ADVANCED POWER ELECTRONICS AND DRIVE

General Course Information:

Course Code: PCC-EE301-T Course Credits: 3.0 Mode: Lecture: (L) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20 marks, class performance measured through percentage of lecture attended (4 marks), assignments, quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus; it will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

Course outcomes:

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Indicate the fundamental of electronics devices and circuit	**L1(Remembering)**
CO2.	Derive the basic operation and compare performance of various power converters circuits	**L2(Understanding)**
CO3.	Demonstrate the power converter circuits design and learn to select suitable power electronic devices by assessing the requirements of application fields.	**L3(Apply)**
CO4.	Compare, formulate and analyze a power electronic circuit design and control drive performance.	**L4(Analysis)**
CO5.	Evaluate the critical areas in application levels and derive typical alternative solutions, select suitable power converters to control Electrical Motors and other industry grade apparatus.	**L5(Evaluating)**
CO6.	Create the model on the applications basis of the controller	**L6(Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

Course Content

UNIT- I

DC to DC converter: Classification of choppers, Principle of operation, output voltage control techniques, one, two, and four quadrant choppers, Step up chopper.

Switching mode Regulators: Buck, Boost, Buck-Boost, Cuk regulators, Current commutated, voltage commutated chopper and Load commutated chopper.

UNIT- II

Electrical Drives: Introduction, Torque Equation, Multi-quadrant Operation of Electrical Drives, Duty Cycles, Selection of Rating of Electrical Motor, Electrical Braking of Machines, Constant Torque and Constant Power Drives, Rotor Energy Loss of Cage Induction Motors: During Acceleration, Stop and Reversal of Speed, Time taken during acceleration

UNIT- III

Converter Fed DC Drives: Single-phase half controlled and fully controlled converter fed dc motor drives, operation of dc drives with continuous armature current, voltage and current waveforms.

Chopper fed DC Drives: Principle of operation and control techniques, chopper circuit configurations used in dc drives: Type A, B, C, D and E; Motoring operation of chopper fed separately excited dc motor, steady state analysis of drive with time-ratio control.

UNIT- IV

DC Drives: Introduction to electric drives: DC drives – converter and chopper fed dc drives.

AC Drives: Concept of Slip Power in Induction Motors, Static Kramer and Sherbius Drives, Static Rheostatic Control of Induction motors, Voltage and Frequency Controlled Induction Motor Drive.

REFERENCES:

1. PS Bhimbra, "Power Electronics", Khanna Publishers, 2015.
2. G.K. Dubey, "Fundamental of electric drive", Narosa Publication.
3. Mohan N., Undeland T. M. and Robbins W. P., "Power Electronics Converters, Applications and Design", 3rd ED, Wiley India.
4. SK Pillai, "A First course on Electrical Drives" Wiley Eastern Ltd.
5. AK Gupta and LP Singh, Power Electronics, Dhanpat Rai Publishing Co.
6. V. Subrahmanyam, "Electric Drives: Concepts and Applications", Tata McGraw Hill Publishing Co. Ltd., 1994.
7. GK Dubey, "Power semiconductor Controlled Drives, "Prentice Hall, Englewood cliffs, New Jersey, 1989.
8. EL Sharkawi & A Mohamad, " Fundamental of Electric Drive", Vikas Publishing House

Course Articulation Matrix:

Course/Course Code: Advanced Power Electronics and Drive (PCC-EE301-T), Semester: V															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	2	1	-	-	-	2	3	3	3	1
CO2	3	3	2	3	2	2	1	-	-	-	2	2	2	2	1
CO3	2	3	3	2	2	2	1	-	-	-	3	2	3	2	1
CO4	3	2	2	2	2	3	1	-	-	-	3	2	2	1	1
CO5	2	2	2	3	2	2	1	-	-	-	1	2	3	2	1
CO6	3	3	3	2	3	2	1	-	-	-	2	2	3	2	1

Correlation level: **1**- slight /Low **2-** Moderate/ Medium **3**- Substantial/High

CONTROL SYSTEMS-I

General Course Information:

Course Code: PCC-EE303-T Course Credits: 4.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 1 0 Examination Duration: 3 hours	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20 marks, class performance measured through percentage of lecture attended (4 marks), assignments, quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus; it will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

Prerequisites:

Course Outcomes

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Memorize the basics of electric circuits and signal flow.	**L1(Remembering)**
CO2.	Describe the performance of different types of control systems and explain the stability by different methods on the basis of their transfer function.	**L2(Understanding)**
CO3.	Solve the problems related with different control system design and can illustrate briefly.	**L3(Apply)**
CO4.	Compare the performance characteristics of different control systems and examine the behavior of system.	**H1(Analysis)**
CO5.	Judge the control strategy on the basis of their performance.	**H2 (Evaluating)**
CO6.	Develop new controller and compensator on the basis of outcomes and requirement of system.	**H3 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Level**

Course Content

UNIT-I
Introduction to Control System

Introduction to Control Systems: Open & Closed loop, Control System classification, Transfer function analysis, concept of poles and zeros, Mathematical modelling of electrical and mechanical systems, hydraulic, pneumatic systems.

Description of Control System Components: Error detectors, gears, gyroscope, DC motors, servomotors, techo-generators, servo amplifiers, synchros; block diagram and reduction techniques, signal flow graphs, mason's gain formulae, performance of feedback Systems.

UNIT-II
Time Response Analysis (Transient, Steady State and Stability Analysis)

Transient Response Analysis: Standard test signals, time response of first order systems, characteristic equation of feedback control systems, transient response of second order systems, time domain specifications, steady state response, steady state errors and error constants, Proportional, Integral, Derivative systems.

Root Locus Analysis: Development of root loci, root motions under close-looping, effects of pole/zero on loci, Case study- Speed Control of DC Motor using PID.

UNIT-III

Frequency Response Analysis

Stability Analysis: Stbility, Routh-Hurwitz stability criterion, relative stability and frequency-domain specifications analysis using Bode plots, Gain margin and phase margin, Nyquist plot (Polar Plot), Use of Nyquist stability criterion for stability analysis, Case study- DC Motor Control.

UNIT-IV

Classical Control Design Techniques

Compensator Design: Feedback compensation –Lead, Lag compensation, Compensator design using Root locus, Compensator design using Bode Plot

Controller Design: Specifications of time-domain and frequency domain and interrelation between them, design of P, PD, PI, PID error control strategies, impact on transient response and steady-state response.

REFERENCES:

1. N.S. Nise, "Control System Engineering*", 7th Edition*, 2015, Wiley Publications.
2. K. Ogata, "Modern control engineering", *5th* Edition, 2010, Prentice Hall.
3. F. Golnaraghi, and B.C Kuo, "Automatic control systems" 9th Edition, 2008, Prentice Hall.
4. I.J. Nagrath and M.Gopal, "Control Systems Engineering", *5th* Edition, 2009, New Age Publishers.
5. D' Azzo and Houpis, "Linear Control Systems Analysis and Design", *5th* Edition, 2003, McGrow Hill.
6. R.C. Dorf, and R.H. Bishop, "Modern Control systems", *12th* Edition, 2011, Addison-Wesley.
7. S. Hasan Saeed, "Automatic Control System", Katson Publications, 2008.
8. B. S. Manke, "Linear Control Systems with MatLab Applications", Khanna Publications.

Course Articulation Matrix:

Course/Course Code: Control Systems-I (PCC-EE303-T)											Semester: V				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	-	-	-	-	-	-	-	1	3	2	-
CO2	3	2	-	2	1	1	-	-	1	-	-	1	3	2	-
CO3	3	3	1	2	2	-	-	-	-	-	-	1	3	2	1
CO4	3	2	2	2	2	-	-	-	-	-	-	1	3	2	-
CO5	3	2	3	2	2	-	-	-	-	-	-	2	3	2	1
CO6	3	1	2	2	3	1	1	1	1	1	1	2	3	2	1

Correlation level: **1**- slight /Low **2-** Moderate/ Medium **3**- Substantial/High

MICROPROCESSORS and MICROCONTROLLERS

General Course Information:

Course Code: **PCC-EE305-T** Course Credits: 3.0 Mode: Lecture (L) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20 marks, class performance measured through percentage of lecture attended (4 marks), assignments, quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus; it will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

Course outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able:	RBT* Level
CO 1	Describe the evolution of processor architectures.	L1
CO 2	Explain the concepts of 8085 and 8086 microprocessor with their programming.	L2
CO 3	Write simple programs in assembly language of 8085 and 8086 microprocessor	L3
CO 4	Appraise Microprocessors and Microcontrollers for different interfacing applications for various application	L5
CO 5	Develop the microprocessor and Microcontroller based Embedded System.	L6

***Revised Bloom's Taxonomy Action verbs/Levels**

Course Content

UNIT- I

Introduction: Introduction to Microprocessor & Microcontrollers Architectures: Harvard vs. Von Neumann, CISC vs. RISC, Brief history of microprocessors and microcontrollers.
8085 microprocessor architecture, Timing and control unit, Machine cycles, Interrupt diagram. Programming, Addressing modes, Iinstruction set, Assembly language programming, program for multibyte addition/subtraction, multiplication, division, block transfer, Interrupts in 8085.

UNIT- II

Microprocessor 8086: Block diagram of 8086, details of sub-blocks such as EU, BIU; memory segmentation and physical address computations, program relocation, addressing modes, instruction formats, pin diagram, Instruction execution timing, assembler instruction format, data transfer instructions, arithmetic instructions, branch instructions, looping instructions, NOP and

HLT instructions, flag manipulation instructions, logical instructions, shift and rotate instructions, directives and operators, programming examples.

UNIT- III

Interfacing Device: Basic principles of interfacing memory and I /O devices, Data transfer techniques

DMA: Introduction to DMA process, 8237 DMA controller, 8255 PPI chip: Architecture, control words, modes and examples, Interrupt and Timer: 8259 Programmable interrupt controller, Programmable interval timer chips, Interfacing of D/A and A/D converter.

UNIT- IV

Microcontroller 8051: Introduction to 8051 Microcontroller: 8051 architecture and pin diagram, Registers, Timers, Counters, Flags, Special Function Registers, Addressing Modes, Data types, instructions and programming, Single–bit operations, Timer and Counter programming, Interrupts programming, Serial communication, Memory accessing and their simple programming applications.

REFERENCES:

1. Microprocessor Architecture, Programming & Applications with 8085: Ramesh S Gaonkar; Wiley Eastern Ltd.
2. The Intel Microprocessors 8086- Pentium processor: Brey, PHI.
3. Microprocessors and interfacing: Hall; TMH
4. The 8088 & 8086 Microprocessors-Programming, interfacing, Hardware& Applications: Triebel& Singh; PHI
5. Microcomputer systems: the 8086/8088 Family: architecture, Programming &Design: Yu-Chang Liu & Glenn A Gibson; PHI.
6. Advanced Microprocessors and Interfacing :Badri Ram; TMH
7. Ayala, K.J., The 8051 Microcontroller Architecture, Programming and applications, Penram International Publishing (India) Pvt. Ltd. (2007).
8. Mazidi, M.A., The 8051 Microcontroller and Embedded System, Pearson Education (2008).

Course Articulation Matrix:

Course/Course Code: Microprocessors and microcontrollers(PCC-EE305-T),														Semester: V	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	1	1	-	-	1	-	1	-	1	1	1	1	1
CO2	2	-	2	1	-	-	1	-	1	-	1	1	-	1	1
CO3	2	-	2	1	-	-	1	-	1	-	1	1	3	2	1
CO4	2	-	2	2	-	-	1	-	1	-	1	1	3	2	1
CO5	2	-	2	2	-	-	1	-	1	-	1	1	3	2	2

Correlation level: **1**- slight /Low **2-** Moderate/ Medium **3**- Substantial/High

ELECTRICAL ENGINEERING MATERIALS

GENERAL Course Information:

Course Code: ESC-EE307-T Course Credits: 3.0 Mode: Lecture (L) Type: Engineering Sciences Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20marks, class performance measured through percentage of lecture attended (4 marks), assignments, quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus; it will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

Course outcomes:

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Recall the knowledge about the electrical materials.	**L1(Remembering)**
CO2.	Compare different type of electrical materials.	**L2(Understanding)**
CO3.	Use different type of conducting material's for power generation.	**L3(Apply)**
CO4.	Compare the different type of electrical components and materials.	**L4(Analysis)**
CO5.	Appraise the use of electrical materials in the field of power generation.	**L5(Evaluating)**
CO6.	Formulate a good materials to remove the limitation related to the power generation	**L6(Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

Course Content

UNIT- I

Dielectrics: Definitions. Multipole development, Electrical dipole, General properties of dielectrics, Fundamental equation of dielectrics, Dielectric sphere, Energy and forces acting on the dielectrics. Polarization mechanisms in dielectrics: induced, orientation, electronic, ionic, and interfacial and lattice polarizations; combined mechanisms, Dielectric losses.

UNIT-II

Magnetic materials Classification of material-dia, para, and Ferro-magnetic materials and applications

Magnetic Properties of materials: Magnetic dipole moment of current loop. Magnetization from a macroscopic viewpoint. Orbital magnetic dipole moment and angular momentum of two simple atomic models. Lenz's law and induced dipole moments. Classification of magnetic materials.

UNIT-III

Conducting materials:

Types of Conducting Materials, Low Resistivity Materials, and High Resistivity Materials Contact Materials, Fusible (or Fuse) Materials, Filament Materials, Carbon as Filamentary and Brush Material.

Conductors, Cables, and Wires: Types and Materials, Solder Materials for Joining Wires and Joints in Power Apparatuses, Sheathing Materials, Sealing Materials

UNIT-IV

Insulating materials: Gaseous materials-Oxide gases, electronegative gases, hydrocarbon gases; Liquid materials-mineral oils, silicon liquids, hydrocarbon liquids; Solid materials-Paper and boards, Resins (Polymers), Rubbers-natural and synthetic, glass, ceramics, asbestos.

REFERENCES:

1. S.P. Seth, P.V. Gupta, "A course in Electrical Engineering Materials", Dhanpat Rai & Sons
2. A.J. Dekker, "Electrical Engineering Materials", PHI.
3. Ian P. Jones, "Materials Science for Electrical & Electronics Engineers", Oxford
4. L. Solymar& D. Walsh, "Electrical Properties of Materials", Oxford
5. J.K. Shackelford & M.K. Muralidhara, Introduction to material science for engineers, Pearson Education
6. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.
7. Adrianus J. Dekker, "Electrical Engineering Materials", PHI Publication, 2006.
8. K.M.Gupta&Nishu Gupta, "Advanced Electrical and Electronics Materials" Online ISBN:9781118998564

Course/Course Code: Electrical Engineering Materials(PEC-EE312-T),Semester: VI															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	1	2	1	1	-	2	2	3	2	1
CO2	2	2	2	1	2	3	1	-	-	-	1	1	3	2	-
CO3	3	3	2	2	1	2	1	1	-	1	1	2	3	3	1
CO4	2	2	2	3	1	2	2	-	-	-	1	2	2	2	1
CO5	1	2	3	2	2	1	2	-	-	-	2	2	3	3	1
CO6	2	2	2	3	2	3	2	-	-	-	2	1	2	1	-

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Course Articulation Matrix:

Correlation level: **1**- slight /Low **2**-Moderate/ Medium **3**-Substantial/High

ADVANCED POWER ELECTRONICS AND DRIVES LABORATORY

General Course Information:

Course Code: PCC-EE301-P Course Credits: 1 Mode: Practical Type: Program Core Contact Hours: 2 hours per week. Examination Duration: 03 hours.	**Course Assessment Methods (Internal: 30; External: 70)** Internal continuous assessment of 30 marks on the basis of class performance and attendance in practical classes. For the end semester practical examination the assessment will be done out of 70 marks by the external and internal examiners.

Course Outcomes

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Memorize the basics of AC & DC electric machines with electromechanical energy conversion principle.	**L1(Remembering)**
CO2.	Describe different combinational electronic and power electronic circuits with the design of electric machines & drive.	**L2(Understanding)**
CO3.	Demonstrate and interpret the working of electric machines at different combinational electronic and power electronic circuits.	**L3(Apply)**
CO4.	Examine the various performance characteristics of special electric machines and drives.	**H1(Analysis)**
CO5.	Select the electrical machines with ratings on the basis of their utilization and performance.	**H2 (Evaluating)**
CO6.	Design machine models with different combinational electronic and power electronic circuits for various engineering problems	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Level**

List of Experiments

1. To perform electrical breaking of DC shunt motor. Discuss the results of various types of electrical breaking.
2. To study the Variable frequency control of three phase induction motor. Plot variation of speed and input power with frequency for constant voltage and constant (voltage/frequency) modes.
3. To study the effect of injected EMF in electrical machines. Plot the variation of speed with injected EMF in case of Schrage motor and discuss the results.
4. Study of A.C single phase motor speed control using Triac
5. To study the Inrush current simulation for squirrel cage induction motor using MATLAB.
6. Study of Thyristor controlled D.C Drive
7. To study the performance of chopper fed DC motor drive.
8. To perform electrical breaking of three phase induction motor.
9. To perform the unbalanced supply operation of three phase induction motor using MATLAB.
10. To study the rotor resistance control of three-phase slip-ring induction motor.
11. PWM inverter fed three phase induction motor control using PSPICE/MATLAB/PSIM software
12. VSI/CSI fed induction motor drive analysis using MATLAB/PSPICE/PSIM software
13. To plot load characteristics of DC series motor.
14. Study of permanent magnet synchronous motor drive fed by PWM inverter using software.
15. Regenerative/ Dynamic breaking operation for AC motor study using software.
16. PC/PLC based AC/DC motor control operation.

NOTE: At least eight experiments are to be performed in the semester, out of which at-least six experiments should be performed from above list. Remaining experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

CONTROL SYSTEMS-I LABORATORY

General Course Information:

Course Code: PCC-EE303-P Course Credits: 1 Mode: Practical Type: Program Core Contact Hours: 2 hours per week. Examination Duration: 03 hours.	**Course Assessment Methods (Internal: 30; External: 70)** Internal continuous assessment of 30 marks on the basis of class performance and attendance in practical classes. For the end semester practical examination the assessment will be done out of 70 marks by the external and internal examiners.

Prerequisites:

Course Outcomes

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Memorize the basics of electric circuits and signal flow.	**L1(Remembering)**
CO2.	Discuss the operation of different control system models with their transfer function.	**L2(Understanding)**
CO3.	Demonstrate and interpret the working of control system models with their transfer function.	**L3(Apply)**
CO4.	Examine the behaviors and performance characteristics of control system model at different parameters physically as well as with the help of software.	**H1(Analysis)**
CO5.	Select the control system model on the basis of their function, utilization and performance.	**H2 (Evaluating)**
CO6.	Design models for various engineering problems to achieve the efficiency of system	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Level**

List of Experiments

1. Study of Step Response and Feed Back Properties for first and second order system.
2. Error Detector Characteristics and Control Applications of the following. (i) LVDT, (ii) Potentiometer
3. Performance Analysis of Thermal System and Design using PID/Relay Control.
4. To study the characteristics (using DIGIAC 1750) of (i) Voltage to Current Converter, (ii) Current to Voltage Converter, (iii) Voltage to Frequency Converter, (iv) Frequency to Voltage Converter.
5. To obtain the Frequency Response Characteristics and Design of Compensator for a given system.
6. To obtain the Transfer Function and Control Characteristics of Servo Motor of DC/AC.
7. To obtain the Operational Characteristics for the Control Application of the following devices. (i) Stepper Motor, (ii) Temperature Detectors (Thermister, Thermo couple etc.)
8. Simulation of control systems using MATLAB.
9. To obtain the Position Control performance of DC Servo Motor.
10. Comparision of different Control Action (P/I/D/Relay) on Industrial Process (Phneumatic/Simulated System.

NOTE: At least eight experiments are to be performed in the semester, out of which at-least six experiments should be performed from above list. Remaining experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

MICROPROCESSORS AND MICROCONTROLLERS LABORATORY

General Course Information:

Course Code: **PCC-EE305-P** Course Credits: 1 Mode: Practical Type: Program Core Contact Hours: 2 hours per week. Examination Duration: 03 hours.	**Course Assessment Methods (Internal: 30; External: 70)** Internal continuous assessment of 30 marks on the basis of class performance and attendance in practical classes. For the end semester practical examination the assessment will be done out of 70 marks by the external and internal examiners.

Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able:	RBT* Level
CO 1	Explain the concepts of 8085 and 8086 microprocessor with their programming.	L2
CO 2	Write simple programs in assembly language of 8085 and 8086 microprocessor	L3
CO 3	Appraise Microprocessors and Microcontrollers for different interfacing applications for various application	L5
CO 4	Develop the microprocessor and Microcontroller based Embedded System.	L6

LIST OF EXPERIMENTS:

1. Write and implement on 8085 kit, the program of multiplication of two 8 bit numbers.
   (a) Using bit wise multiplication method.
   (b) Using repetitive addition method.
2. To interface stepper motor and run clock wise and anti-clock wise at various speeds using 8085 μ P.
3. To generate square wave, saw tooth wave, triangular wave of 1 KHz frequency and 50% duty cycle using 8085 μ P kit.
4. Write and implement 8085 μ P Programm for
   (a)Factorial of a given number
   (b) Finding no. I's in a given data stored in 2050H.
5. To interface induction motor with 8085 μ P kit for speed control.
6. To generate a square wave of 1 kHz frequency using
   (a) 8085-8253 interface
   (b) Timer of 8051
7. To study up/down 4- digit counter in decimal mode.
8. To display your name on the LCD display of kit and operate the buzzer on/off at various duty cycle using 8051 microcontroller.
9. To operate stepper motor in clockwise and anti- clockwise direction at various speeds using 8051 microcontroller.
10. To interface an A/D converter with 8085 microprocessor and store ten conversions in memory.

NOTE: At least eight experiments are to be performed in the semester, out of which at-least six experiments should be performed from above list. Remaining experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus

PRACTICAL TRAINING-I

Course Code: **INT-EE309-P** Course Credits : 1 Type: Program Core Mode: Practical Contact Hours: 2/week	**Course Assessment Method: (Internal:100)** Assessment of Practical Training-I will be based on presentation/seminar, viva-voce, report and certificate for the practical training taken at the end of 4th semester.

Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to:	RBT Level
CO 1	Outline technical documents and give oral presentations related to the work completed.	L1
CO 2	Prepared to engage in independent and lifelong learning in the industry.	L2
CO 3	Acquire and apply fundamental principles of engineering for working in an actual working environment.	L3
CO 4	Analyze practical application of the subjects taught during the program.	L4
CO 5	Develop, social, cultural, global and environmental responsibilities as an engineer.	L5
CO6	Design and implement solution methodologies with technical & managerial skills for solving engineering problems.	L6

Course Articulation Matrix:

Course/Course Code: Practical Training-I (INT-EE309-P),														Semester: V
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	2	3	1	2	2	2	3	3	3	2	2
CO2	3	3	2	2	2	3	2	-	3	3	3	3	3	3	3
CO3	3	3	2	2	3	3	2	-	2	2	3	3	3	2	2
CO4	3	3	3	3	3	3	1	2	3	2	3	3	3	3	3
CO5	3	3	3	3	3	3	1	2	2	2	3	3	3	2	3
CO6	3	3	3	3	2	3	2	2	2	3	3	3	3	2	2

Correlation level: **1**- slight /Low **2-** Moderate/ Medium **3-** Substantial/High

POWER SYSTEMS - II

General Course Information:

Course Code: **PCC-EE302-T** Course Credits: 4.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 1 0 Examination Duration: 3 hours	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20 marks, class performance measured through percentage of lecture attended (4 marks), assignments, quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus; it will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

Course outcomes:

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	List and describe the construction, principle and working of different types of switchgear equipments along with protective schemes.	**L1(Remembering)**
CO2.	Classify the circuit breakers, relays and protective schemes based on construction, principle of operation and requirement.	**L2(Understanding)**
CO3.	Deploy an appropriate switchgear and protective scheme for various components of power systems to protect against different types of faults.	**L3(Applying)**
CO4.	Analyze the causes and counter measures of over-voltages in power systems.	**L4(Analyzing)**
CO5.	Appraise the power systems with neutral grounding and various grounding Schemes.	**L5(Evaluating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

Course Content

UNIT- I

Circuit breakers: Theory of arc formation and its extinction (AC and DC), Re-striking and recovery voltages, Current chopping, Capacitance and resistance switching, Types of circuit breakers: Air blast, Air break, Oil, Vacuum and SF6, comparative merits and demerits, HVDC circuit breaker system, Testing of Circuit breakers, Rating and selection of Circuit breakers

UNIT- II

Protective Relays: Requirement of Protective Relaying, Zones of protection, primary and backup protection, Essential qualities of Protective Relaying, Classification of Protective Relays:

Electromechanical - Electromagnetic, Attraction and induction type relays, Thermal relay, Gas actuated relay, Static and Numerical relays, Microprocessor based relays

Protective Schemes: Over current relaying: Instantaneous, time delayed, definite time, inverse time, IDMT relays and relay coordination, Differential relays: circulating current and voltage balance differential relays, Biased percentage differential relays, Directional over current and directional power relays, Distance relays

UNIT- III

Power Apparatus and lines Protection:
Generator protection: faults in Generators, stator and rotor protection, Motor Protection: Protection against overload, unbalance, single phasing, under voltage and reverse phase, Loss of synchronism
Transformer protection: Faults in transformers, differential, over current and earth fault protection, Bucholz relay, Harmonic restraint relay, over flux protection
Protection of feeders: Differential pilot protection, Merz price protection, Translay system
Protection of Lines: Over Current, Carrier Current and Three-zone distance relay protection using impedance relays

. UNIT- IV

Over voltages in power systems: Power frequency over voltages-Switching over voltages, causes of over voltages, Protection against over voltages, surge arrestors, Wave propagation in transmission lines and cables, transmitted and reflected waves, Surge impedance

Neutral Grounding: Grounded and Ungrounded neutral Systems, Effects of Ungrounded neutral on system performance, Methods of Neutral Grounding: Solid, Resistance, Reactance, Arcing Grounds and Grounding practices

REFERENCES:

1. C. L. Wadhwa, "Electrical Power Sytems", New Age Internationals, 7th edition, 2016.
2. A. Chakrabarty, P. V. Gupta, M. L. Soni and U. S. Bhatnagar , "A Course in Electrical Power" Dhanpat Rai Pub. Co.(P) Ltd., 2008.
3. R. Gupta, "Power System Analysis and Design", S. Chand, 7th edition, 2014.
4. S. S. Rao, 'Switchgear and Protection', Khanna Publishers, New Delhi, 2008.
5. Rabindranath and N. Chander, 'Power System Protection and Switchgear', New Age International (P) Ltd., First Edition 2011.
6. B. Ram, and B.H. Vishwakarma, 'Power System Protection and Switchgear', New Age International Pvt Ltd Publishers, Second Edition 2011.
7. Y.G.Paithankar and S.R.Bhide, 'Fundamentals of power system protection', Second Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
8. R. P.Singh, "Switchgear and Power System Protection", PHI Learning Private Ltd., New Delhi, 2009.
9. S. K. Gupta, "Power System Engineering", Umesh Publications, 2009.

Course Articulation Matrix:

Course/Course Code: Power Systems- II (PCC-EE302-T),															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	-	2	1	-	1	-	1	2	3	2	2
CO2	3	2	2	1	-	2	1	-	1	-	1	2	3	1	1
CO3	3	2	2	2	-	2	1	-	1	-	1	1	3	2	2
CO4	3	3	2	2	-	2	1	-	1	-	1	1	3	2	2
CO5	3	3	2	2	-	2	1	-	1	-	2	1	3	2	2

Correlation level: **1**- slight /Low **2-** Moderate/ Medium **3-** Substantial/High

ELECTRICAL MEASUREMENTS AND INSTRUMENTATION

General Course Information:

Course Code: PCC-EE304-T Course Credits: 4.0 Mode: Lecture (L)+Tutorials(T) Type: Program Core Teaching Schedule L T P: 3 1 0 Examination Duration: 3 hours	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20 marks, class performance measured through percentage of lecture attended (4 marks), assignments, quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus; it will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

Course outcomes:

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Exhibit memory of previously learned material by recalling facts, terms, basic concepts and answers.	**L1(Remembering)**
CO2.	Recognize the basic measuring instruments in the field of engineering	**L2(Understanding)**
CO3.	Choose the proper type of meter and measuring instruments for different industrial.	**L3(Apply)**
CO4.	Compare performance of MC, MI and Dynamometer types of measuring instruments, Energy meters and CRO	**L4(Analysis)**
CO5.	student will be able to select techniques, skills, and modern engineering tools necessary for electrical engineering practice	**L5(Evaluating)**
CO6.	Design an electrical and electronic project using new sensing and measuring schemes.	**L6(Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

Course Content

UNIT- I

Measurements: Method of measurement, Measurement system, Classification of instruments, Definition of accuracy, Precision, Resolution, Speed of response, Error in measurement, Classification of errors, loading effect due to shunt and series connected instruments.

Analog meters: General features, Construction, Principle of operation and torque equation of Moving coil, Moving iron, Electrodynamometer, Induction instruments. Principle of operation of the Electrostatic, Thermoelectric, Rectifier type instruments, Extension of instrument ranges and multipliers.

UNIT-II

Instrument transformer: Disadvantage of shunt and multipliers, Advantage of Instrument transformers, Principle of operation of current & potential transformer, errors.

Measurement of Power: Principle of operation of Electrodynamic & Induction type wattmeter. Wattmeter errors.

Measurement of resistance: Measurement of medium, low and high resistances, Megger.

UNIT-III

Measurement of Energy: Construction, theory and application of AC energy meter, testing of energy meters.

Potentiometer: Principle of operation and application of Crompton's DC potentiometer, Polar and Co-ordinate type AC potentiometer and application.

AC Bridges: Measurement of Inductance, Capacitance and frequency by AC bridges.

UNIT-IV

Cathode ray oscilloscope (CRO): Measurement of voltage, current, frequency & phase by oscilloscope. Frequency limitation of CRO. Sampling and storage oscilloscope, Double beam CRO.

Electronic Instruments: Advantages of digital meter over analog meters, Digital voltmeter, Resolution and sensitivity of digital meters, Digital multimeter, Digital frequency meter, Signal generator.

Sensors & Transducers: Introduction to sensors & Transducers, Strain gauge, LVDT, Temperature transducers, Flow measurement using magnetic flow measurement.

REFERENCES:

1. AK Sawhney, "Electrical and Electronic Measurements & Instrumentation", Dhanpat Rai, Delhi.
2. C.T. Baldwin, "Fundamentals of Electrical Measurement", Lyall Book Depot.
3. E.W. Golding, "Electrical Measurement", Reem Publications.
4. W.D. Cooper "Electronics Instrumentation and Measurement Techniques", Prentice Hall India.
5. B.C. Nakra and K.K. Chaudhry "Instrumentation Measurement and Analysis", Tata McGraw Hill Publishing Company Limited, New Delhi.
6. H.K.P. Neubert, "Instrument transducers", Oxford University press.
7. A.D. Heltric & W.C. Copper, "Modern Electronic instrumentation & Measuring instruments", Wheeler Publication.
8. H.S. Kalsi, "Electronic Instruments", Tata McGraw hill, 2nd Edition.

Course Articulation Matrix:

Course/Course Code: Electrical Measurements and Instrumentation(PCC-EE304-T)														Semester: VI	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	2	2	-	-	-	1	2	3	3	1
CO2	3	3	3	2	2	1	1	-	-	-	2	1	3	3	1
CO3	3	3	3	3	3	2	1	-	-	-	3	2	2	3	2
CO4	3	2	2	2	3	1	1	-	-	-	2	2	3	2	1
CO5	3	2	2	2	2	3	2	-	-	-	3	3	2	2	1
CO6	3	3	2	1	2	2	1	-	-	-	2	3	2	1	1

Correlation level: **1**- slight /Low **2**- Moderate/ Medium **3**- Substantial/High

CONTROL SYSTEMS-II

General Course Information:

Course Code: PCC-EE306-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20 marks, class performance measured through percentage of lecture attended (4 marks), assignments, quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus; it will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

Prerequisites: PCC-EE303-T

Course Outcomes

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Describe the state of system and recall the z-transform along with stability theory.	**L1(Remembering)**
CO2.	Illustrate the performance of different control system models and controllers on the basis of their transfer function model.	**L2(Understanding)**
CO3.	Solve the problems related with linear and non linear systems and give some examples.	**L3(Apply)**
CO4.	Compare the performance characteristics of different control systems and examine the behavior of system.	**H1(Analysis)**
CO5.	Judge the control strategy on the basis of their performance and requirement.	**H2 (Evaluating)**
CO6.	Design controller and compensator with optimum set of equations on the basis of outcomes and requirement of system.	**H3 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Level**

Course Content

UNIT-I
State Variable Approach

State space equations in canonical forms, modelling of electrical and mechanical systems in state space form, solution of time invariant/variant continuous/ discrete time system state equations, state transition matrix, state transformation, Eigen values and Eigen vectors, controllability and observability, State space representation of transfer function systems

UNIT-II
Discrete Data Systems

Introduction to digital control: The digital control problem and solution possibilities, Signal processing in digital control, principles of signal conversion, sampling and reconstruction, principles of discretization, impulse and step invariance, finite difference approximation, bilinear transformation.

Mathematical models of discrete-time systems: Transfer function and system response, stability in the z-plane and the Jury stability criterion, sampling and data reconstruction process, z-domain description of closed loop systems, systems with dead-time.

UNIT-III
Digital Control Design

Digital control design: Implementation of digital controllers, digital controllers for deadbeat performance, root locus methods and frequency domain methods, effect of nonlinearity in root locus and Nyquist plot.

UNIT-IV
Non Linear Systems

Introduction to nonlinear systems: Characteristics of nonlinear systems,inherent and intentional nonlinearities, qualitative behaviour of linear Vs nonlinear systems, multiple equilibrium points, limit cycle, bifurcation, jump response, chaos,

Stability analysis of nonlinear systems: Describing function of common nonlinear functions and stability analysis, phase plane analysis, construction of phase portraits, singular points, concept of stability in the sense of Lyapunov, asymptotic stability, local and global stability, construction of Lyapunov function using Krasovskii and variable gradient method.

REFERENCES:

1. Raymond T. Stephani, "Design of Feedback Control Systems", 4th Edition, 2002, Oxford University Press.
2. Donald M. Wiberg, "State Space and Linear Systems", 1st Edition, 1971, Schuam's Outline Series,
3. Katsuhiko Ogata, "Discrete-Time Control Systems", 2nd Edition, 2015, Prentice-Hall.
4. M. Gopal, "Digital Control and State Variable Methods", 4th Edition, 2012, Tata McGrow Hill.
5. B. C. Kuo, "Digital Control System", 2nd Edition, 2006, Oxford University Press.
6. J. J. E. Slotine and W. Li, "Applied Nonlinear Control", 1st Edition, 1991, Prentice Hall.
7. Hassan. K. Khalil, "Nonlinear Systems", 3rd Edition 2002, Prentice-Hall.

Course Articulation Matrix:

Course/Course Code: Control Systems-II (PCC-EE306-T)												Semester: VI			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	-	-	-	-	-	-	-	1	3	3	-
CO2	3	2	-	2	1	1	-	-	1	-	-	1	3	2	-
CO3	3	3	1	2	2	-	-	-	-	-	-	1	3	2	1
CO4	3	2	2	2	2	-	-	-	-	-	-	1	3	2	-
CO5	3	2	3	2	2	-	-	-	-	-	-	2	3	2	1
CO6	3	1	2	2	3	1	1	1	1	1	1	2	3	2	1

Correlation level: **1**- slight /Low **2-** Moderate/ Medium **3**- Substantial/High

POWER SYSTEMS - II LABORATORY

General Course Information:

Course Code: **PCC-EE302-P** Course Credits: 1 Mode: Practical Type: Program Core Contact Hours: 2 hours per week. Examination Duration: 03 hours.	**Course Assessment Methods (Internal: 30; External: 70)** Internal continuous assessment of 30 marks on the basis of class performance and attendance in practical classes. For the end semester practical examination the assessment will be done out of 70 marks by the external and internal examiners.

Course Outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT Level
CO1.	Explain the need and operation of various protective devices.	**L2 (Understanding)**
CO2.	Identify the possible faults and select appropriate protective scheme for various components of power systems.	**L3 (Apply)**
CO3.	Plot and analyze the operating characteristics of various types of relays.	**L4 (Analyzing)**
CO4.	Design the suitable protection scheme for different power system equipment.	**L6 (Creating)**

LIST OF EXPERIMENTS:

1. To Study construction and working of SF_6 and Vacuum circuit breakers.
2. To study and determine the time -current characteristics IDMT over-current relay (single phase).
3. To study and determine the operating characteristics of a percentage biased differential relay.
4. To study the protection of transformer with percentage biased differential relay.
5. To study the construction and working of Buchholz relay.
6. To study microcontroller based over/under voltage relay.
7. To study operation of various Numerical relays and interfacing.
8. To realize the various Time-current characteristics of combined numerical over-current and earth fault relay.
9. To study on distance protection scheme with a digital relay.
10. Realization and operation of parallel feeder protection.
11. To study the complete protection of alternator unit.

NOTE: At least eight experiments are to be performed in the semester, out of which at-least six experiments should be performed from above list. Remaining experiments may either be performed from the above list or designed & set by the concerned institution as per scope of the syllabus

ELECTRICAL MEASUREMENTS AND INSTRUMENTATION LABORATORY

General Course Information:

Course Code: **PCC-EE304-P** Course Credits: 1 Mode: Practical Type: Program Core Contact Hours: 2 hours per week. Examination Duration: 03 hours.	**Course Assessment Methods (Internal: 30; External: 70)** Internal continuous assessment of 30 marks on the basis of class performance and attendance in practical classes. For the end semester practical examination the assessment will be done out of 70 marks by the external and internal examiners.

Course Outcomes:

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Memorize the knowledge and skills to provide solutions to Electrical and Electronics Engineering problems in industry and governmental organizations or to enhance in educational institutions.	**L1 (Remembering)**
CO2.	Students will be able to Discuss the different type of instruments use for measurements in real life.	**L2 (Understanding)**
CO3.	Demonstrate the working of analog and digital meters.	**L3 (Apply)**
CO4.	Perform an experimental set using different type of meter.	**L4 (Analyzing)**
CO5.	Select a proper type meter for absolute measurement.	**L5(Evaluating)**
CO6.	Design a model using different type of measuring instruments in various engineering applications.	**L6 (Creating)**

LIST OF EXPERIMENTS:

1. To measure the displacement using LVDT.
2. To calibrate an energy meter with the help of a standard wattmeter & a stop watch.
3. To measure the capacitance by De Sauty's bridge and unknown capacitance sharing bridge method.
4. To measure the frequency by using Wien's bridge.
5. To measure the power with the help of C.T & P.T.
6. To measure magnitude & phase angle of a voltage by rectangular type potentiometer.
7. To measure high resistance by loss of charge method.
   To measure the unknown inductance by using Hay's and Maxwell bridge method
8. To measure the low resistance by using Kelvin Double method , medium resistance by using whetstone bridge and high resistance by using loss of charge method
9. To calibrate PMMC ammeter and PMMC voltmeter.
10. To test Dielectric oil using H.T. testing Kit.
11. To test C.T. using mutual Inductor Measurement of % ratio error and phase angle of given CT by Null method.
12. To measurement of % ratio error and phase angle error of the given PT
13. To study Digital Instruments – Digital Voltmeter, Digital Frequency Meter, Digital Panel Meter, Digital Storage Oscilloscope

NOTE: At least eight experiments are to be performed in the semester, out of which at-least sixexperiments should be performed from above list. Remaining experiments may either beperformed from the above list or designed & set by the concerned institution as per the scope of the syllabus

CONTROL SYSTEMS-II LABORATORY

General Course Information:

Course Code: PCC-EE306-P Course Credits: 1 Mode: Practical Type: Program Core Contact Hours: 2 hours per week. Examination Duration: 03 hours.	**Course Assessment Methods (Internal: 30; External: 70)** Internal continuous assessment of 30 marks on the basis of class performance and attendance in practical classes. For the end semester practical examination the assessment will be done out of 70 marks by the external and internal examiners.

Course Outcomes

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Memorize the basics of electric circuits and their utilization in process control.	**L1(Remembering)**
CO2.	Discuss the operation of different control system models with their transfer function in industrial process control.	**L2(Understanding)**
CO3.	Demonstrate and interpret the working of embedded system and electronically adjustable control models.	**L3(Apply)**
CO4.	Examine the behaviors and performance characteristics of industrial process control model at different parameters physically as well as with the help of software.	**H1(Analysis)**
CO5.	Select the control system model on the basis of their function, utilization and performance.	**H2 (Evaluating)**
CO6.	Design models for various engineering problems to achieve the efficiency of system	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Level**

List of Experiments

1. Study of PID control for industrial processes.
2. Study of PID control for position Control of DC motor.
3. Study of Relay characteristics.
4. Study of heating process and its control.
5. Study of Micro controller kit with interfacing.
6. Study of micro controller kit with ADC interfacing.
7. Study of Micro controller kit with stepper motor.
8. Study of control device (M/E,L/E,strain/E,humidity/E, Relay, Solenoid, Signal Conditioners)
9. Study of Control of Inverted Pendulum using LAB VIEW.

NOTE: At least eight experiments are to be performed in the semester, out of which at-least six experiments should be performed from above list. Remaining experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.