**	1) Instrument Engineer's Handbook, Process Control - B. G. Liptak, Third Edition, Chilton Book company, 1996. 2) Process Control Instrumentation technology - C. D. Johnson, Prentice- Hall of India, 1993. 3) Switchgear and Protections - Sunil S. Rao, Khanna Publication.

Section A: Includes Unit I, II and III; **Section B**: Includes Unit IV, V and VI.

Pattern of Question Paper:

The Six units in the syllabus shall be divided in two equal parts i.e. 3 units respectively. Question paper shall be set having two sections A and B. Section A questions shall be set on first part and Section B questions on second part. Question paper should cover the entire syllabus.

For 80 marks Paper:

- Minimum ten questions.
- Five questions in each section.
- Question No-1 from section A and Question No-6 from section B be made compulsory and should cover complete syllabus of the respective section and should be set for ten marks each. The Question no.1 and 6 should be of objective nature.
- Two questions of 15 marks each from remaining questions from each section A and B be asked to solve.

COURSE OUTCOMES:

1. Students will be able to introduce about the definitions about Automation, concepts of Automation.
2. Students will be able to understand the levels of Automation, techno-commercial requirements and feasibility, technologies used for Automation and its features, merits and de-merits.
3. Students will be able to understand the basics review of PLC using ladder diagrams, programming, interfacing with motors.
4. Students will be able to understand the basic SCADA system architecture, human machine interface, remote terminal unit, alarm handling and trending, access control and interfacing to hardware and software.
5. Students will be able to understand the hardware architecture, properties, configuration of SCADA hardware and its applications.
6. Students will be able to understand the architecture, system elements and communication link of distributed control system, field buses, multiplexers, remote sensing and input-output hardware.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

(Faculty of Engineering & Technology)

Syllabus of T. Y. B. Tech. (Electrical Engineering) Semester – VI

Code No. : EE377 **Lab IX:**

Title: Industrial Automation

Teaching Scheme: 02Hrs/week **Teachers Assessment: 50M**

Credits: 01

Course Objectives	**:**	• To provide students on fundamentals Automation. • The students have to know the in-depth study on PLC, SCADA in software along with hardware.
Term Work	**:**	**Minimum EIGHT experiments out of following:** 1. PLC supply, input, output wiring scheme development & testing. 2. Study of digital inputs, outputs, Analog Inputs, outputs. 3. Pump Control for Overhead Water Tank Level maintenance. 4. Timer function application Study. 5. Counter function application, for a. Standard Digital Input. b. High Speed Inputs (Encoders, digital scales) – Study. 6. Speed Measurement of Motor. 7. Speed Control of Induction Motor from SCADA, PLC through VFD. 8. DOL starter & star delta starter operation by using PLC. 9. Measurement of voltage, current, PF, Power & Energy. 10. Study of Ladder Diagram logic programming. 11. Study of function blocks & their applications in logic programming. 12. Stepper motor control through PLC for motion control (High speed pulse train output) 13. Temperature measurement using analog input. 14. Alarm annunciation using SCADA. 15. Reporting & trending in SCADA system. 16. Case study of Industrial DCS. 17. Interface of DCS with SCADA/PLC using protocol/field bus.
Reference Books	**:**	1) "Process Control", Peter Harriot, Tata McGraw-Hill. 2) "Process System analysis and Control", Donald R. Coughnour, McGraw-Hill, 1991. 3) "Process dynamics and control", D E Seborg, T. F. Edger, John Wiley, 1989. 4) "Programmable Logic Devices and logic Controllers", Enrique Mandado, Jorge Marcos and Serafin A Perrez, Prentice-Hall, 1996. 5) "Distributed Computer Control for Industrial Automation", Dobrivoje Popovic, Vijay P Bhatkar, Marcel Dekker INC, 1990. 6) Hughes: Programmable Controllers, ISA Publications, 1989.

		7) Stuart A Boyer: SCADA supervisory control and data acquisition. 8) Gordan Clarke, Deon Reynders, Practical Modern SCADA Protocols. 9) M. Lucas: Distributed Control Systems. 10) Understanding Distributed Process Systems for Control, Samuel Herb, ISA.

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above

The assessment of practical examination shall be on the following criteria:

The practical examination shall consist of performing an experiment based on the practical work done during the course, the record of the experiments submitted by the candidate and viva-voce based on the syllabus.